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20 January 2014 (Revised 20 April 2014)

Latvia

Innovation System Review and Research Assessment Exercise: Final Report

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1. Introduction

This paper has been prepared as a component of a larger assessment of research in the Republic of Latvia for the Ministry of Education and Science (MoES), which will be complete early in 2014. It is intended to follow up a Policy Mix peer review[1], undertaken under the responsibility of the former CREST (now ERAB) committee of the European Union in 2010. It is based on document reviews and interviews with some key stakeholders in Latvia and on the results of a major research assessment exercise, which used panels of international peer reviewers informed by bibliometric analysis and self-assessment reports prepared by the research groups assessed to judge the quality and other characteristics of research in Latvian research and higher education institutions.

2. Conceptual framework

There are large differences between different national contexts, so it would be foolish to offer a unique example as 'best practice'. What works in one place may not work in another. Nonetheless, there are some ideas that have emerged from the last 40-50 years of research into research and innovation that seem to have wide application[2]. These form the conceptual background to the review so it seems useful briefly to state them here.

The most important is probably the idea of a national innovation system – which we prefer to refer to as a National System of Research and Innovation (NRIS). We define this as a system of interconnected organisations or core actors **and** wider framework conditions within which societies create, store and transfer the knowledge, skills and artefacts that contribute to innovation (Figure 1). From this perspective, the innovative performance of an economy depends not only on how the individual organisations perform in isolation, but also on how they interact with each other and on their interplay with social institutions (such as values, norms and legal frameworks[3]. This is now very much the mainstream perspective in the field of research and innovation policy.

The current perspective on innovation and research is that these are vital components of socio-economic performance within complex national, international and regional systems. Individual components of these systems – such as companies, universities, institutions, institutes, governance, education, tax laws and other 'framework conditions' and so on – all need to work well if the system as a whole is to generate economic welfare. Not only the components of the system but the way they are interconnected need to be efficient and of high quality. Correspondingly, the balance among different system components and the policies that relate to them needs to be appropriate and the policies need to be mutually consistent.

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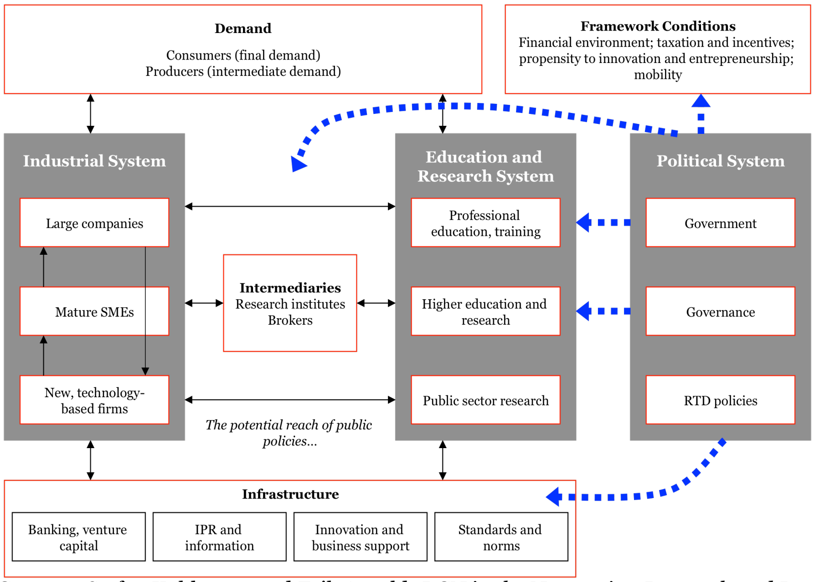
[1] Geir Arnulf, Carl Jacobson, Jari Romanainen, Keith Smith and Giedrius Viliunas with Erik Arnold, Policy Mix Peer Review: Latvia Peer Review Outcome Report, April 2010

[2] This section draws heavily on previous studies of innovation systems, notably Erik Arnold and Bea Mahieu, *International Audit of Research, Development and Innovation in the Czech Republic: Synthesis Report*, Brighton: Prague: Ministry of Education, Youth and Sport, 2011

[3] Keith Smith and Jonathan West, *Australia's Innovation Challenges: The Key Policy Issues*, submission to the House of representatives Standing Committee on Science and Innovation, Inquiry into Pathways to Technological Innovation, Hobart: University of Tasmania, April 28, 2005

Figure 1 A National Innovation System Heuristic



Source: Stefan Kuhlmann and Erik Arnold, *RCN in the Norwegian Research and Innovation System*, Background Report No 12 in the Evaluation of the Research Council of Norway, Oslo: Royal Norwegian Ministry for Education, Research and Church Affairs, 2001

Traditionally, the state is regarded as intervening in research because there is a 'market failure'[4] in capitalism that means the private sector under-invests in fundamental research because it cannot readily monopolise the results. Rather, these results tend to 'spill over' to the rest of society. So research can be a bad investment for individual companies but a good one for the state, because society gets the spillovers. It is efficient for companies to do R&D on things that are 'closer to market' where they can appropriate more of the benefits. The innovation systems perspective stresses that, because the NRIS comprises fallible organisations with imperfect knowledge but the ability to learn, there are various kinds of 'systems failures' such as lock-in and failures in institutions or framework conditions that also justify intervention. The need for modernisation of university organisation and governance would be an example of such a failure.

Because systems failures and performance are highly dependent upon the interplay of characteristics in individual systems, there can be no simple rule-based policy as is possible in relation to the static idea of market failure.[5] Rather, a key role for state policy making is 'bottleneck analysis' – continuously identifying and rectifying structural imperfections.[6]

While it would be foolhardy to try to state a set of iron rules for managing an NRIS, a number of principles do emerge from this discussion that help provide criteria for reviewing the Latvian system

- Since innovation, applied and basic research are interdependent, all three need to be healthy and interlinkages among them and the institutions that perform and fund them must be strong

[4] Ken Arrow , 'Economic Welfare and the Allocation of Resources for Invention,' in Richard Nelson (Ed.) *The Rate and Direction of Inventive Activity*, Princeton University Press, 1962; see also Richard Nelson, 'The simple economics of basic scientific research,' *Journal of Political Economy*, 1959, vol 67, pp 297-306

[5] Johan Hauknes and Lennart Norgren, *Economic Rationales of Government Intervention in Innovation and the Supply of Innovation-Related services*, STEP Report 08 1999, Oslo: STEP Group, downloadable from www.nifu.no

[6] Erik Arnold, A systems world needs systems evaluations, *Research Evaluation* 13(1), 3-17

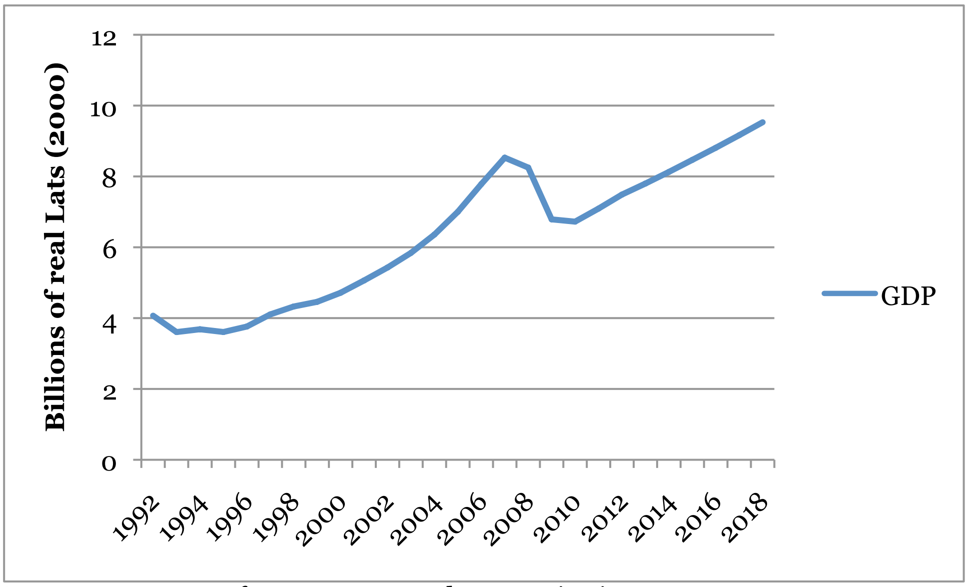
- Scientific performance (in terms of productivity and quality) must converge towards global levels and preferably over time exceed this in selected areas of national or industrial importance
- Since a lot of important innovation involves adapting and using knowledge that is not new to the world, there must be strong capabilities for accessing global knowledge, including through foreign direct investment (FDI), connecting multinationals' demands to domestic supply chains, reverse engineering and 'unbundling'
- It is important to have broad capabilities in basic research in order to keep university teaching up to date, ensure there is scientific capability available in most fields to meet policy and societal knowledge needs and to provide a point of growth when it turns out that increased capacity is needed
- However, a significant proportion of basic and applied research should be directed towards areas of national and industrial priority – not only to supply knowledge but – crucially – to supply relevantly educated and trained people. Therefore, both quality and relevance criteria are important at appropriate points in the system
- Links between industry and the research and higher education system (including the applied research institutes) are important both for 'advanced' and less advanced companies, though the type of link and the right counterpart will depend upon the absorptive capacities of the individual firm
- NRIS governance needs to include a transparent 'arena' in which stakeholders and decision-makers can debate and establish broad R&D&I priorities, leaving the budget to the government and the details of implementation to others. Members of the arena should act as experts and not as representatives, and should not be incentivised by the process to represent their own or other organisations
- The strategic intelligence needed should be created and analysed in a distributed way across the institutions of the NRIS
- Evaluation is a key component of strategic intelligence and requires the same 'intervention logic' at its heart as programme design. The overriding purpose of evaluation is to understand the degree to which interventions tackle and solve societal problems. Counting outputs alone has limited value
- R&D&I policy should be implemented according to the principle of subsidiarity: namely, that decisions should be made as low down as possible in the hierarchy of organisations involved
- The organisations involved, not least those responsible for funding R&D&I, need appropriately skilled and experienced people and should use transparent, efficient and rational programming practices that take account both of national priorities and the needs of stakeholders
- Mechanisms are needed to articulate demand for technology and research, not only supply. The knowledge and experience of stakeholders is needed in order to do this effectively
- The state's role in governing the parts of the NRIS under its control must include the ability to act as a 'change agent' – overcoming lock-ins where these have a negative effect on the NRIS. It needs to be able to tackle systemic failures as well as the traditional market failures involved in funding research
- More broadly, the state must have the capacity to do 'bottleneck analysis' in the NRIS, generating strategic intelligence about performance, problems and opportunities for change
- The NRIS must be internationally open, both in industry and in the research and higher education system, linking the national communities to global sources of knowledge and to the quality demands of the global science and technology systems

3. Production and Innovation

3.1.1 Production

While the costs of the economic crisis have been very large, GDP growth has resumed its upward path (Figure 2) and Latvia has been able to move back towards its previous pattern of export-led growth. Latvian GDP per head in 2010 was 52% of the EU average, lagged only by Bulgaria and Romania. Income levels peaked in 2007 then crashed in response to the financial crisis but have since stated to recover. Overall GDP has shown the same pattern, with almost one quarter of national income disappearing before the recovery started. Latvia has nonetheless had one of Europe's highest growth rates for the period 1995-2010 – but from a low base. Poverty is a significant problem and Latvia's Gini coefficient (the most commonly used indicator of income inequality) has declined gently in the range around 37-39 in recent years, making it one of the highest in Europe. As in other transition economies, opinion surveys show low levels of satisfaction with life and democracy and low levels of trust in government[7].

Figure 2 Real (2000) GDP per year, 1992 to 2018



Source: IMF; Data from 2012 onwards are projections

Latvia has long traditions in industry. Riga has been a major centre for mechanical engineering as well as trade since Tsarist times. In the Soviet period, Latvia was heavily dependent upon the Soviet Union for supplies of energy and raw materials. Industry specialised in high-volume electro-mechanical products ranging from washing machines to trolley cars, high-volume radio-electronics (radios, televisions, telephones, etc), pharmaceuticals and chemicals. These industries shrank dramatically in the years after the transition, as the 'safe' markets of the Soviet Union disappeared and as they were exposed to international competition[8].

The collapse of the Soviet bloc disconnected Latvia from many of the supply chains in which it had previously operated. After the large-scale destruction and privatisation of

[7] Stockholm School of Economics, Latvian Competitiveness Report 2011, Riga: Stockholm School of Economics, 2102; Klaus Schwab, *Global Competitiveness Report 2012-2013*, Geneva: World Economic Forum, 2013

[8] Janis Stradins, *The Latvian Academy of Sciences: Origins, History, Transformation*, Vol 1, Riga: Zinatne, 1998 [in Latvian; cited from Rambaka, 2011]

industry that ensued, Latvia entered a period of growth driven by the once-off impact of structural reforms, market-based resource reallocation towards more profitable firms and activities[9]. Growth was buoyed up further by accession to the EU in 2004 and driven to very high (overheated) levels in 2005-7 by an influx of foreign capital[10] and a boom in both construction and consumer spending. The collapse of foreign and then domestic demand as the recession took hold was starkly reflected in Latvia's growth rate in 2008 and 2009, so that the country had to turn to the IMF for support.

The structure of Latvian production has changed over the past decade from a focus on domestic demand to growth that is increasingly export-led. Within manufacturing, wood processing, metals, chemicals and various kinds of machinery have led the growth. 60% of manufacturing production is now exported[11]. While growth in the earlier part of the decade was fuelled in an unsustainable manner by an inflow of foreign capital, post-crisis growth seems to have more solid foundations.

Structure of the Economy
(by value added, percentage)

	2000	2005	2008	2009	2010	2011
Agriculture, forestry and fishery	4.5	3.9	3.0	3.8	4.5	4.5
Manufacturing	14.4	12.9	10.8	10.9	13.4	14.1
Other industries	4.2	3.3	4.3	4.9	5.3	5.2
Construction	6.8	7.0	10.1	8.0	5.9	6.1
Trade, accommodation and catering	18.5	21.6	18.8	16.9	18.2	18.6
Transport and storage	9.5	10.5	8.1	11.1	12.1	13.0
Other commercial services	25.1	25.7	28.4	27.5	25.8	24.7
Public services	17.0	15.1	16.5	17.0	14.8	13.8
Total	**100**	**100**	**100**	**100**	**100**	**100**

The evidence suggests that Latvia's degree of industrial cluster formation is weak[12]. This limits Latvian business' ability to share scale and experience and to build national and local advantages of specialisation. Rather, it is forced to rely on less 'sticky' sources of advantage such as the price of labour.

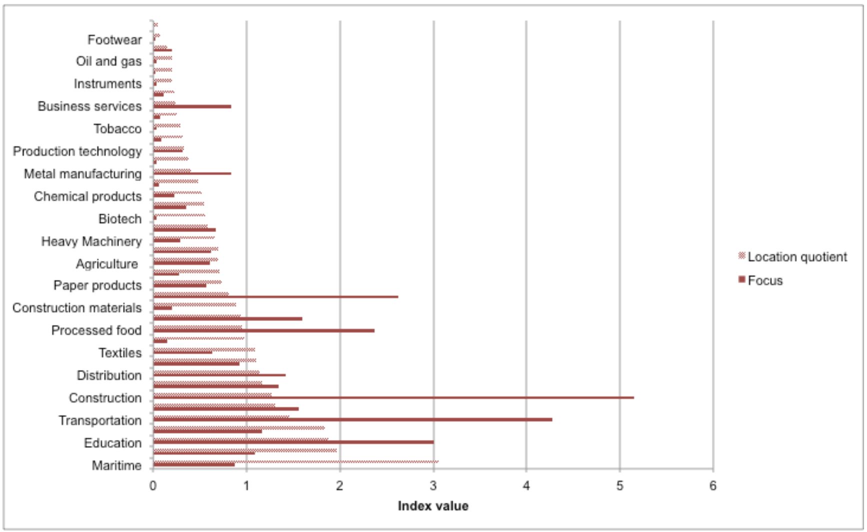
[9] Alfred Watkins and Natalia Agapitova, *Creating a 21st Century National Innovation System for a 21st Century Latvian Economy*,

[10] Ministry of Economics, Republic of Latvia, *Economic Development of Latvia*, Riga: Ministry of Economics, June 2009

[11] Ministry of Economics of Latvia, *Economic Development of Latvia Report*, Riga, 2012

[12] Ministry of Economics of Latvia, *Economic Development of Latvia Report*, Riga, 2012

Figure 3 Employment shares in Latvian Clusters



Source: European Cluster Observatory, 2011

Some 40% of the economy is informal or 'black'[13]. To avoid entering the formal economy, informal producers have to remain small (and invisible to the tax authorities) and have difficulty trading with larger, formal and more efficient firms in higher-productivity supply chains. The black economy has a negative effect not only on the government's ability to raise taxes but also on development. It discourages investment (especially FDI) and hampers the development of efficient supply chains involving smaller firms.

3.1.2 Exports

Total exports have shown remarkable development, growing 4.4 times between 1995 and 2000. Since the period of acute financial crisis in 2009, when export volume fell by 20%, there has been a remarkable recovery with some 30% growth[14]. The share of production exported roughly doubled over the last ten years or so. This resulted from growth in the Latvian share of established markets rather than expansion to new territories. In particular, the expansion has been in neighbouring and probably rather price-sensitive markets, which is consistent with indicators suggesting that Latvian companies are not very innovative, tending to compete on price (notably via labour cost advantages) in established industries – although there is clearly a growing number of exceptions. A positive aspect of export development in the period has been the growing diversity of product types exported – and a corresponding shift from raw materials and low value-added products based upon them to higher value products[15]. There is anecdotal evidence of growth among younger, more technology- and export-based companies that suggests that supports this pattern in the statistics.

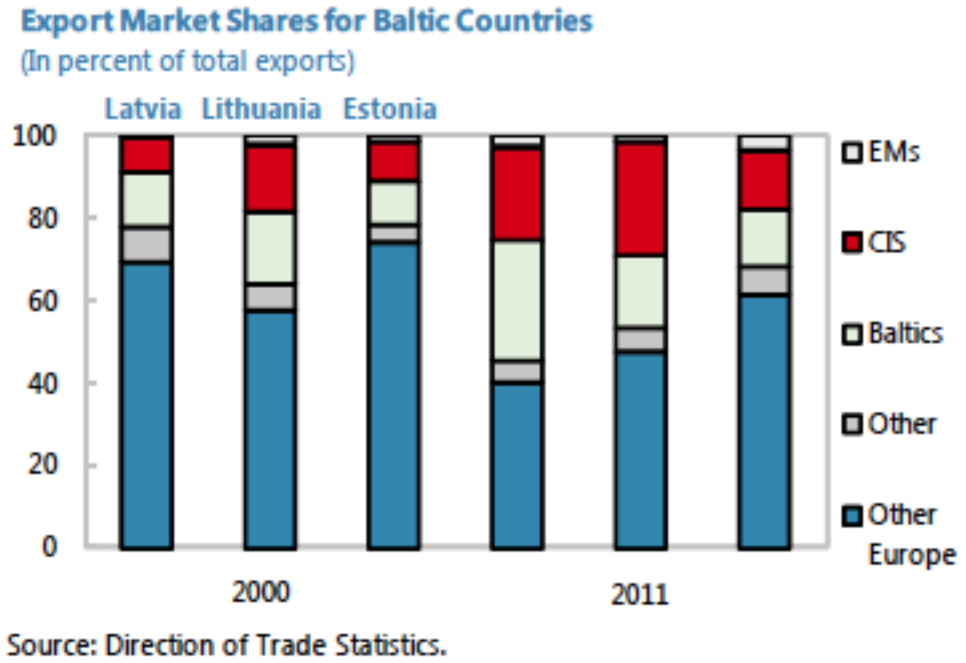
There are high rankings on some aspects of labour market efficiency, suggesting that labour is each to employ and easy to dispense with.

[13] Stockholm School of Economics, Latvian Competitiveness Report 2011, Riga: Stockholm School of Economics, 2102

[14] Ibid.

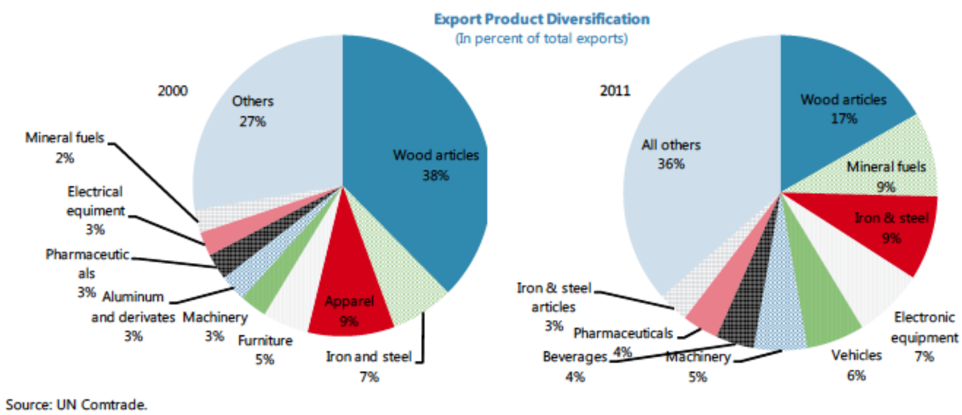
[15] Ibid.

Figure 4 Export shares for Baltic countries, 2000 and 2011



Source: IMF, *Republic of Latvia: Selected Issues,* IMF Country Report No 13/29, Washington DC: IMF, 2013

The structure of exports became more fragmented over the same time period, spreading across a wider range of industrial sectors. This is reflected in a rising Herfindahl index, which is conventionally seen as a sign that the economy is becoming more developed, robust against changes in the fortunes of individual branches of industry and less volatile. In a small economy like Latvia, however, one would also want to see a degree of specialisation that ties key national industries and clusters into international supply chains. In fact, the share of exports in production of things like wood products, where Latvia has traditionally been strong, has decreased while increases in exports have taken place across a wide range of different products. About 10% of exports are re-exports[16], suggesting that where Latvia is involved in international supply chains it tends to be in the higher tiers (ie furthest away from integration or final assembly).

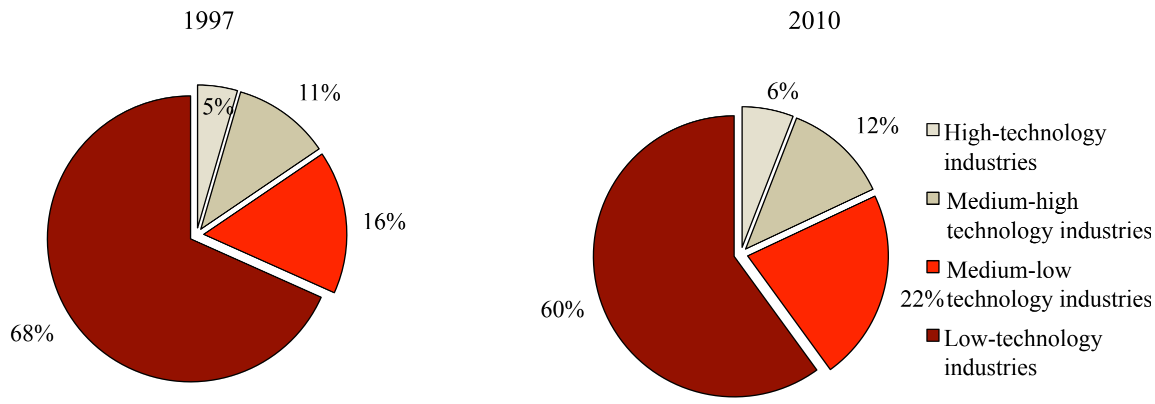


[16] Ministry of the Economy, Guidelines on National Industry Policy for 2014 – 2020

Source: IMF, *Republic of Latvia: Selected Issues,* IMF Country Report No 13/29, Washington DC: IMF, 2013

n 2011, two thirds of exports were in OECD's 'low technology' category and just over 11% in the 'high technology' one.

Figure 5 Structure of Manufacturing by Technology Level



Source: Ministry of the Economy, Guidelines on National Industry Policy for 2014 – 2020

Exports are dominated by five major product groups, which make up 70 % of the total exports of goods. The largest group is wood and wood products (16.8 % in 2011), agricultural and food products constitute nearly as much (16.4 %), followed by metals and metal articles (14.5 %), the share of machinery and electric equipment, as well as products of the chemical and allied industries is slightly lower (correspondingly 12.7 % and 10.5 %).

A recent report[17] on production, productivity and opportunities for diversification (inspired by the Haussman style of analysis) emphasises the importance of productivity improvements as a basis for growing per capita income. It argues that a growth path that built on Latvia's low labour costs would therefore be self-defeating – an argument that is reinforced by the emergence of a productivity gap between wages and output in recent years. It provides evidence that Latvia has been shifting into exporting more sophisticated, higher added value goods and that this process has gone especially far in chemicals and certain pharmaceuticals. However, the improvement lags behind that of the more advanced countries of central Europe and Estonia.

A key weakness of this style of analysis is that it assumes that the characteristics of the individual firm do not have an effect on its ability to diversify from sector to sector. The corollary is that increasing the absorptive capacity of firms increases not only their ability to compete successfully in existing product markets but also their capacity to diversify. The policy implication is that it is important to address the capabilities of individual firms irrespective of sector – but that there may be especially rich pay-offs to building on existing sector strengths.

3.1.3 Productivity

Recorded labour productivity is low: €14.4 of GDP per working hour, compared with €31.9 in the EU-27. In the EU, only Bulgaria and Romania have lower productivity than Latvia. Formalising a greater proportion of the economy is an important

[17] Structural transformation opportunities of the Latvian Economy ...

government objective, leading to changes in the tax system intended to encourage producers into the formal sector.

Total Factor Productivity (TFP), which is an indicator of technological change and organisational performance in industry, had contributed more to growth in the Baltic countries and Slovenia over the last decade or so that in the other New Member States – but much of this effect seems to be caused by catching up with the higher levels of technology in the other countries, starting from a lower base[18].

Figures from the Ministry of the Economy, however, show that in many sectors the volume of production has been increasing more quickly than employment since the crisis, so increasing productivity is making a significant contribution to growth, tending to increase Latvian competitiveness. (However, it is not clear to what extent this is due to labour hoarding during the crisis or to increased investment and improved technology.)

3.1.4 Good business environment but poor indices of competitiveness and innovation

The World Economic Forum ranks Latvia's competitiveness as rather low: overall, 127th out of the 144 countries considered. While the meaning of the Forum's 'Global Competitiveness Index' is not completely clear – it is a composite of 111 separate sub-indices (some of which, such as 'malaria cases per 100,000 of population – an index on which Latvia unsurprisingly does rather well – seem of little relevance in the Latvian context) – the country's ranking on sub-indices relating to factors we know to be important components of competitiveness is poor. Business sophistication rankings are weak – almost all over 100. Most innovation rankings are towards the bottom of the list in positions 135 to 141 out of 144. The ranking of institutions (efficiency, trustworthiness and so on) is almost as low[19].

The Global Entrepreneurship Monitor (GEM) study[20] shows that Latvia has a very high rate of new company formation compared with other European countries or its neighbours. This is more 'needs driven' (ie necessity driven) than in most countries, meaning that people start companies because they lack other opportunities rather than because they have a particularly good business idea that they think offers better opportunities than employment. Start-ups are often internationally orientated, as would be expected in a small country. Earlier GEM studies have suggested that the extent to which start-ups are needs- or opportunities based may not have much effect on their survival rate so the high rate of start-up is a potential advantage for Latvia. However, innovativeness **is** an important influence, and both the GEM study and the broader Community Innovation Survey point to innovation as a driver of growth and success. The low (if improving) proportion of Latvia's firms that undertakes innovation is a key brake on the development of industry. This poor performance is partly visible in the Community Innovation Survey data (Figure 6).

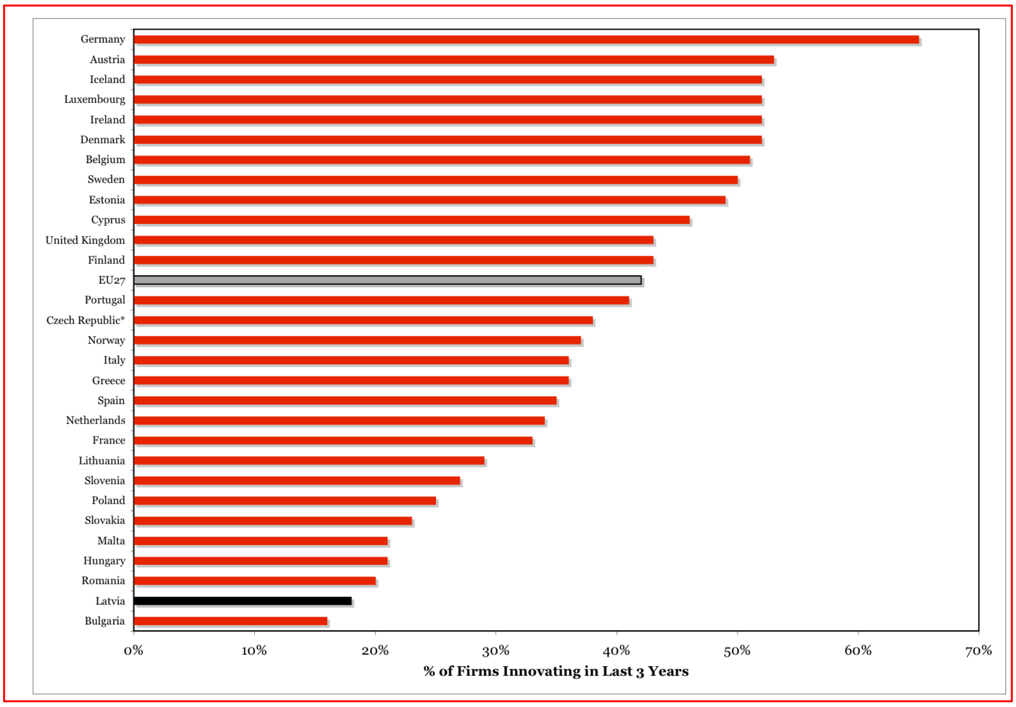
Much innovation is not based on new technology, but an important sub-set of innovation is based on R&D. The Latvian statistical agency (CSB) identified 264 companies that performed R&D in 2009 and 267 the following year. In 2011, however, the number rose by about half to 393. The number of researchers doing R&D in industry rose from 317 to 553 across these two years. This appears to be a very positive development – while the size of the numbers underscores the small absolute size of the industrial R&D effort.

[18] Stockholm School of Economics, Latvian Competitiveness Report 2011, Riga: Stockholm School of Economics, 2102

[19] Klaus Schwab, *Global Competitiveness Report 2012-2013*, Geneva: World Economic Forum, 2013

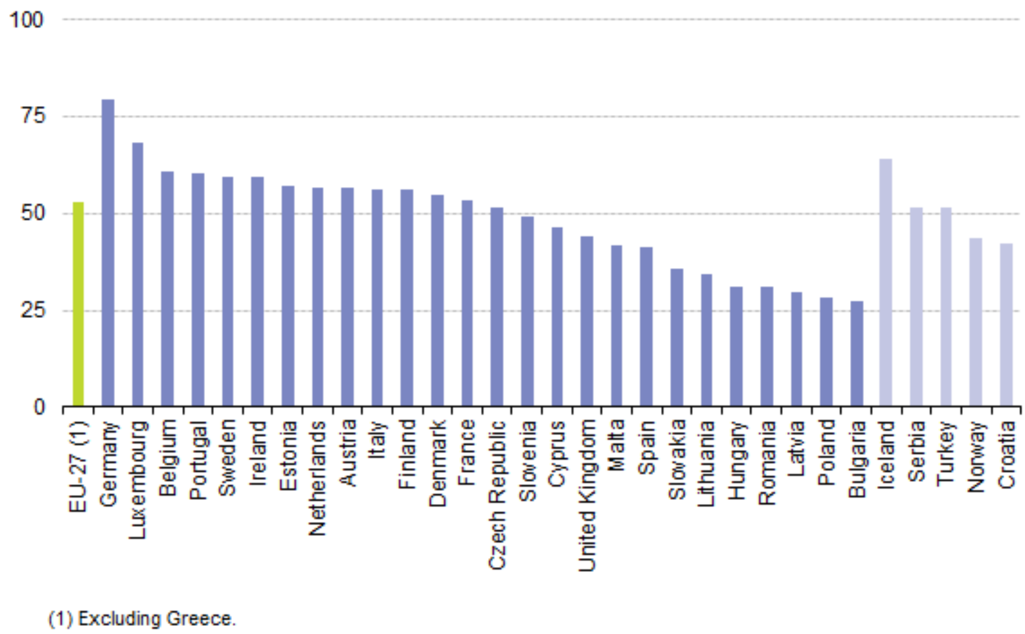
[20] Z.J..cs and L.Szerb, Global Entrepreneurship and Development Index, Cheltenham: Edward Elgar, 2010

Figure 6 Proportion of Firms Innovating in 2002-4, EU-27 [Add more recent data]



Source: EUROSTAT

Figure 7 Proportion of Firms Innovating in 2008-10, EU-27



Patenting provides a different window on innovation. The number of Latvian inventions per million of population awarded patents in the US patents office was 1.8 in 2010, compared with 171 for Sweden and 81 for the EU-15. Patenting in the Latvian Patent Office is small and comprises a minority of patents taken out by Latvians plus a majority of (largely 'defensive') patents held by multinationals. Overall, the observable innovation performance of Latvian companies is very poor.

Understanding the reasons for this poor performance is not easy from the available quantitative indicators. These do hint at a competitive position focused on less demanding markets where low labour costs are an important competitive advantage but where quality and innovation are less crucial. Given Latvia's low level of GDP per head and the frequent unwillingness of the state to be a demanding customer for high-quality products, this is understandable, but it is not a tenable position over time – especially as wage inflation has been substantially higher than the increase in labour productivity over the past decade, leading to the emergence of a productivity gap.

The importance of new technology-based start-ups in generating employment and growth rends to be exaggerated in many European countries. In particular, there is a tendency to think in terms of such firms as spin-offs from university research, whereas, where they exist, in general they are more likely to be set up either by recent graduates or by mid-career people spinning off from private industry.

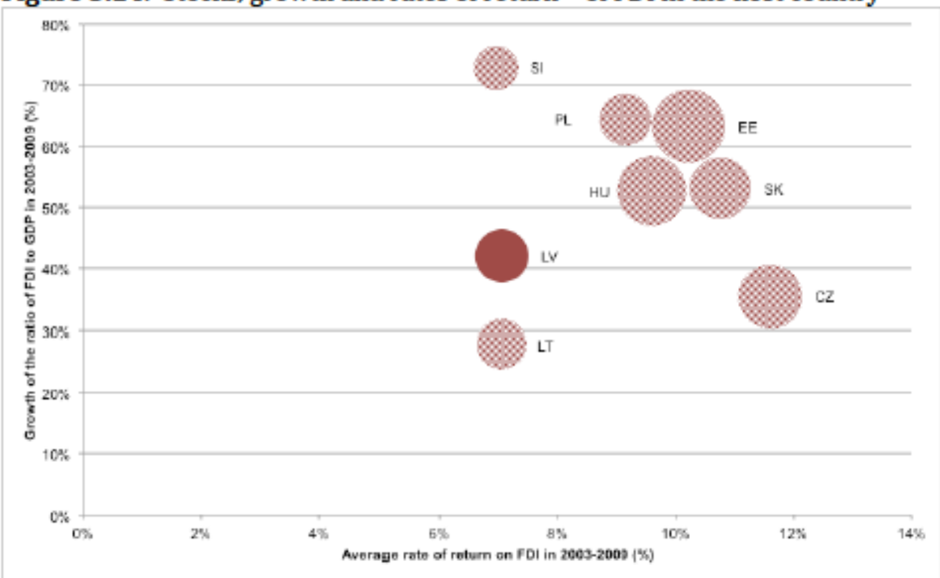
Evidence on the availability of venture capital and private equity is not clear. Our interviewees tended to believe that the VC market in Latvia is at a nascent stage. However, the Latvian Competitiveness Report places it at 0.2% of GDP – ahead of most of the other New Member States and respectively half and two thirds of the levels in Denmark and Sweden.

3.1.5 Foreign Direct Investment

While Foreign Direct Investment (FDI) has grown in recent years, it has done so more slowly than in the other Baltic countries. Not only is the overall growth in FDI slower than the other New Member States but the rate of return is lower – suggesting that (whether the sectors involved are typically regarded as 'high tech' or not) Latvia is positioned towards the low-value-added end of the sectors in which foreign multinationals are investing. Some 30% of FDI in 2009 was in financial intermediation and about 22% in real estate and associated business activities, so most FDI involves rather local activities. Only 11% was in manufacturing. Inward investment seems primarily to be motivated by a desire to participate in Latvian markets rather than to build a platform for innovation or exports. (LCR)

Figure 8 Stock, Growth and Rates of Return to FDI in Latvia and the Other New Member States, 2009

Figure 3.14: Stocks, growth and rates of return[34] of FDI in the host country



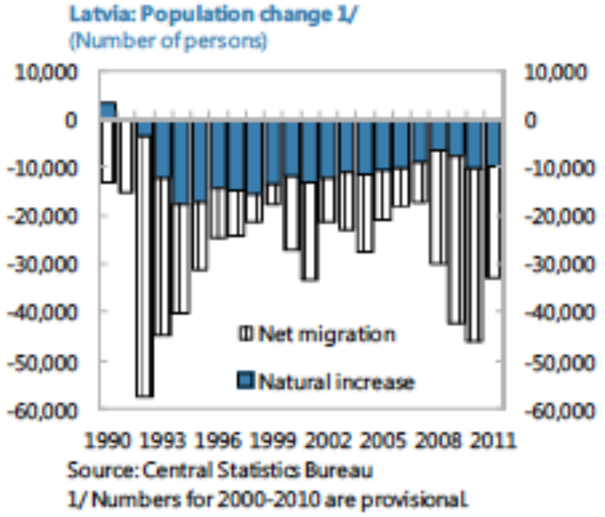
Note: Bubble size proportional to the stock of FDI in 2009 (as a percentage of GDP).
Source: Eurostat; authors' calculations.

Source: Latvia Competitiveness Report, 2011 (Hereafter referred to as 'LCR')

Inward investment is not only an indicator of the attractiveness of an innovation system and a provider or employment but also a very important source of systemic learning. For example, the Irish experience has been that the multinationals act as training schools in management, technology and entrepreneurship as well as promoting the development of national supply chains and offering needed competition to local companies. People with a background in the multinationals have started much of the indigenous software and electronics industry in Ireland. In cases where foreign multinational eventually failed (Amdahl) or moved on to lower labour cost countries (DEC, Apple), they left behind them a trained and technologically capable labour force. So there are good reasons to continue to pursue FDI also in Latvia.

4. Research, Development and Human Resources

Latvia's population is rapidly declining, through a combination of a low birth rate and emigration. This is turn knocks on to the higher education and research system, where the average age is high. Recent growth in PhD production (from a very low level) means there is an emerging generation of young researchers but much of the leadership is ageing and there is something of a 'missing generation' in between.



School education performs at a good European level, even if it is not outstanding. About 26% of the 30-34 age group has university-level qualifications compared with a European level of 32.3% and the gap appears to be closing.

Driven by the low birth rate, MoES data show that enrolment to higher education fell from 44,000 in 2005 to about 32,000 in 2011. Of these, 15,000 entered vocational programmes in 2005 while only 12,000 did so in 2011.

Professional education has significantly lower status than academic education in Latvia. At the same time, the LCR indicates that employers believe the colleges do not provide employees with sufficient practical skills. There is no real formal apprenticeship system in Latvia and employers apparently lack motivation or incentives to establish one. Participation in life-long learning and continuing vocational education is amongst the lowest in Europe[21]. Our interviews suggest that Latvia also suffers from a shortage of people in industry with middle-level and partly experience-based skills (technicians, logisticians, craftspeople, project managers, etc). These skills are vital for effective design and production. In their absence, industry operates at low levels of quality and productivity.

Available literature questions the quality of university education, especially in the social sciences, which for some time have made up over half the available study places. Only 11% study engineering disciplines and a further 5% study natural sciences – subjects, which are more demanding and more expensive to teach. These proportions appear to significantly be too low, especially in the context of percentages approaching 50% for the 'hard' subjects in some of the emerging economies.

At the level of wider skills, a recent report[22] on the likely development of the Latvian labour market suggests there is likely to be a severe shortage of people with higher education in engineering, manufacturing and construction, based on the current levels of education provision. A number of other mismatches arise between expected supply and demand but these are less severe. The report recommends

- Increasing the supply of people with higher education in engineering, ICT, health care, social welfare, pharmaceuticals agriculture and forestry – with the biggest needs being in engineering and ICT

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[21] IMF, *Republic of Latvia: Selected Issues,* IMF Country Report No 13/29, Washington DC: IMF, 2013

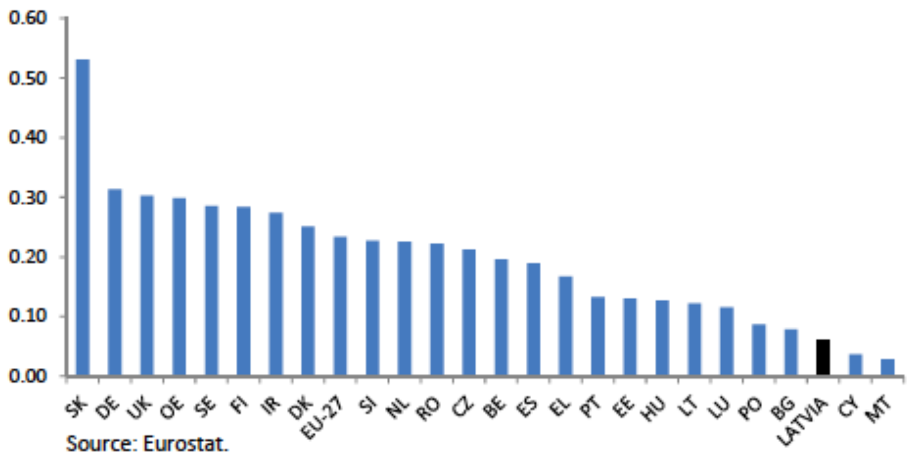
[22] The Informative Report on the Labour Market: Medium- and Long-term Forecasts, 2012

- Increasing the supply of people with vocational education in agriculture, metals, engineering and related fields as well as services including hotels, travel and restaurants

PhD production is small and the proportion of PhDs in the population is among the lowest in Europe. This not only affects the research-performing organisations but also undermines the ability of the business sector to do technological innovation.

Latvian PhD production per thousand of population was 0.4 in 2010, compared with an EU average of 1.4, ie 30% of the European rate[23]. Production of PhDs was 174 in 2009, 132 in 2010 and shot up to 287 in 2011[24] – partly under the influence of increased investment of ERDF funds in PhD education and (to be confirmed) partly as a response to the introduction of 11-month PhD completion grants. Much of the increase in PhD production has been in humanities and the social sciences, rather than in fields of more urgent importance to the economy. Lack of funds means that many PhD students have employment alongside their PhD studies. Generous grants to support them while completing were recently introduced in order to accelerate completion. Grant holders have a strong incentive to complete – the grant is repayable if they do not submit a thesis. The expected effect is to induce a temporary peak in PhD completions, with numbers declining as the stock of incomplete theses reduces.

Figure 2.11. Number of PhD Graduates per 1000 Population, 2010



Source: Eurostat.

The number of people in the age range 25-34 with PhDs is a good indicator for the growth or replacement of the PhD cadre nationally. Increasing the stock of PhD researchers is an important priority, given the ‘missing generation’ between younger researchers and the much older generation that still dominates research. (We are told that there is a similar pattern of a ‘missing middle generation’ also in industry.) While Latvia has the third-lowest proportion of people with PhDs in that age range in Europe (after Malta and Cyprus), the rate of growth is relatively fast (from a low base). Given the small numbers involved, continuing the increased PhD output should be an important priority. Figure 9 shows national PhD production in 2012. Surprisingly, in the light of the history and importance of pharmaceuticals in Latvia, there were no PhDs in pharmacology granted in 2012 and only 7 in the preceding decade.

[23] Innovation Union Scoreboard, 2010

[24] Development of S&T in Latvia, 2011

Figure 9 Number of PhDs Defended, 2012

Subject	Number
Sciences	53 (22%)
Medicine and Pharmaceuticals	19 (8%)
Agriculture	4 (2%)
Technology	54 (2211%)
Humanities	26 (%)
Social Sciences	
Total	245 (100%)

Source: RIS3 report

The proportion of foreign university students in Latvia is low (2.8%), owing to difficulties of funding student places in Latvia, a grade system that is not yet aligned to European norms and the national requirement that most teach must be done in Latvian. (LVSS)

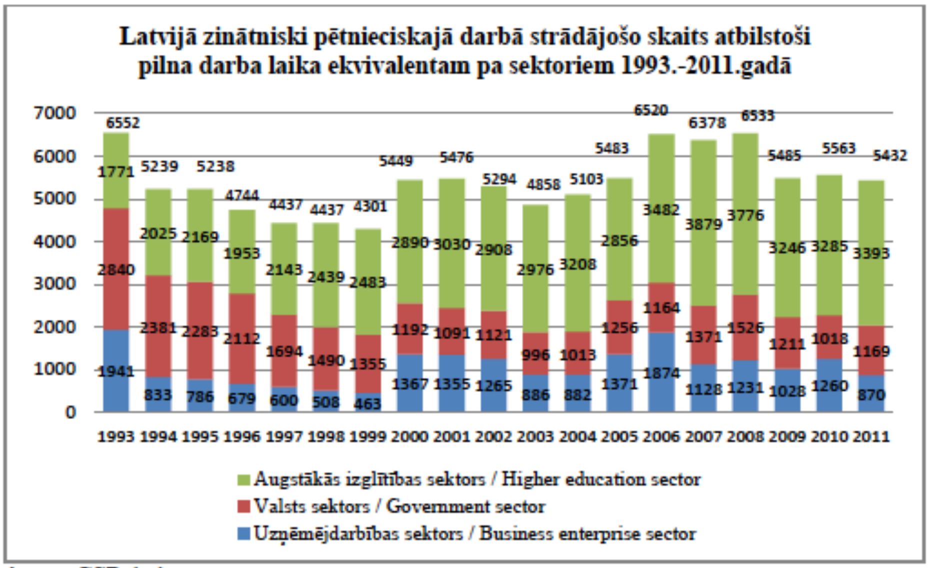
At the end of the 1980s, there appear to have been some 17,000 people working on R&D in Latvia, including 895 PhD-holders in Academy institutes. More than two thirds of these people left the system in the following few years – in technical and engineering sciences the loss is said to have been as high as 87%[25].

The number of full-time equivalent (FTE) R&D workers has been quite volatile in recent years (Figure 10). In 2011 there were 5432 full-time equivalent R&D workers in Latvia, of whom 3947 were researchers and the remainder various sorts of support personnel. The numerical dominance of the higher education sector may be overstated – such figures from universities are normally produced by applying an arbitrary formula to the number of academic staff, while in fact teaching crowds out research in most real universities. Nonetheless, the proportion of R&D workers in the business sector is very low.

[25] Dace Rambaka, *Policy Reform and Research Performance in Countries in Transition: A Comparative Case Study of Latvia and Estonia*, PhD thesis, Manchester Business School, 2011

Figure 10 FTE Researcher Workers in Latvia by Sector

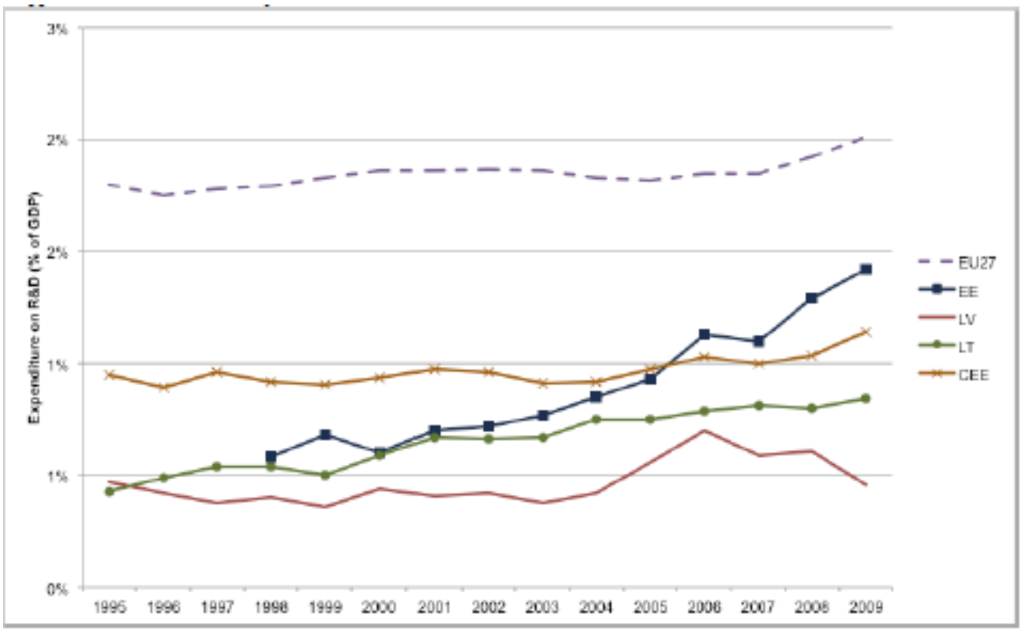
15.attēls



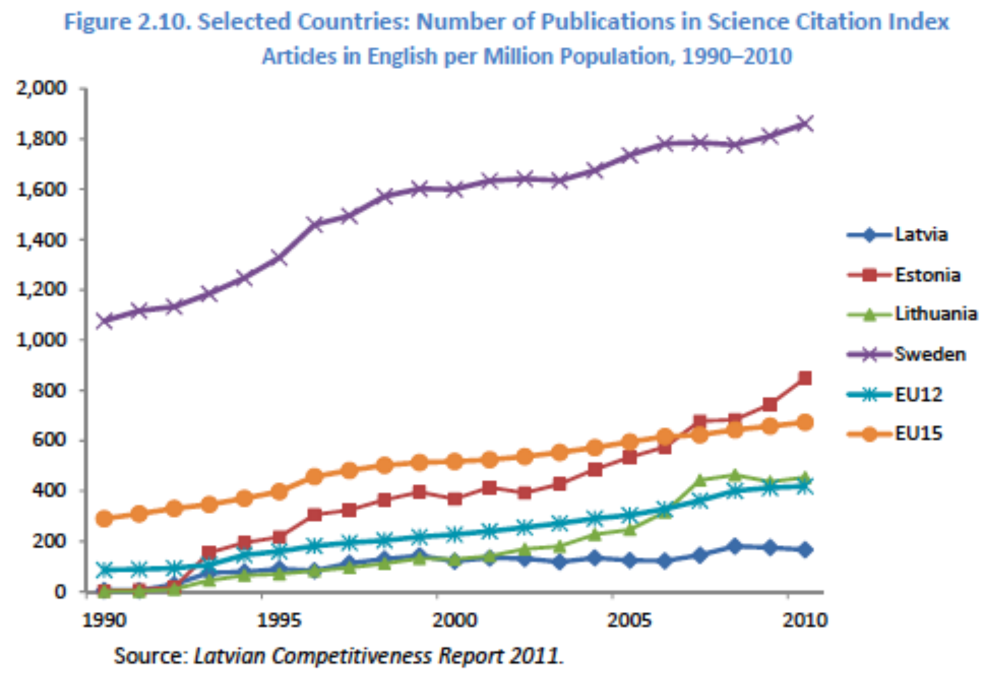
Avots: CSP dati

Source: LVSS

There is little growth in GERD/GDP. Uniquely among the New Member States, the share of Latvia's GDP devoted to R&D **fell** during the financial crisis.

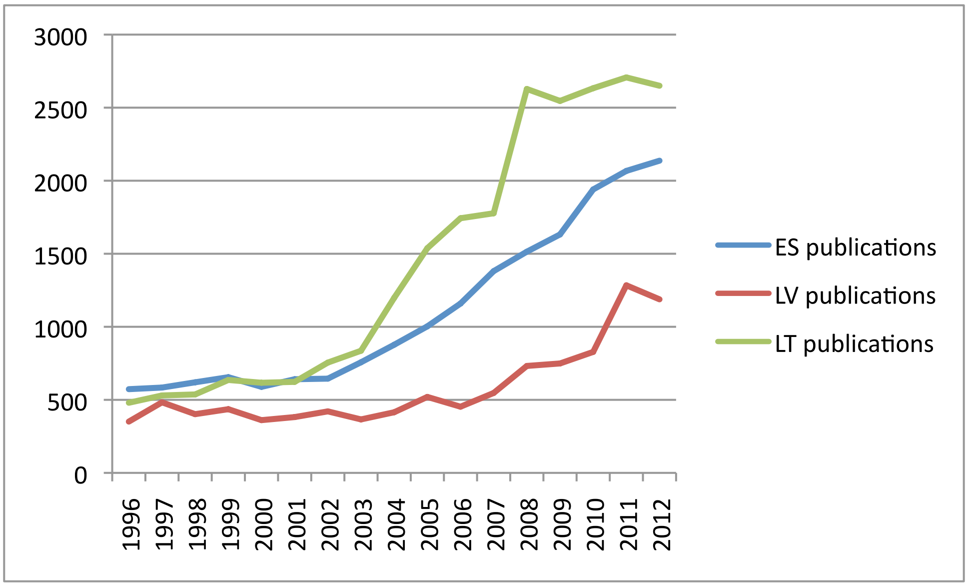


Source: Eurostat



Whereas the two other Baltic states have rapidly increased both the quantity and quality of their scientific publications in the last decade, especially since EU accession, Latvia's output has stagnated. Figure 11 shows how performance looks through the alternative lens of Scopus, in terms of total numbers of publications per year, with Latvian production increasing but more slowly than in its neighbouring countries.

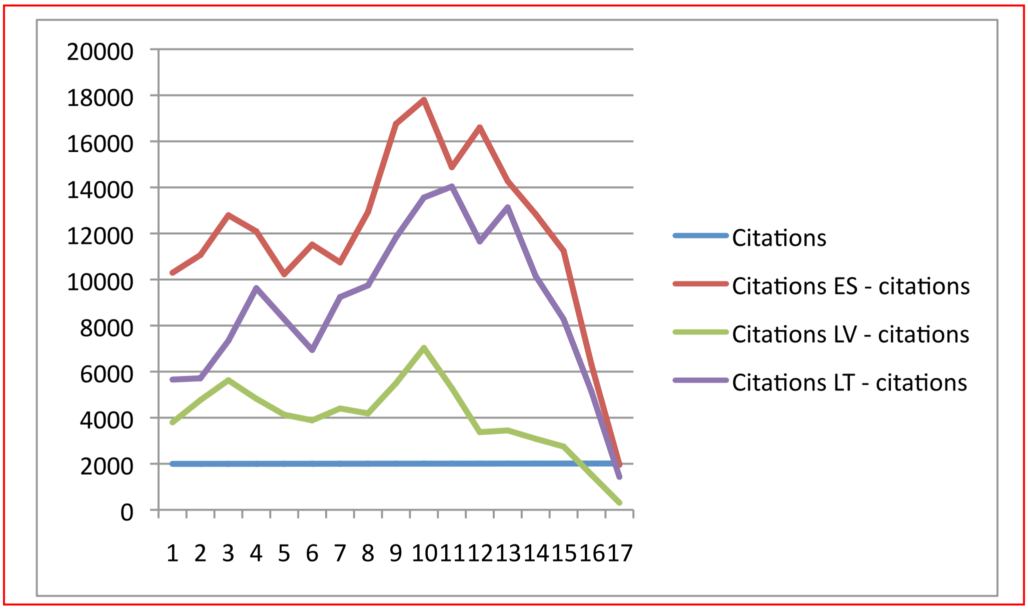
Figure 11 Scopus Publications 1996-2012 in the Baltic States



Source: SCIMAGO, 2014

Figure 12 Shows the numbers of citations to papers published in the Baltic states, according to their year of publication (hence, numbers are low for recent years and higher for earlier ones, where articles have had tome to accumulate citations). This shows a similar picture of Latvia performance lagging that of the two other states.

Figure 12 Scopus Citations by year of publication, 1996-2012 in the Baltic States

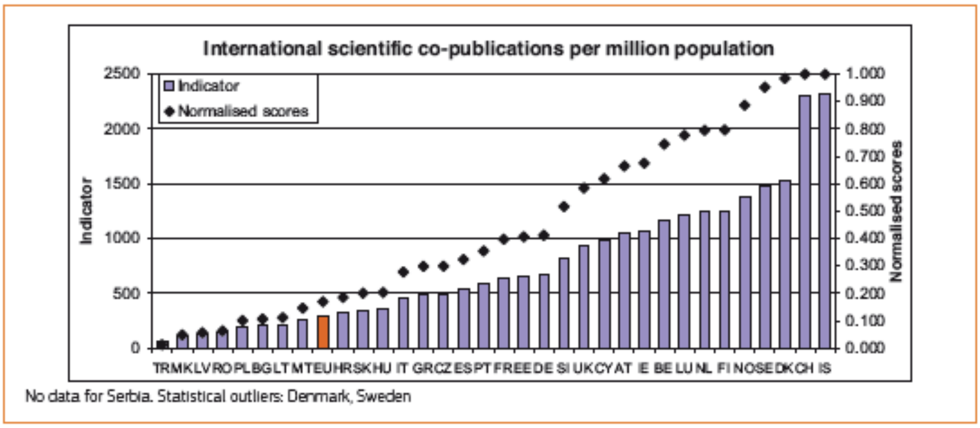


Source: SCIMAGO, 2014

Overall, publication productivity of Latvian science is low compared with other European countries and even the other Baltic states. (SSLV)

Figure 13 Scientific papers co-authored with Non-EU authors per million of population, 2010

1.2.1 International scientific co-publications per million population



Source: Innovation union Scoreboard, 2011

Scientific publication is dominated by physics, chemistry and materials science. As with the PhD production data, production of scientific articles in pharmacology is surprisingly low, given the industrial context.

Figure 14 Top-20 Publication categories, Latvia 2001-13

Web of Science database listed in Top 20 categories in which to Latvia
2001 to 20 January 2013 is the most publications

Web of Science Category	Publications number
Physics Condensed Matter	897
Materials Science Multidiscip.	759
Organic Chemistry	734
Mechanics	537
Polymer Science	473
Applied Physics	451
Materials Science Composites	440
Biochemistry, Molecular biology	403
Engineer Electrical Electronics	308,
Physical Chemistry	301
Nuclear Science and Technology	299
Optics	271
Atomic Physics mol. Chemical	268
Plasma Physics Fluids	Of 240
Oncology	237
Multidisciplinary Physics	222
Pharmacology, Pharmacy	196
Biotech. Applied Microbiology	179
Instruments Instrumentation	173
Cell Biology	163

Source: Thomson Reuters data

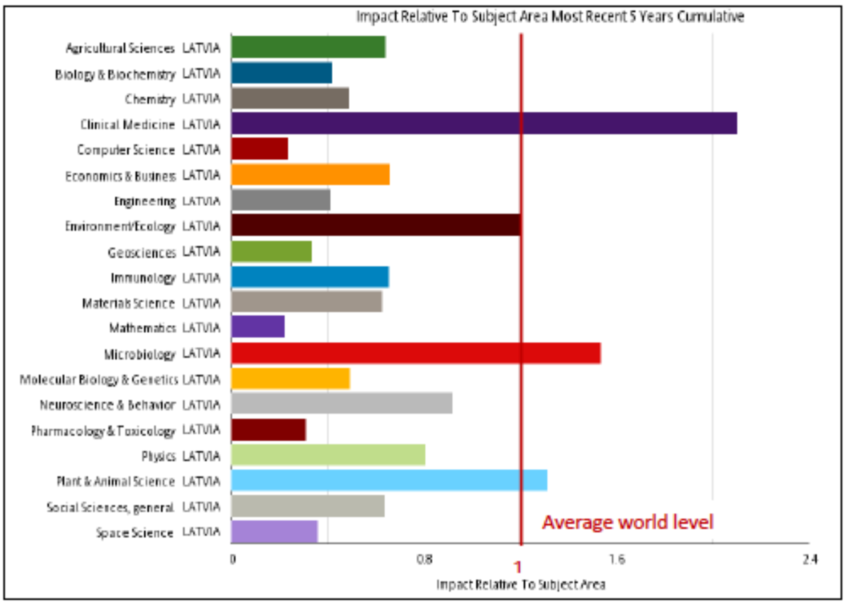
(SSLV)

To the extent that field-normalised impact factors indicate quality, the apparently poor quality of research in areas where production is high, and in areas of relevance to Latvian industry, is a cause for concern.

Figure 15 Relative Impact Factors of Latvian ISI Publications, 2005-9, by Discipline

Web of Science **datu bāzē atrodamo zinātnisko publikāciju relatīvā ietekme (*Impact factor*) pēc zinātņu nozares, % 2005. – 2009.gadu periodā**

28.attēls



Avots: Thomson Reuters dati

(SSLV)

Numbers of successful ERC applications are increasingly seen as simple but crude indicators of national research performance. The first successful application from Latvia was approved in 2013.

Figure 16 shows a recent picture of the pattern of international co-publication for the Baltic states. Not surprisingly, the main cooperation partners are large countries. The absolute numbers of papers written in collaboration by Latvian authors are small compared with the neighbours and people in the Russian system remain more important partners for Latvia than the other countries shown.

Figure 16 Pattern of international co-publication, Baltic states, 2008-2010

Rank	Estonia			Latvia			Lithuania		
		N	%		N	%		N	%
1	**Finland**	**1632**	**9.90%**	**Germany**	**956**	**10.30%**	**Germany**	**1314**	**5.80%**
2	**Sweden**	**1606**	**9.70%**	**Sweden**	**591**	**6.30%**	**USA**	**1254**	**5.60%**
3	**Germany**	**1282**	**7.80%**	**USA**	**523**	**5.60%**	**Sweden**	**1036**	**4.60%**
4	**USA**	**1228**	**7.50%**	**Russia**	**482**	**5.20%**	**France**	**887**	**3.90%**
5	**UK**	**1070**	**6.50%**	**UK**	**365**	**3.90%**	**UK**	**858**	**3.80%**
6	France	724	4.40%	France	350	3.80%	Poland	718	3.20%
7	Italy	703	4.30%	**Lithuania**	**320**	**3.40%**	Italy	626	2.80%
8	Russia	653	4.00%	Italy	273	2.90%	Russia	556	2.50%
9	Spain	555	3.40%	Finland	270	2.90%	Finland	519	2.30%
10	Poland	444	2.70%	Poland	268	2.90%	Spain	432	1.90%
...11...				**Estonia**	**257**	**2.80%**			
...15...	**Lithuania**	**349**	**2.10%**						
...16...							**Latvia**	**320**	**1.40%**
...19...	**Latvia**	**257**	**1.60%**						

Source: Agrita Kiopa, MoES, based on data from the Thomson-Reuters Web of Science

5. The Knowledge Infrastructure

Latvia has a very large number of higher education institutions – a total of 47 organisations provide either academic or professional higher education. There are 14 state and 8 private universities providing academic education plus 13 state and 11 private colleges providing professional education[26]. About half the student population is enrolled either at the University of Latvia or Riga Technical University (RTU)[27]. Despite the institutional proliferation, however, public expenditure on tertiary education is very low by international standards: 0.79% in 2009, compared with an EU average of 1.22%. The Nordic countries spend over 2% of GDP on tertiary education.

The effects of the Soviet period on the structure of Latvian science and industry remain significant[28]. In science, the fragmentation of the effort under ten different all-union departments and about 50 ministries with multiple layers of administration meant that there was no central overview, thematic or institutional coordination. Budgetary and hierarchical rigidities meant there was little flexibility to respond to the emergence of new fields and there was little feedback from performance to the size of

[26] http://www.aikos.smm.lt consulted on 17 May, 2013

[27] IMF, *Republic of Latvia: Selected Issues,* IMF Country Report No 13/29, Washington DC: IMF, 2013

[28] Dace Rambaka, *Policy Reform and Research Performance in Countries in Transition: A Comparative Case Study of Latvia and Estonia*, PhD thesis, Manchester Business School, 2011

the budget.[29] Separation between teaching in the universities and research in the academy institutes made it difficult to keep teaching up to date.

The decision in the 1990s to privatise the pilot and demonstration facilities that had been set up during the Soviet period had a drastic and negative effect on Latvian industrial R&D capabilities. The patent law was repealed and little funding was granted for applied research, hastening the loss of human capital from the research and innovation system.

From 1996-2006, surviving Academy research institutes were integrated with the Universities or attained independent status, reducing the Academy largely to an advisory body. The applied research institutes set up in the Soviet period to support the industries the system allocated to Latvia have tended to wither away since the transition[30].

Buildings and equipment for research in the university and institute sectors show clear signs of the lack of investment in the 1990s following the political transition and of comparative neglect in the current century. European funding is making improvements possible but the most casual inspection suggests that the remaining problem is very large.

Currently, the Law on Scientific Activity of 2007 specifies that Scientific Institutions must be registered with the Ministry of Education and Science, in order to qualify to receive 'basic' funding for research (ie, a modest level of institutional funding allocated in the basis of recent performance in terms of the production of various categories of scientific papers, PhDs, patents and other research outputs) or to be funded from the competitive schemes for state funded research (via the Latvian Science Council or various state programmes of research).

5.1.1 Structure of research funding

Latvian universities have a high degree of autonomy, deciding their own curricula and governance structures. The academics, students and staff elect the rectors. HEIs' governing bodies are academic. The MoES has proposed to change the law to require boards to be 2/3 external but the autonomous status of the HEIs makes this difficult to implement.

The Higher Education Council commissioned a review of educational quality that found that 265 of 850 programmes were of poor quality or needed improvement. While the MoES asserts that the review understates the problem[31], it in any case appears that a more rigorous course accreditation process is required. As an initial measure, the MoES has promulgated new accreditation regulations that exclude low-quality courses from state budget financing.

For understandable historical reasons, existing regulations stress the use of the Latvian language in HEI teaching. However, this is a significant barrier to the internationalisation of both the research community and the student body in Latvia, and MoES has proposed to relax this requirement.

The system for funding research in the universities is in important respects still in transition. The components are

- 'Basic' research funding, which is distributed using on a formula based on numbers of outputs such as scientific papers in various categories, patents and doctorates produced. This funding totals about 10m Lats per year

[29] P Hanson and K Pavitt, *The Comparative Economics of Research, Development and Innovation in East and West: A Survey*, Chur: Harwood Academic Publishers, 1987

[30] Janis Stradins, *The Latvian Academy of Sciences: Origins, History, Transformation*, Vol 1, Riga: Zinatne, 1998 [in Latvian; cited from Rambaka, 2011]

[31] IMF, *Republic of Latvia: Selected Issues,* IMF Country Report No 13/29, Washington DC: IMF, 2013

- Academically orientated research funding from the Latvian Council for Science. Five disciplinary sub-councils distribute this in response to calls for proposals. The success rate is about 15% and the total amount distributed is currently of the order of 3m Lats per year
- State research programmes in more applied areas. Applications are peer reviewed by the Council of Science but spending decisions are finally taken by the Ministry of Education and Science
- European funding
  - From Structural Funds, allocated nationally
  - From the Framework Programme

In addition, the universities receive funding to pay for education, based essentially on student numbers, and have (since 1991) been allowed to charge students fees for education.

Only 17% of research funding is institutional (ERAWATCH Country Report, 2011), making Latvia's one of the most highly 'contested' systems in the world. While there is no clear international benchmark for what the proportion of institutional funding should be, there is some consensus that 50% is the minimal viable level. The Finnish Research and Innovation Council recently observed that the share of competitive funding in the university research system has recently approached that value and that to do any further would be dangerous[32]. Low relative levels of institutional funding are normally argued to undermine continuity, the ability to invest in facilities and equipment and therefore ultimately quality. A degree of institutional funding stability is also a requirement in order to establish good links with industry. Without this, it is hard to be a credible research partner for the longer term.

Figure 17 Elements of University Funding

Funding line	2011 (LVL)	2012 (LVL)	2013 (LVL)
Base funding	7.94m	8.14m	7.94m
Grants of the Council of Science		3.3m	3.27m
State Research Programmes		4.0m	4.0m
Total State Funding	22.4m		
Total International Funding	50.1m		
Total Private Funding	24.7m		

Source: Ministry of Education and Science

Academic employment conditions are said to encourage fragmentation. Salaries are generally very modest by international standards. While it is in principle difficult to work more than 40 hours per week for a single employer, it is said that there are no effective constraints on the number of employees one may have (beyond the obvious physical limits of human endurance) and that this encourages researchers to have more than one job. A related incentive is faculties' needs for teaching capacity and their frequent willingness to satisfy this by employing a member of staff from a relevant research institute. Externally funded grants can be used, at least in part, by the individual principal investigator to boost their own wages. So incentives for fragmentation can be strong. While in many countries, researchers seem relatively indifferent to their wage levels – once above a certain threshold of comfort, they respond more readily to better research conditions – our interviewees argued that Latvia has yet to reach this income level.

[32] Research and Innovation Council of Finland, Research and Innovation Policy Guidelines 2011-2015, Helsinki: Research and Innovation Council, 2011

At present, there appears to be no domestic scheme for funding post-doctoral researchers. RTU has about 100 post-docs, but all are funded through the Framework Programme and other European sources. This is an important inhibitor for research productivity. In other systems, post-docs are the 'middle managers' of the research system, handling the day to day organisation and supervision of work and making it possible for the system to advance from the old style of research group (effectively defined as one professor together with a small number of doctorands) to larger teams.

Critics of the current system argue that there has so far been insufficient modernisation.

> *In Latvia, the rapid transition to grants as a sole mechanism of funding, coupled with the bare-minimum provision of funding has not only hampered productivity but led to some unintended outcomes of the funding reform. Firstly, constant funding proportions between fields have been maintained for nearly two decades, ensuring the minimum provision of funding to most projects. Secondly, the obtainment of funding based on merit (largely, determined by publications in internationally peer-reviewed journals) has not materialised, as this standard was lowered to include regional and national publications. Thus, the funding reform has largely faltered in achieving its original objectives, leading to the institution of mechanisms that have promoted the status quo. And, while this has been essential to safeguarding the research base, it has failed to provide the necessary incentive mechanisms to improve the productivity in terms of research output*[33].

5.1.2 Science-Industry Links

The amount of science-industry linkage in Latvia is generally regarded as low. Certainly, the level of co-publication between the academic and industrial sectors in Latvia is the lowest in Europe, after Malta (2 per million of population, compared with an EU average of 36.2 in 2008[34]). This suggests that there is limited research collaboration between science and industry, where both sides play active parts in doing the research.

However, business' investment in research in the Higher Education sector jumped from 3.0% to 4.7% of the total between 2009 and 2011 – a period, during which higher education research itself doubled from 23.3 to 48.6 million Lats[35]. This is not far below the level commonly observed in OECD countries, although the absolute volume of interaction is small, given the small absolute sizes of both the academic and the industrial effort.

Clearly, the amount of interaction differs among the universities. Riga TU cooperates quite extensively with industry, providing a mixture of contract research, advice, consulting and other services.

Encouraged by a law that grants Bayh-Dole style ownership of inventions made in state institutions to those organisations, universities have begun to build up technology transfer and commercialisation functions. Both LU and RTU have small groups that bridge the Technology Transfer Office function (ie trying to patent and generate income from university inventions) and the Industrial Liaison Office function (ie more generally building links with industry through advice, contract research, education, student projects based in industry and so on). In total, there are 7 such groups in Latvian universities. Given that the TTO function is rarely profitable and certainly takes many years to establish, requires scale, specialist skills and the

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33 Dace Rambaka, *Policy Reform and Research Performance in Countries in Transition: A Comparative Case Study of Latvia and Estonia*, PhD thesis, Manchester Business School, 2011

34 Innovation Union Scoreboard, 2010 [update]

35 CSB

construction of a portfolio, there may be an argument for adopting the French style of technology transfer companies (SATTs, working for a regional group of universities) but at the national level.

6. Governance and Policy

6.1.1 National Development Plan and Overall Research and Innovation Policy

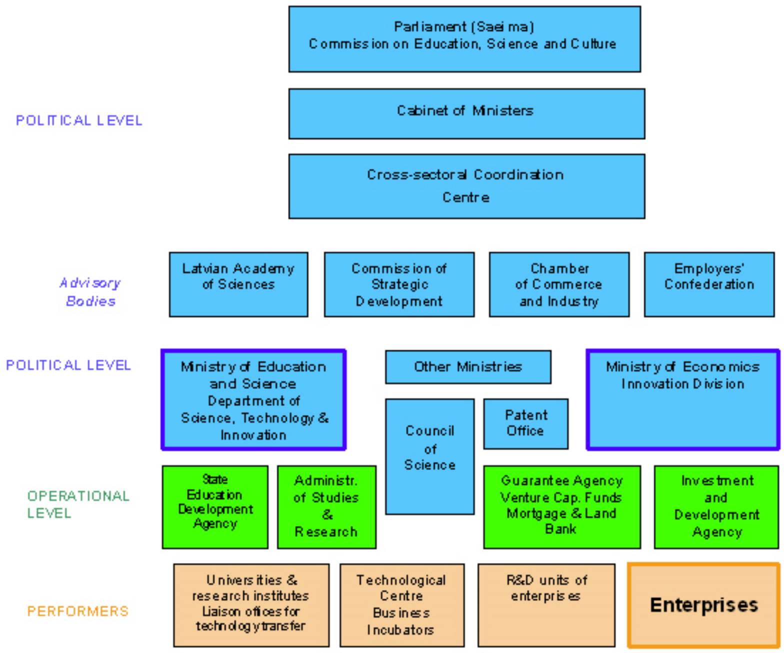
Current policy recognises the importance of increasing and focusing the research and innovation effort. The National development Plan target is to raise GERD as a percentage of GDP to 1% by 2015 and 1.5% by 2020. Given the poor state of the research infrastructure in the form of buildings and equipment, it would be possible to achieve some of this expansion through investment in the knowledge infrastructure of universities and institutes. An a crude calculation, if the expansion were to take place with the current ratio between investment in research and investment in infrastructure, increasing the number of researchers in Latvia from some 5,000 now to 8000 by 2015 and to 12,500 by 2020. With an annual PhD production rate currently of about 250 per year, this might be possible but is certainly ambitious.

6.1.2 The system and institutions of governance

In principle, government (through the Parliament) sets state policy for the development of science and technology, decides what fields and themes should be prioritised and sets criteria for evaluating the efficiency of research institutions and allocated budget to science and technology policy. In practice, research and innovation policy has had rather low priority, and budget for this area certainly has not had the kind of privileged status given to it in other EU countries.

The Latvian Council of Science was created in 1991 to formulate and coordinate science policy and to act as a research council, assessing applications for research funding and allocating money in competition. In the early days, ministers were members of the Council but over time a representative from the Ministry of Education and Science replaced their role. Today it has five 'expert commissions', which act as assessment panels for proposals, dealing with different disciplines and while it continues to advise on the implementation of science, higher education and R&D policy, the policymaking function is the responsibility of the Ministries, especially of education and industry, leaving the Council primarily operating as a research funding council, mostly orientated to the academic research community. In practice, it tends now to function as a funding agency of the Ministry of Education and Science fulfilling the 'administration of studies and research' role identified in Figure 18, thereby fulfilling the mandate laid down for it in law. It also plays roles in relation to evaluation, international cooperation and the provision of opinions about doctoral study programmes. The Ministry of Education and Science is responsible for science and technology policy as well as the overall coordination of innovation policy, a role it fulfils in cooperation with the Cross-sectional coordination centre for the national development plan (see below).

Figure 18 Governance of Research and Innovation In Latvia



Source: ERAWATCH, 2011

The character of the Academy of Sciences changed between 1991 and 1994. It was stripped of its research institutes – many of which subsequently merged with universities – and it lost its policymaking role, becoming and advisory body of eminent national researchers.

Most universities are responsible to the Ministry of Education and Science. However, the Ministry of Agriculture is the principal of the University of Agriculture and Riga Stradins University. A total of six ministries have responsibility for higher education organisations, with the Ministry of Education and Science playing a coordinating role with respect to overall education policy and accrediting programmes[36]. The need for some of the sector ministries to maintain their own government labs further complicates the task of coordinating overall research policy.

The Ministry of Economics has had responsibility for innovation, using the Latvian Investment and Development Agency (LIDA) as its agency for implementing innovation support programmes. In practice, the Economics and Education ministries have maintained different thematic priorities for research and innovation in the past. While LIDA has had responsibility for innovation instruments for some years, it appears not to have developed the deep technological skills found in innovation agencies such as VINNOVA or Tekes.

From 2011, the new Cross-Sectoral Coordination Centre, attached to the office of the Prime Minister, has had the task of developing the National Development Plan (NDP) for 2013-2020. This provides a central instance that in principle can coordinate at least the medium-term priorities of the various ministries. Important inputs to the plane have been the Latvian Competitiveness Report of 2011 and Latvia's RIS3 Smart Specialisation Strategy, currently under discussion. A group that includes the government ministers as well as the key stakeholder organisations manages the

[36] Dace Rambaka, *Policy Reform and Research Performance in Countries in Transition: A Comparative Case Study of Latvia and Estonia*, PhD thesis, Manchester Business School, 2011

development of the NDP. The effectiveness of the Centre as a coordination instrument is yet to be seen. However, given its high level and the occasional nature of its task, it will need to be complemented by more continuous coordination and interaction among the ministries through the life of the NDP, in order to tackle issues such as the more detailed division of labour among ministries the coordination of policy instruments

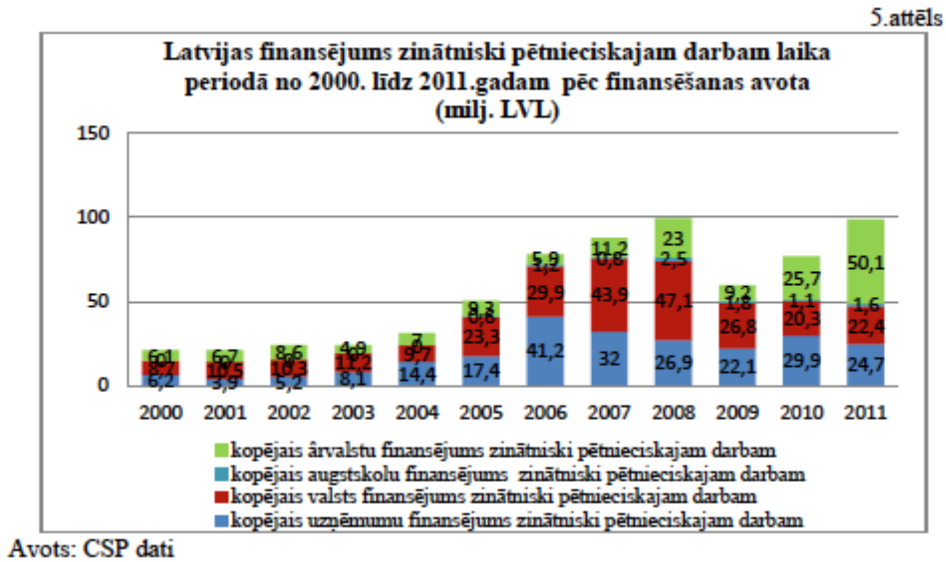
6.1.3 Paying for research and innovation policy

The acute lack of money in recent years has had a number of undesirable effects on the research and innovation system. An obvious one is that the principle of increasing state expenditure on R&D by 0.15% of GDP per year until it reached 1% was effectively abandoned after the first year. A second is that it has diluted thematic priorities, for example in the state research programmes. Given a reasonable budget, it would have been possible to focus the effort by growing certain activities, without effectively leaving other parts of the research system unfunded. Given the acute shortage of money, the practice has been to broaden the priorities so that almost everyone can get a little funding. This has not produced the desired focusing of the research and innovation system.

Policy has also been to allow structural funds and the Framework Programme to crowd out national investment in R&D during the period of recovery from the financial crisis –in part driven by the need to conserve national funds for debt repayment. FP funding is a key ingredient in the funding mix. It is strongly quality controlled, tending to raise the standard of national research while also acting as a major training school for younger researchers, and it helps network the Latvian research and industrial communities more widely in Europe. Its disadvantage is that it tends to fragment the national research community, so it needs to be complemented by measures that support intra-Latvian networking and critical mass.

Over time, it is important to replace Structural Funds with national money. First, Structural Funds are by definition transitional – they will not permanently be available, so the Latvian system needs to become able itself to sustain a viable research and innovation policy. Second, Structural Funds are not only complex and bureaucratic to administer but also involve limitations on their use such as regional limitations (making it harder to support Riga than less important hubs for research and innovation) and usage limitations, such as rules for the use of capital equipment that make it difficult to implement cohesive instruments that at once tackle innovation and research.

Figure 19 GERD by source of funds, 2000-11 (From the smart specialisation report)



Key

Total foreign funding for research activities
Total funding for university research activity
total state funding for research activities
total corporate funding for research activities

6.1.4 Priorities and how they are set

From 1996, a series of national research funding programmes was set up by the Ministry of Education and Science, initially in

- Chemistry, pharmacy and biomedicine
- Forestry and timber manufacturing
- Humanities (esp. Latvian history, language and literature, folklore, art etc)
- Materials science
- Information technologies

The list has subsequently been extended, under pressure of the limited amount of money available to fund research, to a rather inclusive one.

Accession to the EU has been accompanied by attempts to reform the legal system under which R&D is funded, partly supported by funding via European Structural Funds (ESF). The Law on Research Activity[37] adopted in 2005 envisages an annual increase in public R&D funding of at least 0.15% of GDP up to a limit of 1% of GDP. Initially, annual increases were achieved but this aim has fallen victim to the need to cut the budget and the intervention of the IMF.

The Ministry of Education and Science set out guidelines for Development of Science and Technology for 2008–2013. They identified the following issues to be resolved by policy

- Too few human resources in research and development (R&D) to ensure economic development and sustainable growth, the main problems being an ageing researcher labour force, falling numbers of research staff and an insufficient number of doctoral students
- Inadequate level of investment in R&D
- Poorly developed R&D infrastructure with a limited number of well-equipped laboratories, in particular in regional establishments of higher education
- Low number of patent applications in comparison to the European Union (EU) average and a lack of patents in high-tech sectors
- Limited opportunities/skills to ensure the commercialisation of knowledge
- Low awareness in society, and among youth in particular, about achievements in science and innovation

The Guidelines set out the need to

- Rejuvenate and develop the current human resources and infrastructures
- Transform universities into internationally competitive R&D centres, with which regional higher education establishments and other public and private research organisations can co-operate
- Ensure a substantial increase in public R&D investment and develop funding mechanisms, which encourage co-funding from the private sector

37 This section on laws and policies leans heavily on the ERAWATCH Latvia country report

- Strengthen the international competitiveness of national R&D performers and
- Support international cooperation in S&T
- Support knowledge and technology transfer and develop an institutional environment and support mechanisms to facilitate innovation

While these and similar guidelines have been discussed since 2002/3, Guidelines were only finally approved by Government in 2009. According the Guidelines adopted for 2009/13, the key objective of the science and technology development policy is to develop science and technologies as the long-term development foundation of civic society, economy and culture, ensuring the implementation of knowledge economy and sustainable growth. The objective is to be achieved by implementing the following tasks

- To facilitate the recovery and development of intellectual potential and infrastructure of scientific activity by developing institutions of higher education into international, competitive S&D development centres, in cooperating with which higher education institutions in the regions develop, and to strengthen other public and private scientific institutions
- To ensure a significant increase in State investment in science and technology development so that the financing allocation mechanisms would ensure increasing attraction of private sector investments
- To facilitate competitiveness of scientific activity at the international level by promoting international cooperation in the field of science and technology development
- To promote science and technology transfer, by creating an institutional environment and supporting activities favourable for innovative activity, as well as to promote public and private partnership, as well the accepted priority scientific directions attachment

The National Research Programme priorities in the 2010-13 cycle were

1. Energy and environment (renewable energy and climate technologies)
2. Innovative materials and technologies (IT, nanotech,)
3. National identity (history, language, culture, demography)
4. Public health (clinical medicine, health biotech)
5. Sustainable use of natural resources (food, forestry, natural resources)

The point at which the Ministry of Economics' priorities were clearest is at the launch of the Competence Centres programme, where the priorities were defined as

1. Chemistry and Pharmaceuticals
2. Forestry and Wood Products
3. Environment, Biotechnology, Bioenergy
4. Electronics
5. IT
6. Mechanical Engineering.

Thematic priorities therefore appear to only partly coordinated across different policy spheres.

6.1.5 Policy framework for science, technological development and innovation in Latvia

The overarching long-term policy planning document in Latvia is the Sustainable Development Strategy of Latvia until 2030 that was adopted by the Saeima in June

2010. The strategy provides a long-term vision for the national development, identifying the main priorities, goals and suggesting potential activity areas for their fulfilment. One of the priority areas of the strategy is “Innovative and Eco-efficient Economy”, including aspects of user-driven innovation, open innovation, innovative entrepreneurship and culture of mass creativity.

The National Development Plan 2014-2020 (NDP2020), adopted by Saeima in December 2012, is the highest level medium-term planning document. The NDP2020 serves as a roadmap for the implementation of the Sustainable Development Strategy 2030. It is also closely aligned with the National Reform Programme for the implementation of the EU2020 strategy. The NDP2020 leitmotiv is “Economic Breakthrough” aiming to encourage growth and competitiveness of the national economy and improvement of the people's well-being. The overall objective is to provide targeted and prudent investment of resources in areas that ensure smart specialisation, employment and cohesion.

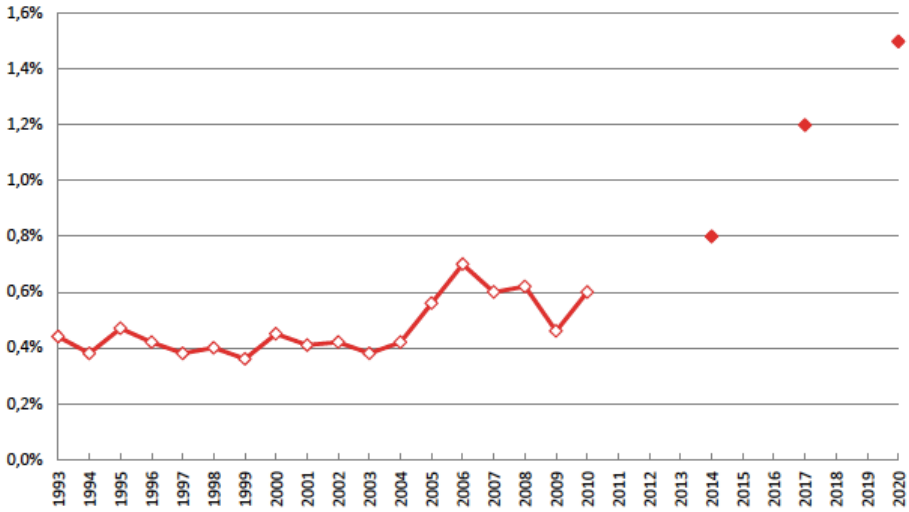
The NDP2020 envisions that science in Latvia is concentrated in research institutions that are globally competitive and a significant proportion of research is co-founded by the private sector. Academia and industry work together to generate new, innovative and creative products and services that are competitive in the world markets. To realise this vision the NDP2020 puts forward a strategic objective “Advanced Research, Innovation and Higher Education” outlining concrete targets, key performance indicators and expected results that are set in accordance with the National Reform Programme of Latvia.

With respect to research and innovation, the NDP2020 includes the following goals:

- Significant increase in R&D investment reaching 1.5% of GDP in 2020 ensuring targeted attraction of human resources, development of innovative ideas, renewal of research infrastructure, improvement of cooperation between higher education, science and industry and promotion of technology transfer;
- Promotion of the development of innovative, internationally competitive products with high added value and their successful commercialisation increasing the proportion of the output of such products in the national economy.

The total indicative funding for the implementation of this strategic objective over the seven year period is LVL 1.02bn. This includes funding from state, international and private sources.

Figure 20: NDP2020 projection of investment in R&D by 2020



Source: Analysis by the Cross-Sectoral Coordination Centre

Over a ten year period, NDP2020 quantitative targets for research and innovation foresee a significant increase in private R&D investment (11%) and increase in the number of researchers employed in the private sector (6.8%). The target is also to more than double the 2011 level for the European patents granted to researchers residing in Latvia. With respect to human resources, the goal is to maintain the current number of students graduating from universities and colleges and slightly increase the share of population (aged 30-34) that holds higher education degree.

Figure 21: NDP2020 quantitative targets for research and innovation

	Base value (year)	2014	2017	2020	2030
[172] Private sector investment in research and development in 2020 reaches at least 48% of the total investment in research and development (private sector investment in research and development, as a percentage of the total investment)	37 (2010)	42	46	48	51
[173] Number of researchers employed in the private sector, as a percentage of the total, full-time equivalent	16.2 (2010)	18	21	23	27
[174] Number of students obtaining degrees or qualifications at universities and colleges, thousands	24.8 (2011)	23.9	24.1	24.6	28.6
[175] Higher education (percentage of the population aged 30 to 34 with higher education)	36 (2012)	37	38	40	>40
[176] European patents granted, applied for by researchers residing in Latvia	11 (2011)	13	18	26	35

	Base value (year)	2014	2017	2020	2030
[179] Turnover of innovative products (as a percentage of the total turnover)	5.9 (2008)	8	9	11	>14
[180] Proportion of innovative businesses (as a percentage of all companies)	20.1 (2008)	22	25	30	>40

Source: NDP2020

The overall national science and technology policy framework in Latvia is developed by the Ministry of Education and Science in the Guidelines for Science and Technology Development 2009-2013. The Guidelines stipulate that the overarching aim of the national R&D policy is to promote science and technological development as the basis for long-term social, economic and cultural development fostering the emergence of sustainable knowledge economy. The main principles of the R&D policy are to:

- Promote the development of intellectual potential in science and the renewal of research infrastructure by forming universities into internationally competitive R&D centres that cooperate and promote also the development of regional higher education institutions and other state and private research institutions;
- Ensure substantial increase in public R&D investment attracting an increasing share of private R&D investment;
- Promote international competitiveness of Latvian science by supporting international cooperation in research and technological development;
- Promote knowledge and technology transfer by forming appropriate institutional environment, introducing necessary support measures and fostering public-private partnerships.

Latvia does not have a separate innovation policy. Before 2013, policy aspects with respect to innovation were covered by the Programme for the Promotion of Business Competitiveness and Innovation 2007-2013 developed by the Ministry of Economy. According to this programme, the main goal is to promote the increase of capacity and efficiency of the national innovation system ensuring supportive information, regulatory and financial framework conditions for innovative activities. The programme entails the following main strategic objectives:

- Support the cooperation between higher education, science and industry and promote collaborative research for the needs of the industry;
- Foster technology transfer and research commercialisation;
- Promote the introduction of innovative processes in industry;
- Ensure the availability of financial support services for entrepreneurs and start-ups;
- Promote the creation and development of innovative start-ups.

In the spring 2013, the Cabinet of Ministers approved the Guidelines for National Industrial Policy (NIP) 2013-2020 developed by the Ministry of Economy. The goal of the NIP is to promote structural changes in the national economy favouring the development and export of higher added value products and services, increasing the role of manufacturing in the overall economic activities and supporting the modernisation of manufacturing and service sectors. The promotion of innovation is included among the six priority areas of the NIP2020.

Taking into account the low innovation performance of Latvia and the domination of low and medium technology enterprises in the overall industrial composition, the NIP2020 outlines the following strategic objectives:

- Direct the development of technologies and manufacturing sector towards higher value added production;
- Foster knowledge absorption and dynamic entrepreneurship.

The NIP2020 underlines the necessity to develop a balanced and complementary mix of innovation support instruments addressing knowledge creation, diffusion and commercialisation. Taking into account the identified bottlenecks and market failures, the NIP2020 identifies the following priority areas for increasing research and innovation capacity of businesses in Latvia:

- The substitution of the current incentives for private R&D investment with new incentives stipulating in the corporate income tax law that defined types of private R&D investment are written off from income tax in triple the amount of the actual expenditure that took place within a respective year;
- Continuation of the support to entrepreneurship in the form of grants for high-risk initiatives developing new products and technologies. Support should be provided for industrial research, development of experimental facilities and industrial design and for the strengthening of industrial property rights. Support for seed-capital investment that is necessary for the introduction of new products and technologies in manufacturing should be provided mainly through financial instruments.
- Support for innovative start-ups improving business consultative (mentoring and couching) and incubation services and provision of tailored financial instruments for innovative and technology intensive enterprises in their start-up phase.

In addition to the aforementioned priority actions, the NIP2020 outline also these complementary activities:

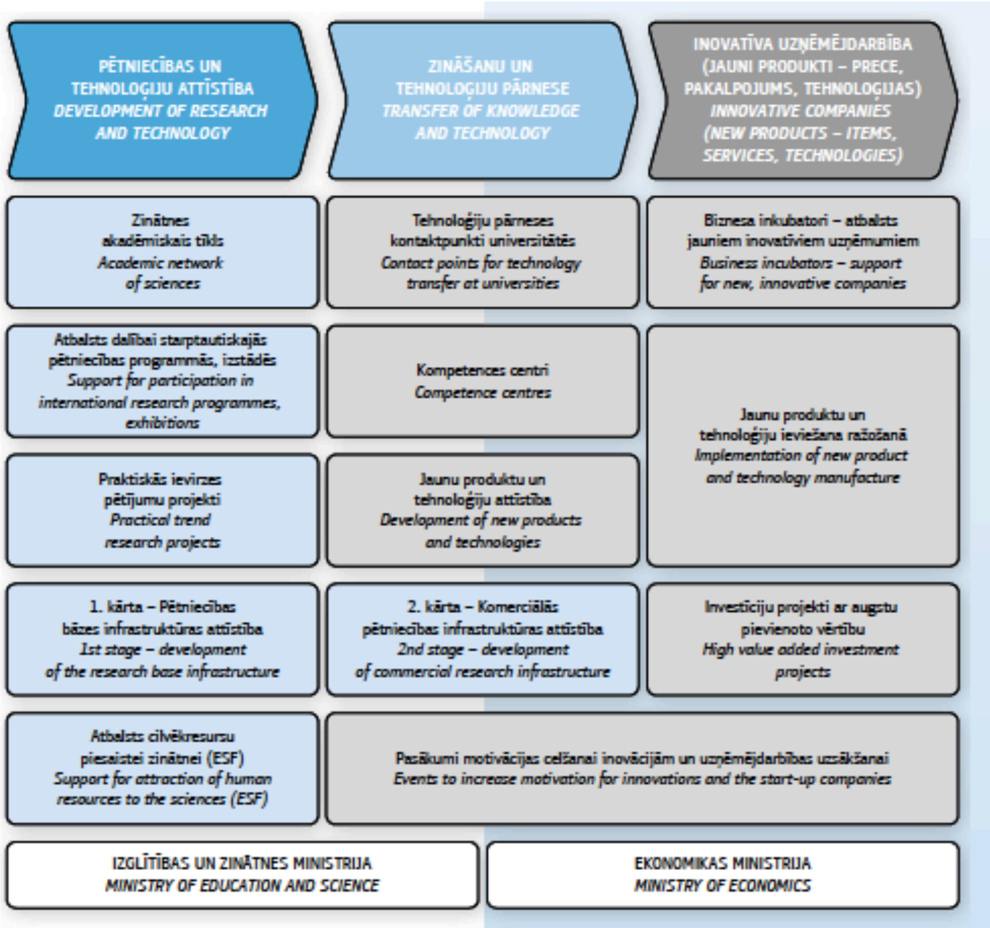
- Development of scientific excellence by promoting the consolidation and improvement of research infrastructure and human resources in science;
- Development of technology transfer system by supporting joint public-private R&D initiatives and providing support to small and medium-sized enterprises for the purchase of R&D services; Formation of a joint national platform for technology transfer that is not linked to any individual research institution; Provision of combined support for technology transfer with incubation and financial support services for start-ups.
- Support for the development of creative industries and their cooperation with traditional industrial sectors to increase the non-material value of products and services.

6.1.6 Research and innovation support measures and funding

Figure 22 is a recent picture of the main funding instruments used to support research and innovation by the Ministry of Education and Science on the one hand and the Economy on the other. This corresponds well to the kind of portfolio found elsewhere. Three categories omitted are

- Funding orientated to developing researchers and the research career. Many countries have a young researcher scheme of some sort that shelters early-career researchers from competition from senior members of the research community with impressive track records. Whether orientated to early career faculty members or to post-docs, these are a vital ingredient in renewing the national research community
- Schemes that educate and encourage the development of absorptive capacity by industry, especially smaller companies
- There is effectively no demand-side innovation policy (Trend Chart Mini-report 2011)

Figure 22: Support measures for science, technology development and innovation funded from the EU structural funds



Source: MoES (2011) Development of Science and Technology in Latvia, 2011

6.1.7 Difficulties in Implementation

The difficult financial climate, short-term planning within the state, insufficient administrative capacity and the low political priority of innovation and research and a heavily bureaucratic tradition all make it hard to implement research and innovation policy in Latvia.

- Government commitments to research and innovation appear hard to maintain, despite the important of these to national competitiveness and wealth creation (for example, the inability to raise the overall budget by 0.15% per year as intended, or the failure to fund the universities in line with the commitment to a specific amount of money per student
- Significant budget uncertainties and fluctuations from year to year make it hard for research performers to develop and implement strategies
- Bureaucratic restrictions impede the use of new funding instruments. For example, the legal form of the competence centres meant that they had initially to launch formal competitive procurement processes in order to buy simple input such as chemicals; inability to use ERDF-funded university equipment in connection with commercialisation; inability for a long time to establish a business incubator in Riga rather than in the regions, despite this being the location with the greatest obvious innovation potential

- A common difficulty for the Ministries has been limited capacity. This has been exacerbated by the need to cut costs and by civil service wage reductions in recent years, making it difficult to retain or replace key personnel. It leads to excessive caution and the inability to take decisions at a sufficiently high rate.

But the most powerful reason behind these issues of implementation seems to be a lack of political commitment to the idea that research and innovation are important drivers of development and growth. This problem is likely to have two elements: first, a lack of experience and exposure at political level to success examples, especially in the specifically Latvian context; second, the problem of 'dynamic inconsistency', by which we mean the incompatibility of the short time constants relevant to political life and the rather long ones that apply in research and innovation. These are spheres where little can be achieved in the way of societal impacts during the lifetime of any one government. Almost all other countries nonetheless manage to give them priority – and in the context of the financial crisis, the level of priority given to them by other countries is quite extraordinary. This is essentially achieved by partly depoliticising research and innovation policy (for example through multi-party consensus) and establishing the idea that enacting policies that promote innovation and research is itself an important contribution to the national good. Politicians therefore get credit for doing things about research and innovation, even if the results of their actions are not visible in the short term.

7. Findings of the Research Evaluation Exercise

7.1 The RAE process

The RAE is reported separately from this volume in detail and was conducted by six disciplinary panels of scientific peers. Some 150 research groups recognised by the Ministry of Education presented self-assessments of their research performance, using a common format devised by the Ministry, and were assessed by the panels. The panels were also provided with analyses of data presented in the self-assessments as well as simple bibliometric indicators per research group, based on the Scopus database. Each panel was in Latvia for a week. This meant that they were able to make site visits to about half the groups. A deliberate choice was made to focus the visits on the larger and apparently better-performing groups, in the expectation that this would enable the panels to identify the leading researchers and groups. The panels provided a report on each research group that had submitted a self-assessment.

The RAE aimed to assess Latvian research in international context – in effect using the standards prevailing at the global level to define the benchmark. This necessarily means that the scores for a small research community in a small country are likely to be on the low side. However, the alternative – namely, to devise a Latvia-specific scale – would have left the meaning of the assessment unclear. Panels expressed their assessments in both prose and numbers. The reader is referred to the full documents for a nuanced understanding of the assessments; for reasons of space, only a fairly crude summary can be given here.

The panels assessed the research on five dimensions

- Scientific quality
- Impact on science
- Economic and social impact
- Research environment and infrastructure
- Development potential

They additionally provided a qualitative Overall score based on their overall view (and not, therefore, generated by doing arithmetic on the other scores).

Figure 23 shows the assessment criteria used for scientific quality. The panels used similar scales to assess the other dimensions, except that the 'social and economic impact' dimension was referenced to impacts in Latvia, rather than the world. The Development Potential dimension was intended to reflect the panels' view of how worthwhile it was likely to be for the state to invest in the particular research group, given its quality and circumstances.

Figure 23 Assessment criteria for Sub-element A: scientific quality

A: SCIENTIFIC/RESEARCH QUALITY		
Particular factors to take into account		• Pure and applied research shall be evaluated as being of equal significance
SCORE	**DEFINTION**	**DESCRIPTION**
5	**Outstanding**	**The institution is a <u>Global Leader</u>** In terms of the quality, the research output of an institution is comparable with the best work internationally in the same area of research. The research possesses the requisite quality to meet highest international standard in terms of originality, significance and accuracy. Work at this level should be a key international reference point in the respective area.
4	**Very good**	**The institution is a <u>Strong International Player</u>** Research by the institution possesses a very good standard of quality in terms of originality and importance. Work at this level can arouse serious interest in the international academic community, and international publishers or journals with the most rigorous standards of publication (irrespective of the place or language of publication) could publish work of this level.
3	**Good level**	**The institution is a <u>Strong National Player with some International Recognition</u>** The importance of research by the institution is unquestionable in the experts' assessment. Internationally recognized publishers or journals could publish work of this level.
2	**Adequate**	**The institution is an <u>Satisfactory National Player</u>** The international academic community deems the significance of the research by the institution to be acceptable. Nationally recognized publishers or journals could publish work of this level.
1	**Poor**	**The institution is an <u>Poor National Player</u>** Research by the institution contains new scientific discoveries only sporadically. The profile of the research by the institution is expressly national, i.e., the institution is not involved in international debates of the scientific community. It focuses on introducing international research trends in Latvia.

7.2 What we can infer from research units' self assessments

Analysis of self-evaluation reports and bibliometric performance of Latvian research groups allows some observations can be made.

- The number of research-performing institutions and the number of research groups are very large in relation to the population of the country. Multiple groups work in similar areas. The structure is therefore fragmented and probably in many respects under-critical – especially in fields where infrastructure is important for doing research
- The proportion of 'indexed' publications (Web of Science, Scopus, etc) in total publications is very low, suggesting that a lot of the research is primarily of local

interest. This reinforces the impression of limited international contact provided by Figure 16

- In many cases, indexed articles are not much cited, suggesting there may be a quality issue
- There is a small number of groups, who seem to perform well and to be visible in the international literature
- Funding per researcher varies greatly, even within similar fields
- PhD production is concentrated in the major universities but with a long 'tail' across many institutes. If this is a symptom of joint working it is likely to be useful – many PhDs benefit from an institute context, where the worker can focus on specialised research. But it may also be a symptom of fragmentation and failure to create effective graduate schools, sharing infrastructure, teaching on methods etc.
- Only a modest number of groups obtain Framework Programme funding. Where people work in areas of relevance to the Framework Programme, the ability to participate is an important 'litmus test' of research groups' international networks and quality
- The humanities always tend to be more national and less orientated towards academic journals than the sciences. Nonetheless, the impression from the output performance in Latvia is of a high degree of national focus. The humanities are increasingly seen as places for international rather than just national scholarship, so this may give grounds for concern

7.3 The panels' views

Figure 24 shows the mean scores each panel gave on each dimension. Ten of the units were adjudged by the panels not to be performing research and scored zero. The panels were carefully briefed on the use of the scales at the start of their visits to Latvia, with the aim to encourage them to use the scales in similar ways. Since it is not possible to triangulate across the panels, we cannot be certain that despite the efforts of those supporting the panels the scores are fully comparable. However, in the judgement of those of us who accompanies the panels and supported them, there is a good level of consistency between their verbal and numerical accounts.

Figure 24 Mean RAE scores per discipline

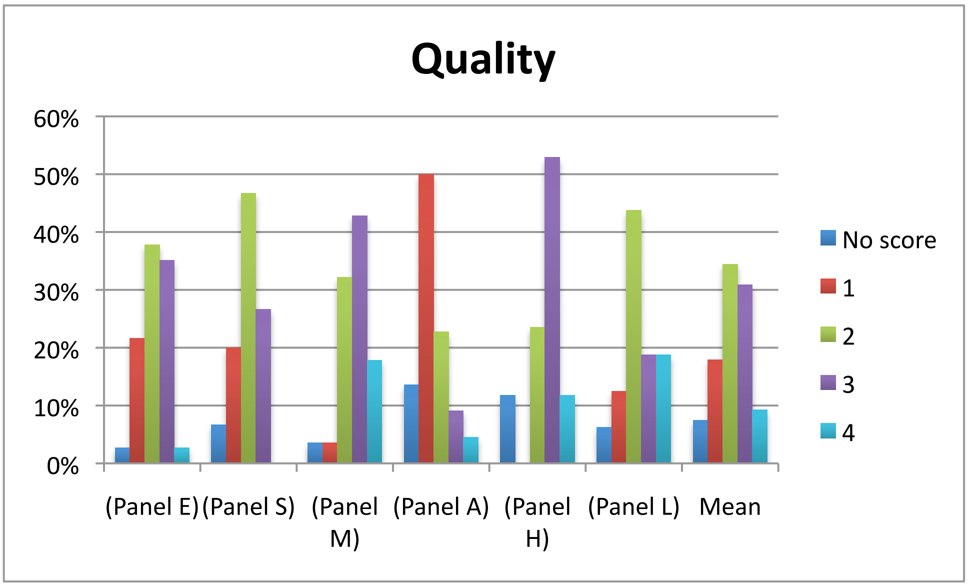
	Engineering & Computer Science	Social Science	Natural Science & Mathematics	Agriculture, Forestry & Veterinary Science	Humanities	Life Sciences & Medicine
Overall score	2.2	2.0	2.6	1.6	2.2	2.3
Quality	2.1	1.9	2.7	1.4	2.5	2.3
Scientific impact	2.3	1.9	2.4	1.8	2.6	2.3
Economic and social impact	2.4	2.4	2.9	2.3	2.6	2.5
Research environment	2.3	1.9	2.5	1.6	2.1	2.1
Development potential	2.2	1.9	2.7	1.7	2.2	2.4

As the numbers suggest, overall the panels found that the average level of research quality, management and infrastructure left much to be desired. At the same time, there are important high points, such as the Institute of Organic Synthesis, the Latvian Biomedical Research and Study Centre, the Institute of Electronics and Computer

Science and that of Food Safety. These and others provide potential nodes for future investments.

The averages shown in Figure 24 of course conceal a range of scores[38]. Figure 25 shows the distributions for scientific quality. Twelve groups scored '4' for quality; there were no 5s. The commonest score was '2' – a satisfactory national player but not good enough to operate internationally. In maths and the natural sciences, the commonest score was 3, while in Agriculture it was 1.

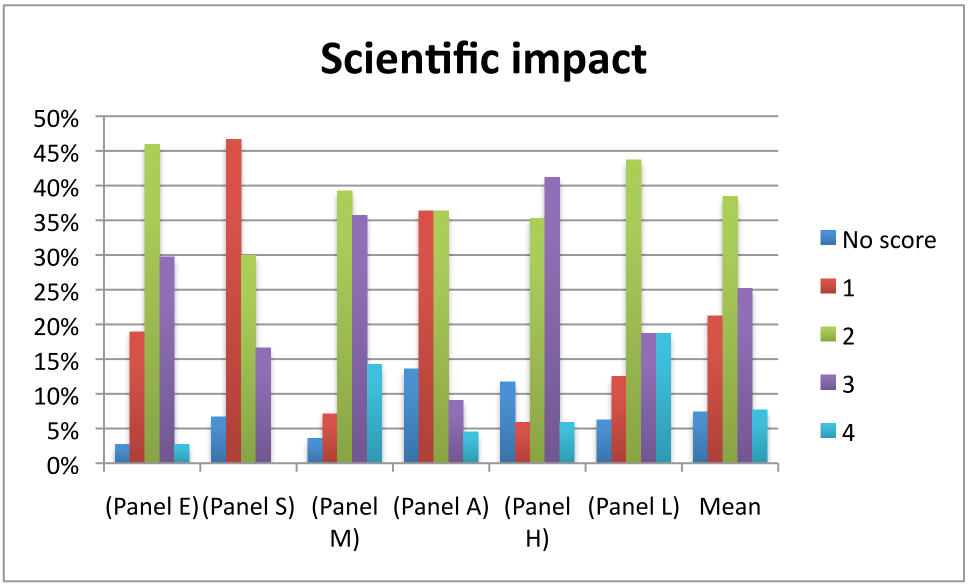
Figure 25 Score distributions for scientific quality



As with quality, the commonest score for impact or influence on the scientific field was '2'. There were ten 4s (mainly in maths and the sciences) but no 5s. The social scientists were the weakest, reflecting the novelty of many of the fields in Latvia while the humanists (by a small margin) were the strongest with a peak of 3. But both they and the mathematics and natural sciences fields had rather similar numbers of 2s and 3s.

[38] Strictly, because the scales used are qualitative, Likert scales where the 'distance' between numbers is not mathematically defined, distributions rather than averages should be used. However, showing averages provides a useful shorthand

Figure 26 Score distributions for impact on science



The economic and social impact dimension represents a judgement about the effects of the groups **in Latvia**, which is one reason the scores are a bit higher than for other dimensions. Overall, there are about as many 3s as 2s. The humanists have the biggest proportion of 4s, reflecting their importance not only in culture but also in areas like pedagogy.

Figure 27 Score distributions for economic and social impact

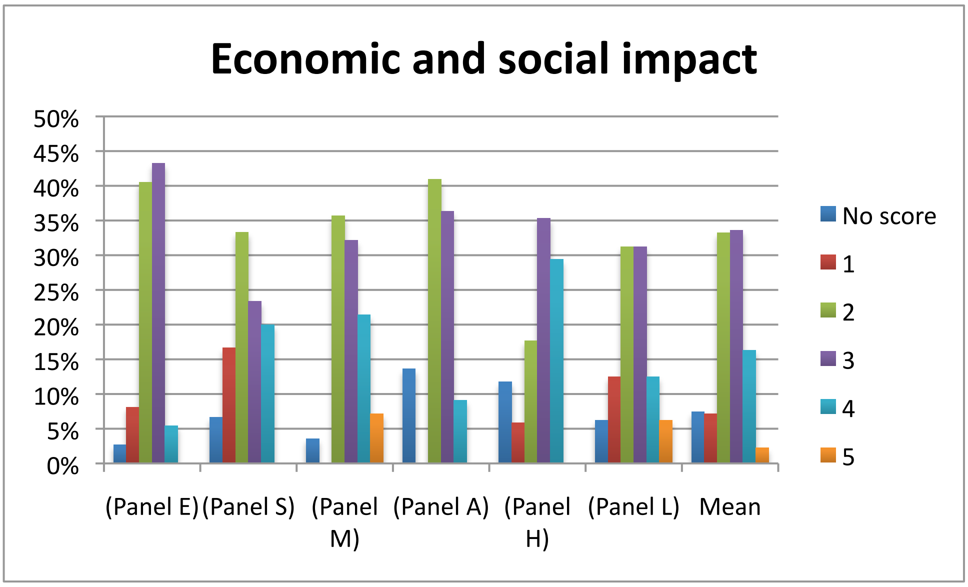
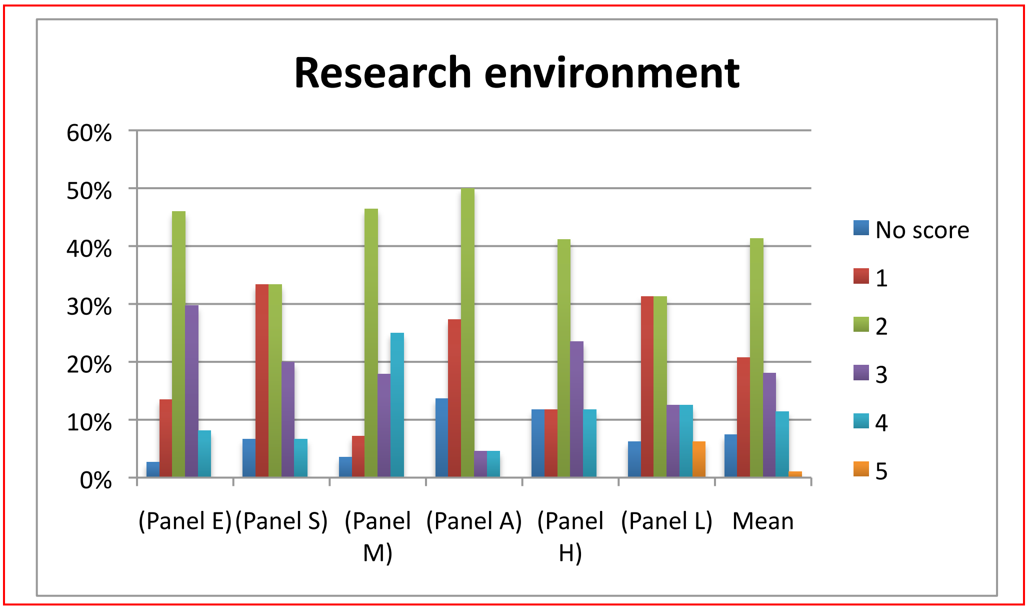


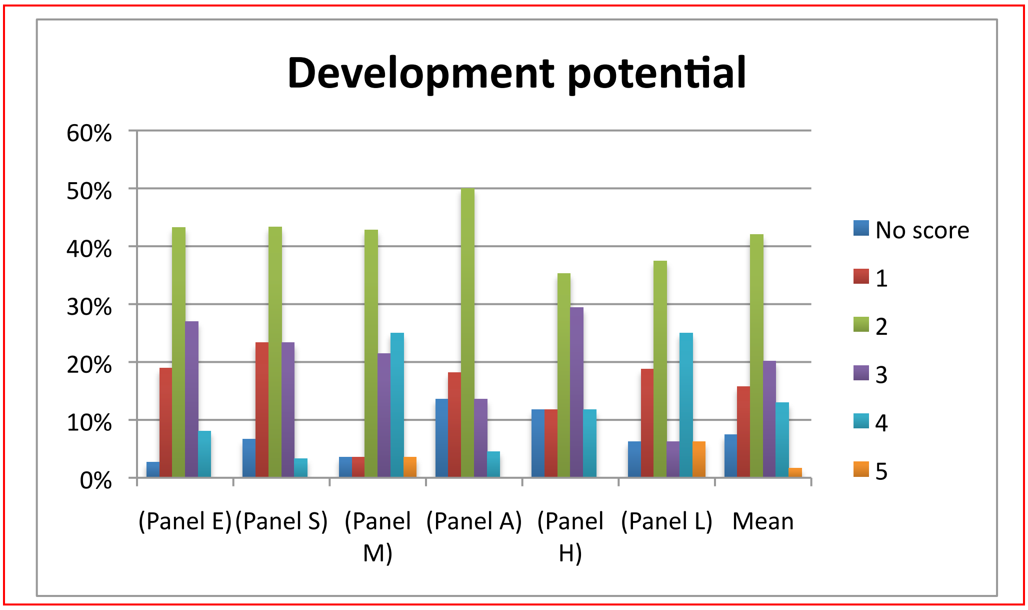
Figure 28 shows score distributions for research environment and infrastructure, which represents a composite judgement about both the physical infrastructure and the appropriateness of management, especially in relation to research strategy and human resources. Again, '2' is the commonest score, but both the life and the social sciences have as many 1s. But the distributions also show quite a number of higher-performing groups on this dimension.

Figure 28 Score distributions for research environment and infrastructure



The scores shown in Figure 29 represent the panels' judgements about which groups are promising enough to be worth an investment. The majority are unpromising (2s) but there is nonetheless a substantial number of 3s and 4s – and even a small number of 5s – that suggest the research system contains a number of nodes around which it could usefully coalesce – reducing fragmentation and building strength.

Figure 29 Score distributions for development potential



Overall, the judgement is that

- Engineering and computer science (Panel E) is surprisingly fragmented, with a great deal of activity at levels below international norms but also with important high spots. Given the importance of these disciplines for the economy, strengthening their performance should have high priority

- Social sciences are not very mature in Latvia, with many of the disciplines involved having being developed mainly in the post-Soviet era
- Mathematics and the natural sciences (Panel M) are comparatively strong and well established, though there are low as well as comparatively high performers. This strength represents an important economic opportunity
- Agricultural research (Panel A), like humanities, needs to a fair extent to be focused on national needs but is overly so, fragmented and in need of more international perspective. The division of labour between the ministries of education and agriculture seems to exacerbate the fragmentation – perhaps because the distinction between fundamental research and education on the one hand and the legitimate need for government laboratories in agriculture is not clearly made
- Humanities (Panel H) is especially fragmented – though it should be noted that this is the case in most countries – and especially focused on Latvian issues and norms
- Life sciences (Panel L) groups are mainly national players but there are high points with a handful of units that can functional at international levels of quality and relevance

Underpinning these patterns is a series of problems, the most fundamental of which is the absolutely low level of research funding in the system as a whole. Much of that limited funding has come from Structural Funds in recent years and is therefore at risk. Ultimately, any developed country must be financing its own research on a permanent basis. Temporary funds are useful for supporting transitions but cannot sustainably fund 'business as usual'.

The separation between teaching and research that has in Latvia been perpetuated beyond the end of the Soviet system is generally problematic. While large countries like Germany can coherently maintain parallel university and institute systems with critical mass, doing so in a very small country is difficult. The fact that many of the best and most robust research units in Latvia are institutes is a symptom of this fact rather than a reason to keep them separate from the teaching system. Generically, teaching requires breadth while research needs depth. In order to have a robust research-based teaching system that produces relevant human capital and good-quality research the two elements need to be merged in a small country – or at the very least to be closely integrated.

Incentives for both teaching and research in the Latvian system encourage fragmentation – which is the opposite of what is necessary in a small country. The practice of registering any qualifying, self-defined group of researchers as a research unit is one of the causes of this fragmentation. The result is a structure that is fragmented and duplicative across all areas of research. The panels found many cases where infrastructure and equipment were poorly tied to units' research programmes, so there is scope for better planning and utilisation of such resources. Strengthening the research system will depend upon reducing this fragmentation, using the capabilities of stronger research units to lead the way towards fewer centres, which should have critical mass and a meaningful international profile, so that Latvia can participate more fully in international science.

Human resources are a problem. Except in social sciences, there is generally a bimodal age distribution, in many cases with leaders who are well beyond a normal retirement age. This poses important problems of renewal. The positive aspect is that there are generations of younger researchers – and in the view of the panels, many promising PhD students – who, with adequate training and funding support, can step in and lead Latvian research towards a more dynamic and internationally integrated performance. Achieving this requires improved understanding of research leadership and management as well as funding and internal career incentives that support development, including funding for young researchers and post-docs. Better support to mobility, reducing inbreeding in the research community and connecting it better to the international community, is also needed.

The mediocre quality of much (but by no means all) of the research the panels reviewed is manifested in over-focus on Latvian issues, Latvian channels of communication, Latvian conferences. This isolates the Latvian research community from international science, reduces competitive pressure on that community and its understanding of international quality norms and impedes the communication and integration even of good-quality Latvian research results with world science. Of course, national issues are important – more so in some fields than in others – but in the unanimous judgement of the panels this balance is in the wrong place. More internationalism is needed. That requires recruitment and career development incentives that are more orientated to the international research community and not least to publication in international, peer-reviewed English-language journals. While the predominance of English publications undoubtedly represents an unfortunate sort of cultural imperialism, the reality is that English is the language of modern scholarship, just as Latin was in the distant past. Incentives need to be adjusted accordingly.

The disciplinary coverage of Latvian research is broadly good: there is at least some competence in most subjects. The social sciences in this respect are – for historical reasons – less well placed. Economics lacks strong centres and needs further development. Business and management are important subjects that are largely tackled outside the public system, and are correspondingly over-focused on education at the expense of research. These also need strengthening within the public system.

7.4 Policy implications

The biggest question is, as earlier indicated, the absolute lack of money. This is completely understandable in the current economic context. However, the plain fact is that you cannot build and sustain a modern economy without making a significant expenditure on research and higher education. If you fail to make this investment, the supply of high-quality human resources to society and industry is too small and those people who could be driving socio-economic development and growth tend to drift abroad. The production of knowledge is of course one very important reason for funding research; but the production of human capital is probably an even more important reason for doing so. Lack of human capital means not only that the country has difficulties in exploiting its own knowledge production but also, crucially, that it is hard to exploit the more than 99% of new knowledge that is generated abroad. Without these capabilities, the country will enter a declining spiral that infects the performance of the economy as a whole.

Major policy needs are

- Allocation of permanent national funding to research, using Structural Funds as far as possible only to pay for the costs of reforming and transitioning the system to higher levels of performance
- De-fragmenting and strengthening the research system by consolidating research units – primarily around the 'cores' provided by the existing well-performing units – and proving incentives for quality and international reach
- Provision of a higher level of competitive, project-based funding, using a number of instruments to
  - Support different stages of the researcher career, not least post-docs and young researchers
  - Support the formation of larger centres and groups, through centre funding and the provision of large as well as small research grants
  - Encourage better research-industry cooperation, raising industrial capabilities and providing signals to the research community about relevance and which

problems are especially interesting from a societal perspective; here the experience of VINNOVA and TEKES in developing such links may be especially valuable to Latvia

- Use of an institutional funding system that is based on a balance of prospective planning, international peer review and performance indicators, so as to combine strategic development, incentives related to measurement and embedding in the international research system

8. Recommendations

As the preceding diagnosis implies, the extent of change needed in the Latvian NRIS in order to bring its performance even up to an average EU level is significant. Here we outline the main policies needed.

8.1 Production and innovation

Since companies ate the organisations that translate knowledge into money and jobs, it is central to innovation and research policy to focus on ensuring they have the capacity and capabilities to do so. How can this be done?

Companies tend to respond to market signals, so one key set of policies relates to the **demand** companies experience. International markets tend to be more demanding of innovation than domestic ones, so using traditional 'export council' services (help in understanding markets, identifying opportunities, making international contacts) produces signals about needs for innovation to which companies can be expected themselves to respond. Innovation can also be encouraged if customers in Latvia become more demanding. State or semi-state organisations such as electricity companies, ministries and other large buyers can set higher standards for quality and performance, to which their domestic suppliers can respond. Encouraging the use of ISO 9000 and 14 000 standards for quality and sustainability is another way for make the domestic environment more demanding – in addition to encouraging companies to obtain certification that serves them well in international markets. A separate set of demand-side policies such as 'innovative procurement' is also available, which can encourage the development of specific innovations of in the delivery of public services, which in turn create advantages for the companies that develop them in seeking other national and international markets.

Raising the level of absorptive capacity in individual firms is a precondition for many to be able to recognise and respond to market signals demanding innovation. Two kinds of interventions can be undertaken.

- One set is concerned with helping companies to understand improvement opportunities. These can be technology-related or more conventionally business-related. Their common theme is increasing companies' ability to see opportunities
  - In terms of pure business opportunities, Norway has for some decades run a programme called FRAM, where groups of entrepreneurs in different businesses to a mixture of classroom training and project work with the aim of achieving a 10% increase in their company's profits. The persistence of the programme reflects Norwegian confidence that this improves companies' strategies and ability to exploit markets. Such an initiative could be a very useful complement to the high rate of necessity-driven entrepreneurship in Latvia
  - Many countries have run 'technology audit' programmes, where an experienced engineer and manager reviews the company's activities and technologies and proposes a number of improvements and a programme for implementing them – again with the aim of increasing profitability

- Wider publicity campaigns showing examples of how successful innovation turns into money have also been run in many countries; innovation prizes are a variant of this idea. We have not seen anyone focus publicity on the 'costs of non-innovation' but this might be a further useful ingredient in a publicity campaign
- A second helps inject new or additional human resources into companies.
  - One of the longest-standing ideas is the 'Teaching Company Scheme' operated in the UK and a number of Commonwealth countries (under a range of changing names). This involves placing a fresh graduate (typically an engineer or hard scientist) in a company with some subsidy and a link back to her or his college, to get supervision for an innovation project. Some schemes do not involve this link, but the use of fresh graduates tends to mean that those involved nonetheless exploit their academic networks. After a period of subsidy, these people tend to remain in the company – raising technological capabilities, triggering innovation and eventually encouraging the recruitment of further graduates without subsidy
  - Denmark created an 'industry doctorand' scheme some years ago, which has been widely copied. In these schemes the state and the company share the cost of a PhD student, working on a problem of relevance to the company, with the expectation that they will join the firm on a full-time basis once they complete, giving the company access to higher-level skills and an improved ability to exploit the international knowledge base for innovation

It is important to include MNC subsidiaries in at least some innovation instruments, in order to strengthen the hand of local plant in the international competition for work that normally exists within MNCs and to help develop the innovation capabilities of people who will over time tend to migrate into domestic industry, or to set up their own companies based on the experience they have gained with the MNC. (The strong domestic ICT industry in Ireland is one of the good examples of the value of treating MNCs as 'training schools' for domestic industry.)

Innovators do not innovate alone. At the current early stage of cluster policy in Latvia, there is a risk of over-emphasising the aspect of competitors cooperating. That is difficult to achieve in the short run, even if it is very typical of advanced industrial districts. Organising clusters to identify and address common needs (eg lack of apprentices, shared infrastructure, international market access, etc) can be more powerful than focusing on co-production to meet lumpy order flows. Cluster policies and policies that develop companies along supply chains are useful in building the links up- and downstream that companies need. Large state or private buyers can be encouraged to help their suppliers develop better capabilities, products and quality.

Cluster policy is a useful way to build upon existing skills and resources in production and exports. Developing company capabilities within clusters over time should involve cluster-specific links to the further and higher education systems, providing inputs about the specific training needs of the cluster, higher education needs and focusing attention on cluster-specific problems and challenges that need research.

The Ministry of the Economy has identified important skill shortages at national level. The coming shortage of scientists and engineers at degree level can in part be tackled by offering differential fees or other incentives to students studying in these areas.

In parallel, there is a need for better development of Vocational Education and Training, especially in the shortage areas identified by the Ministry. The content of vocational education is currently being reviewed under the ESF project 'Development of an industry qualifications system and raising the efficiency and quality of vocational education'. Activities include the creation and operation of 12 sectoral expert councils (tripartite representation – employers, employees, and the government) to ensure close cooperation with employers; development of sectoral research and industry qualifications framework; improvement of vocational standards; improvement of vocational education programmes for initial and life-long learning using a modular approach, etc

The obstacles the black economy poses to innovation are important. Colombia has developed a formalisation incentive that involves incrementally exposing the informal firm to the formal tax system, easing the transition. The Formalisation Law (1429 of 2010) provides micro credits and other credit programmes to encourage formal employment of people under 28, professionals, technicians, leading to formalization and generation of business, employment and telecommuting, using tools such as tax breaks, capital assistance, grace periods, training programs, technical assistance and expert advice. It allows new small businesses gradually to enter the tax system, with no income tax payable during the first two years, only 25% of the tax due in the third year, 50% in the fourth, 75% in the fifth, and normal taxation in the sixth and subsequent year. Comparable discounts are offered for 'parafiscal' payments – health insurance, social security, and the like and for taking on workers under age 28.

8.2 The knowledge infrastructure

The 'knowledge infrastructure' of universities and research institutes is still deeply influenced by the Soviet past. While much of the old applied industrial research institute sector – where institutes effectively served as the external R&D departments of individual factories – has been integrated into industry or scaled down, there remain parts of the institute sector (and even one or two parts of the university sector, certainly at RTU) that play a substantial role in supporting multiple companies across industry. These come close to being 'Research and Technology Organisations' (RTOs) with functions similar to those of the Fraunhofer Society, TNO or VTT. It would be useful to conduct a closer study to identify the opportunities to build on these institutes as a way more consciously to support the development of Latvian industry by sharpening their focus and purpose, clarifying their economics and organising them as a sector – whether in the form of a larger polytechnic organisation on the German / Dutch / Finnish style or as a federation of more free-standing institutes, as in Sweden or Denmark.

Leaving these potential RTOs aside, the picture emerging from initial analysis of the self-assessment returns from research-performing groups is of excessive fragmentation, limited international orientation, limited resources and modest quality (consistent with the bibliometric picture). Against a background of intense global competition in research as well as innovation, and in research labour markets as well as in the production of knowledge and human capital, the policy response should be to increase incentives for quality while changing the structure of the research-performing system to encourage the development of critical mass and specialisation appropriate to national needs.

The too-low level of institutional funding for research encourages fragmentation, makes it hard to recruit, plan or develop sustainable partnerships with other research groups abroad and with industry. Institutional funding should be more like 50% than the current 17% of university research income. It should be influenced by performance, via periodic reviews of quality and relevance (in the style of the current research assessment exercise or a variant of it). Performance-based institutional funding should be paid to the institutions, not to the research groups that generate the performance, in order to provide the institutions with the means to implement strategy. In many cases they will want simply to pass performance-driven funds through to the individual research groups; but in other cases, the ability to change direction becomes vital. This would put a double pressure on research performers

- To build high-quality, sustainable research groups grounded in the fundamentals as well as (where relevant) the applied elements of their disciplines, building on a foundation of institutional funding that – while contested and therefore not in the long run guaranteed – is nonetheless slow to change and therefore dependable

- To seek continued project by project competition for resources, allowing the state and industry to influence the pattern of research (where relevant in both fundamental and applied areas) as well as its quality and relevance

These changes would help change the incentives under which Latvian researchers and groups operate. They should be encouraged to merge groups and activities in ways that make sense to the groups involved but which allow them selectively to build scale by agglomerating the better researchers. Our assumption is that this should take place within the universities, in order to benefit from their administrative capacity and to ensure a link to teaching. It is not obvious that a country as small as Latvia can afford the duplication and fragmentation that is induced by parallel institutes and faculty structures, as perhaps Germany can. This process of rationalisation can be supported by the development of strategy processes within the universities. Other countries' experience suggests that funding for some external evaluation and change management support can speed up and improve the quality of this process, since it involves considerable amounts of institutional learning.

University reform has been on the agenda for a number of years, without having been achieved. It should nonetheless be a high priority, to reduce fragmentation, increase quality and relevance and enable universities to devise and implement strategies for change. Rather than simply to try to impose a new model on the universities, it could be useful to run a learning process together with them, moderated by MoES that involves

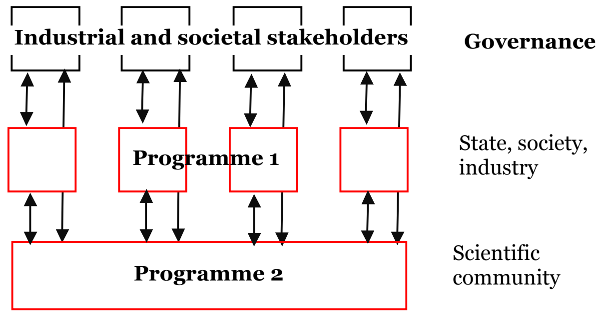
1. Reviewing alternative university management and governance models, in international experience
2. A study tour of senior academics, aiming to learn at first hand about the strengths and weaknesses of different models
3. Defining the outlines of a new model that conforms to national needs while respecting international practice

Programmes to foster inward mobility of researchers are needed, in order to generate more internal competition in the research community and to increase the currently limited number of international research relationships. Removing the current restriction on the use of foreign languages in Latvian university teaching would support the needed internationalisation.

As we understand it, the pattern of research effort across different research disciplines in Latvia remains strongly influenced by the allocation of tasks within the Soviet Union and less so by the now rather changed shape and composition of Latvian industry or societal needs. In some areas there may be little choice but to reduce funding in order to free resources to build new capacity elsewhere. That is a decision that can only be taken at national level, and if this is done it should be implemented on the basis of competition. Growing new capacities to meet changing national and global needs is in principle easier but nonetheless requires resources.

While Swedish research and innovation policy is characterised by a long-running battle between 'basic' and 'innovation' fractions, it is also the place where the need for all the different styles was most clearly and early recognised, when a new innovation agency (Styrelsen för Teknisk Utveckling – STU) was set up in 1968 to act as a 'change agent' and combat the stagnation in national research identified by the OECD review of Swedish science policy in 1964. STU came to argue that Sweden needed the conventional research councils to fund bottom-up and foster excellence across a very wide range of disciplines in order to keep the university teachers current, make sure the foreigners could not fool the Swedes and to ensure that any field that proved promising could quickly be expanded, based on the human capital already in place. This it called 'Programme 2'. STU saw its own role as 'Programme 1': funding research activity in the parts of the system that underpinned industrial and other societal needs – connecting non-academic actors like the major Swedish companies with the academic research community and making sure that enough knowledge and people were generated in the areas of contact between the scientific and other societal systems.

Figure 30 Programme 1 and Programme 2



'Programme 1' funding is implemented through a range of technology programmes and more structural interventions such as competence centres. To some degree these have their counterparts in current Latvian policy. However, in Sweden a very high degree of stakeholder involvement in programme definition has been central to get the interventions to operate as 'focusing devices': signalling to both research and industry about the opportunities to do and exploit useful research in areas of industrial and societal need. The original Swedish Competence Centres programme called for the creation of academic-industrial R&D consortia without specifying what themes the centres should pursue. The result was a sort of 'informal foresight' that identified the technologies and actors with the interest and the power to develop and use knowledge. The industrial effects – as well as the restructuring effects in the Swedish universities – have been very large[39].

The development of the Smart Specialisation Strategy for Latvia offers opportunities to group stakeholders at programme or centre level in order to influence the design or focus of research and innovation interventions in ways that mirror such successes abroad.

Currently, there is growing interest among the universities in running Technology Transfer Offices that take intellectual property rights in knowledge developed at the university and try to commercialise it through licensing or spinouts. Internationally, this is a loss-making activity for most universities; at best, it takes a very long time, quite a lot of luck and a rather good university to build up a portfolio that is good enough to be profitable. It complicates relationships with industry, which fears the universities' desires to own IPR and is less likely to engage in other forms of research cooperation. The more traditional Industry Liaison Office function is also present – especially at RTU – and provides good interaction with (often, but not only) smaller companies and arguably offers a more effective means of knowledge exchange between industry and research[40]. If the TTO effort is to continue, there is a case to build a common national function in order to acquire the needed legal and business expertise and develop a portfolio. At the current stage of development of Latvian industry, there is a strong case for continuing to focus on the ILO function.

[39] Peter Stern, Erik Arnold, Malin Carlberg, Tobias Fridholm, Cristina Rosemberg and Miriam Terrell, *Long Term Industrial Impacts of the Swedish Competence Centres,* VA 2013:10, Stockholm: VINNOVA, 2013

[40] Erik Arnold, Paula Knee, Neil Brown, Zsuzsa Jávorka, Flora Giarracca and Sabeen Sidiqi, *Knowledge Transfer from Public Research Organisations*, European Parliament: STOA, 2012

8.3 Implications of the research assessment exercise

This is the second time a research assessment exercise has been done in Latvia. The first one was done over 20 years ago in a time of radical systems transition when it was perhaps especially hard to implement change. As a result, it has almost no impact on the research system. For all intents and purposes it may as well not have happened.

In an important sense, therefore, the current exercise is the 'first' and is an important learning exercise for research performers as well as for the Latvian system as a whole. The variable quality of the self-assessments and in many cases the uncertainties people experienced in knowing how to represent themselves and their units testify to the fact that many of them lack sufficient experience of research strategy, leadership and communication. These skills should improve over time. But the fact that in many cases learning is at an early stage means that the results of the exercise should be used in a way that reflects the fact that not everyone was able to present themselves well. A harsh, UK-style reallocation of resources, unaccompanied by developmental measures, may do as much harm as good.

Latvia therefore needs to adopt a softer, but nonetheless robust, approach. It would not be wise to make a one-to-one translation of RAE scores into resource allocation – and it would be especially unwise top-down to decide who should merge with whom. The first step is to use the RAE results as a mirror and to ask the research units to explain how they can use this feedback to improve. The requirements for consolidation and improvement are clearly written into the individual unit reports and in a number of cases the panels have cautiously indicated opportunities for merger.

The Education Ministry should now consider what incentives to use to promote consolidation – taking care that it does not in the process needlessly damage individual fields. Clearly, those units scoring 4 and 5 (on a 5-point scale, where 5 is high) are likely to form the nodes round which to consolidate. In a number of cases (but by no means in all of them) units scoring 3 also have strong potential to act as points of consolidation. Units scoring 2 should be strongly encourage to merge themselves into larger and better groups, unless they can develop convincing arguments that they are at an early stage of development and therefore need time and opportunity to grow. (It is important in this process of pruning to cut off the dead wood but to leave the fresh buds intact.) The case for providing institutional funding to units scoring 1 or which were not scored at all on the grounds that they are not doing research would be hard to make.

The next step should therefore be to invite groups themselves to propose mergers and transitional arrangements. More widely, the ministry should be reluctant to tolerate the perpetuation of parallel research and academic units in or near the same university in the same field. Structural Funds provide a transitional opportunity to support such change. Shifting the focus of institutional funding from the research groups to the institutions that host them is a necessary step, in order to enable institutions to have strategies and to provide them with reasons to manage.

8.4 Governance and institutions

Many countries (especially smaller ones, where resources are limited) recognise the importance of having a coherent overall research and innovation policy. A Finnish-style Research and Innovation Council is a powerful instrument but can only operate where research and innovation are given high political legitimacy and priority. (Some empirically derived principles for operating such councils are in the appendix to this document.) There are cases where such councils have been set up, involving the highest levels of government in principle, but in practice have rarely or ever met and therefore achieved nothing. Where such mechanisms do not work, there nonetheless remains a need for some sort of national 'arena' in which policy can be discussed. To some degree this is provided now in Latvia by the coordination of the NDP development process, but this leaves policy coordinated only at a rather high level and the coordination is intermittent rather than allowing continuous adjustment. An enduring instance for coordination is therefore needed.

The main funding organisations – LIDA and the Science Council – have their origins respectively in inward investment and in research system governance. Neither has been 'built for purpose' but they have instead evolved or extended their activities from other specialisations. LIDA's limitations in terms of technological capabilities and the rather narrow project-funding role that the Science Council plays both suggest a need for organisational development. Given the importance of connecting applied research and industrial development in Latvia, there may also be a good case for these organisations to work more closely together. Bringing the innovation and research funding functions together in a single agency is unusual, but could be a useful move in Latvia

- Close coordination of innovation and research instruments is desirable; this can be achieved through the steering of a single agency by multiple principals
- Both organisations need considerable organisational development, so they will in any case need to change in ways that are mutually compatible
- The likelihood of achieving and effective coordination in the NRIS via a Finnish-style Research and Innovation Council seem low. RCN in Norway achieves a quite good level of coordination from the agency level, having multiple ministries as its principals (while it is formally 'owned' by the Ministry of Higher Education and Research. KD). So there is precedent for a joint operation – which is especially relevant in a very small country
- There are opportunities to develop common administration and support systems, increasing efficiency and reducing costs

Many countries have an academy of sciences that actively promotes research and the public understanding of science. The functions of the Latvian Academy seem more oriented towards its former roles and include functions such as pre-approving the quality of PhD dissertations that are not consistent with modern ideas about university autonomy. It could be useful specifically to review the role of the Academy in Latvia, with a view to focusing its mission on increasing the profile and legitimacy of Latvian science – for example taking the Royal Society or the US National Academies of Science as potential models.

Appendix A General Principles for Research and Innovation Councils

These principles were developed in a review of the Chilean Council for the OECD[41].

In the past 20 years or so, many countries have established advisory committees or councils on research and innovation. This appears partly to be due to the increasing degree to which research and innovation policy issues affect several sectors of society and partly to the spread of the 'innovation systems' perspective, which recognises the systemic nature of innovation and therefore the need for a coordinated approach from government. The Finnish Research and Innovation Council has served as an inspiration for many.

There is little wider literature about such councils, so we have here to rely on our own earlier work looking at nine councils internationally[42] plus our evaluations in Chile and the Czech Republic. The councils almost always involve both industry and academia as advisors. Curiously, only the Finnish council involves the research institute sector, despite its inherent closeness to innovation processes. The councils considered tend not to suffer policy capture. They engage with a sufficiently wide set of stakeholders and provide a neutral forum for discussion, so that attempts by special interests to pursue their own objectives quickly become visible.

There are three broad models for councils.

- A **joint planning model** (Japan), where the government uses the council as a virtual 'horizontal ministry of innovation', much as engineering companies build project teams by bringing together people across different disciplines
- A **coordination model** (Chile, Czech Republic, Finland, Netherlands Innovation Platform, Austria), where the intention is that the council should communicate horizontally across ministry responsibilities so as to align policies in support of innovation, without this alignment always being binding. The Czech council is in this category
- An **advice model** (Canada, Ireland, Netherlands AWT, Switzerland, UK), where the government is happy to be advised on research and innovation policy but does not want to be restricted by that advice

The planning and coordination models require significant commitments of ministers' time as well as willingness across political parties to see research and innovation as permanently central aspects of government policy. The councils examined all inhabit systems where there is considerable distributed strategic intelligence within the state's part of the innovation system. This means that a great deal of instrument and policy design takes place at other levels 'below' that of the advisory council. Exploiting the superior knowledge of needs and implementation found at lower levels of the system and demands good communication between the council and organisations working at 'lower' levels. Making good use of the intelligence distributed across the system appears to depend on what might be called 'social networking capital'.

Principles that emerge from the survey of councils include

- An innovation policy council should serve as a publicly open arena in which stakeholders and decision-makers debate and influence the directions of long-

[41] Erik Arnold and Gernot Hutschenreiter, Chile's National Innovation Council for Competitiveness: Interim Assessment and Outlook, Paris: OECD, 2009

[42] Erik Arnold and Gernot Hutschenreiter, Chile's National Innovation Council for Competitiveness: Interim Assessment and Outlook, Paris: OECD, 2009

term research and innovation policy. This arena role should be complemented by actively consulting stakeholders

- Its composition and status should make it socially and politically legitimate and therefore largely robust against changes in government. It should include scientific and technological expertise
- The council may sometimes need to act as referee and take decisions with which not everyone agrees, but an important goal is to create consensus about policy, so that it is natural for stakeholders to do things that are consistent with the policy
- Part of the council's function is to create and collate the 'strategic intelligence' it needs in order to analyse deficiencies in the innovation system and propose improvements. This should be part of a wider pattern of distributed strategic intelligence, in which others also gather and analyse data and exploit them in support of policy analysis and deployment. The information produced and exchanged should be open so that it can be debated
- The council should produce long-term strategy for the innovation system that does not only tackle systemic and market failures but sets thematic priorities, is holistic, suggests an appropriate policy mix and serves to reduce the 'dynamic inconsistency' between the long time constants of the research and innovation system and the shorter term perspectives of the world of politics
- A key role of the council is coordination: vertically, horizontally and over time. In many countries, coordination also needs to have a regional dimension. Coordination serves to reduce inconsistencies and goal conflicts among policies and actors, make the division of labour in the support system efficient and reduce fragmentation of effort while empowering the actors involved to do their jobs effectively
- The council needs to maintain a high profile with the public and at the level of opinion-formers, promoting the importance of research and innovation and demonstrating its own impact
- It should be sufficiently independent of the system that it can act as a change agent. This means it should have no agendas or operational functions other than its brief to promote R&D&I and it should not have an interest in acquiring or spending significant resources of its own
- The council should have a clear interface to government, at least at the level of ministers, so that someone is responsible for accepting (or rejecting) and implementing its advice. This often means that some ministers should be members of the council

Appendix B Existing Research and Innovation Funding Instruments

Ministry of Education and Science: funding for R&D

- **Base funding (state budget)**: calculated taking into account the number of FTE researchers and last year outputs (peer-reviewed publications, monographs, international projects, patents). In 2012 the base funding was granted to 41 research institutions. In 2012 the granted base funding totalled LVL 8.14m, in 2013 it is planned to grant LVL 7.94m.
- **Grants for Fundamental and Applied Research (state budget)**: competitive funding is granted in five thematic areas of the state research programmes– energy and environment, innovative materials and technologies (IT, nanotech), national identity, public health, sustainable use of natural resources (food, forestry). In 2012 the funding amounted to LVL 3.3m, in 2013 it is planned to allocate LVL3.27m.
- **State Research Programmes 2010-2013 (state budget):** In 2012, the total budget for the five state research programmes was LVL 4.0m. The same amount of funding is earmarked for 2013.
- **Support for the Attraction of Human Resources to Science 2010-2013 (ESF)**: aim to promote the emergence of new research groups, including interdisciplinary research groups and support the return of Latvian scientists from aboard and attraction of foreign scientists. The total amount of funding for the whole period is LVL 44.66m.
- **Support for participation in international research programmes and projects (state budget)**: support is provided in the form of co-funding, total annual funding is approximately LVL 1.0m.
- **Support for participation in international research programmes, exhibitions (ERDF)**: till 2013, the programme has supported 20 projects with the total funding of LVL 5.79m.
- **Development of Academic Network for Sciences (ERDF):** total funding LVL 10.51m.
- **Development of 1) Research Base Infrastructure and 2) Commercial Research Infrastructure 2011-2013 (ERDF):** total funding for the 1st stage projects LVL 41.96m. The call for the second stage projects is open in the course of 2013.
- **Practical Application Research Projects 2011-2013 (ERDF):** 122 are being implemented under this programme with the total budget of LVL 41.98m.
- **Market Oriented Research Projects (state budget):** Funding for this programme is decided on an annual basis. In 2012 state budget allocation for this programme was LVL 110 800, and in 2013 it is planned to allocate LVL 151 800.
- **National Significance Research Centres (ERDF)**: aims are to develop a form of research institution cooperation to improve scientific excellence, overcome fragmentation, share infrastructure and increase science-industry cooperation. By 2013, it is planned to establish nine National Significance Research Centres in: 1) IT and Telecommunication; 2) Nano- and multifunctional materials; 3) Pharmacy and Biomedicine; 4) Public Health and Clinical Medicine; 5) Energy and Environment technologies (including

transport sector); 6) Forestry and Water Resources; 7) Agriculture and Food; 8) Language, Cultural Heritage and Creative Industries; 9) Socioeconomics and Public Management.

Ministry of Economy: funding for entrepreneurship and innovation

- **Support to Technology Transfer Contact points 2008-2013 (ERDF)**: established seven TTOs in the main universities. The total budget for the whole period is LVL 1.9m.
- **Competence Centre Programme 2011-2015 (ERDF)**: competence centres established in six sectors: 1) Chemistry and Pharmaceuticals; 2) Forestry and Wood Products; 3) Environment, Biotechnology, Bioenergy; 4) Electronics; 5) IT; 6) Mechanical Engineering. Total budget LVL 59.39m.
- **Support for the Development of New Products and Technologies (ERDF)**: Total budget LVL 7.3m.
- **Support for the Introduction of New Products and Technologies in Manufacturing (ERDF):** Total budget LVL 44.68m.
- **Business Incubator Programme 2009-2014 (ERDF):** total budget LVL 20.m.
- **High value-added investments 2009-2012 (ERDF):** total budget LVL 70.59m.
- **Cluster Programme 2012-2015 (ERDF)**: support to clusters in 11 industrial sectors. Total programme budget LVL 3.4m.
- **Motivation programme for entrepreneurship and innovation 2009-2014 (ERDF):** total budget LVL 2.02m

Financial instruments for promoting entrepreneurship and innovation:

- **Credit guarantees** (Latvian Guarantee Agency)
- **Export Credit Guarantees** (Latvian Guarantee Agency)
- **Mezzanine Loans** (Latvian Guarantee Agency)
- **Loans for Improving Enterprise Competitiveness** (State Mortgage Bank)

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