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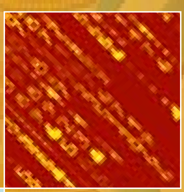
Development in Research

An Outline of the Science Systems in Russia and the Baltic States

NORDFORSK POLICY BRIEFS 2007-1



AADNE AASLAND

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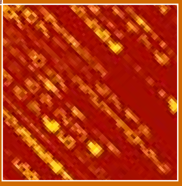

SAMMENDRAG

Russland og de baltiske land (Estland, Latvia og Litauen) har alle gjennomført omfattende endringer i sine forskningssystemer siden Sovjetunionens oppløsning i 1991. Rapporten gir en oversikt over den strukturelle oppbygningen av forskningssystemene i de enkelte land og de viktigste reformer som er blitt gjennomført i denne perioden. Videre skisserer og diskuterer rapporten noen av de forskningspolitiske utfordringer landene i dag står overfor. Forholdsvis lave FoU-budsjetter, hjerneflukt fra forskning til andre samfunnsområder og til utlandet og mangelfulle mekanismer for omsetting av forskningsresultater i økonomisk utvikling er aktuelle problemstillinger i alle de fire landene. Videre presenterer rapporten landenes nåværende og fremtidige forskningsprioriteringer. Alle landene har økt samarbeidet med de vestlige, herunder de nordiske, land betraktelig, og dette samarbeidet blir også beskrevet.

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Author's Preface

The Russian and Baltic science systems have undergone profound changes in the years following the break-up of the Soviet Union. The Baltic States are members of the European Union and are fully integrated into European research structures. These countries underwent reforms of a revolutionary kind that completely altered their science structures. Although Russia's research system has preserved many of the characteristics of the Soviet system, such as a different role of the Academies of Science than what is found in Western countries, many profound reforms have been introduced to solve present-day structural challenges there too. Even though the science systems in the four countries differ considerably, they face some similar challenges, such as the severe decline in research funding in the 1990s, brain drain from research to other parts of the economy and to foreign countries, and a lack of mechanisms that feed science results into the economies at large.

One of the major changes in the four countries' science development is the increased collaboration with Western, and among them, Nordic scientists. While institutional collaboration between Nordic and Russian / Baltic institutions has been encouraged and increased since the early 1990s, during the past few years one has also seen an increased focus on collaboration at the policy level. The Nordic Council of Ministers has been very active in promoting policy dialogue between Nordic and Baltic and Russian actors in order to develop joint initiatives and collaboration programmes. NordForsk, as a new institution for collaboration in research and research training in the Nordic countries, is closely involved in this process. Although most Russian-Nordic collaboration in research with Nordic funding involves actors in North-West Russia, the report only rarely makes a distinction between processes taking places in this specific region and the rest of the Russian Federation.

In order for Nordic policy-makers to enter into such a dialogue with Russian and Baltic research policy actors, there is a need for a certain level of knowledge about the science systems in the four countries. Such information is not necessarily easily accessible. The present report aims at giving a brief, policy-relevant and up-to-date overview of the research systems in Russia and the Baltic States. It gives a short presentation of the science systems themselves, discusses some of the major challenges facing the four countries, and gives information about some of the major reforms which the countries have undergone or are undertaking. Furthermore it gives an overview of current research priorities in the four countries and presents some examples of international, including Nordic, collaboration. It has been a stated objective to be brief, so that policy-makers with little time can obtain the most crucial information in one easy-to-read document. Readers who would like more thorough or analytical literature on the subject are referred to a large variety of documents covering the listed topics.

The report is structured as follows: A brief overview of the Soviet science system common to all four countries at the outset of reform is followed by separate chapters on Russia and the Baltic States. Since the Baltic countries' research systems share many common traits, they are covered in a joint chapter with separate sections on each of the three countries for some specific issues.

I would like to thank all those who have contributed with information, comments and advice to this publication. Joseph McCormick, Imants Gross, Hans Gudmundsson, Birgit Jacobsen, Daina Mežecka, Niels Petersen, Brigita Urmanaite, Katrin Uuind and Marianne Wikgren have all been helpful in providing information. In NordForsk thanks are due to Liisa Hakamies-Blomqvist, Susanna Sepponen, Torkild Vinther and Harry Zilliacus for valuable inputs. I would especially like to thank Kristin Oxley for systematic language editing and constructive suggestions.

FOTO: TERJE HEIESTAD/MILLIMETERPRESS

The Soviet Background

The science systems in Russia and, even more so, the Baltic States have undergone radical change in the years following the break-up of the Soviet Union. Although this report does not aim to provide a thorough description of the Soviet science system[1], it is nevertheless useful to give a very brief outline of the structures which Baltic and Russian policy-makers were confronting at the outset of systemic reforms in the early 1990s.

After World War II, Russia and the Baltic States, as Soviet Union republics, shared the same science structure and institutional framework. After the incorporation of Estonia, Latvia and Lithuania into the Soviet Union, the research systems of the three republics were reorganised along the lines of the Soviet model. Academies of science in each of the republics were founded and subordinated to the Academy of Sciences at the all-union level.

The Soviet science system was characterised by a division between military and civil research. The activity of the scientific sector in the Soviet Union was directed primarily at an accelerated build-up of the defence capacity and industrialisation, and consequently science developed mainly in this direction. While research for the military complex received sufficient resources, research for other public needs as a rule received funding according to the residual principle.

Universities in the Soviet Union had a very limited research role and concentrated more or less exclusively on teaching. The institutions of higher education were supervised by the Ministry of Higher Education of the USSR and the respective ministries in the republics. The main bulk of fundamental and basic research took place within the research institutes of the academies of sciences, all of which were under the control of the Academy of Sciences of the USSR. The Academy of Sciences was a principal policy director in the total framework of the Soviet science policy structure. Various ministries, both at the USSR and the republican level, established branch institutes which carried out different types of applied research. The central industrial research institutes were part of the ministerial structure coordinating innovation process activities (Radosevic, 2003: 2).

State interference was persistent in all three subsystems – branch, academy and university. In social science and humanities, ideological demands prevailed. State science policies were formulated centrally without much influence of professional scientific associations, and decision-making concerning funding priorities was purely administrative. Research financing was distributed in block grants to be allocated by institute directors, instead of a Western system of peer review of competitive grant proposals.

Although suffering from severe deficiencies, Soviet science clearly had a number of important assets. One such asset was the strong educational establishment of the Soviet Union and the generous government and social support for the natural sciences. The science establishment was quantitavely one of the largest in the world. Soviet scientists were among the world leaders in a number of scientific fields, most notably within theoretical physics and mathematics (Dezhina & Graham, 2002). The command economy made it possible to direct resources into certain key target areas, and the Soviet Union was strong within selected practical fields. These included nuclear weapons and space research, in which several impressive accomplishments were made. Other well developed directions of science and technology in the Soviet Union included ICT, research in chemistry and materials, medicine, biology and earth studies (Kovaleva & Zaichenko, 2006: 4). In the Baltic countries, research in high technology in such fields as lasers, material physics, pharmacology, semiconductors and biotechnology were particularly well developed (Kristapsons *et al.*, 2003).

From 1945 – 75, scientific growth in the Soviet Union was much higher than in other sectors of the economy. However, from the end of the 1970s, technical progress was faced with an economic slowdown, causing the growth rate of the number of Russian scientists to decrease. The situation was exacerbated in the mid-1980s with economic stagnation. The R&D system, however, still continued to expand, although at a much slower rate than before. These last few years of Soviet rule were characterised by political and economic instability. Although the economic conditions deteriorated, the science system became more open as a result of *glasnost'* and *perestroika*, and in the Baltic States scientists became front fi-gures in the independence movement.

UNIVERSITIES IN THE SOVIET UNION HAD A VERY LIMITED RESEARCH ROLE AND CONCENTRATED MORE OR LESS EXCLUSIVELY ON TEACHING. THE INSTITUTIONS OF HIGHER EDUCATION WERE SUPERVISED BY THE MINISTRY OF HIGHER EDUCATION OF THE USSR AND THE RESPECTIVE MINISTRIES IN THE REPUBLICS. THE MAIN BULK OF FUNDAMENTAL AND BASIC RESEARCH TOOK PLACE WITHIN THE RESEARCH INSTITUTES OF THE ACADEMIES OF SCIENCES, ALL OF WHICH WERE UNDER THE CONTROL OF THE ACADEMY OF SCIENCES OF THE USSR.

The Science System in Russia

This chapter first gives a general overview of the organisation of Russian science. This is followed by a section on recent reforms in the field of science in Russia. Major challenges currently facing Russian science are then discussed. The chapter includes an overview of priority areas within Russian science today, and a section on international collaboration, with particular focus on collaboration with the Nordic countries.

ORGANISATION OF RUSSIAN SCIENCE

The Russian science structure consists of four main sectors: the executive branch (President/Government/Ministry/Agencies), the legislative branch (the Federal Assembly), consultative bodies chaired by the Russian President, and independent academic bodies.

The Executive

In the Russian Federation, the Ministry of Education and Science has the overall responsibility for developing policy and legislation within the sphere of science.[2] It is also responsible for developing legislation in the area of patents, trademarks and intellectual property.

The Ministry was established in 2004 as a result of a merger of the former Ministry of Industry, Science and Technology and the Ministry of Education.[3] The main reason for the merger was an acknowledgement of a wide gap between education and science and a need for greater integration between the two. However, many critics have argued that the new ministry has put too little weight on basic science and too much stress on the direct usefulness of science to industry.

The ministry consists of six departments[4], including the Department of State Science and Innovation Policy. In addition, there are a number of *executive federal agencies and services*, responsible for the implementation of state policy in the sphere of science, provision of services and management of property. These are the Federal Agency for Science and Innovation (ROSNAUKA), the Federal Service for Intellectual Property, Patents and Trademarks (ROSPATENT) and the Federal Service for Supervision in Education and Science (ROSOBNADZOR).[5]

Other ministries are closely linked to applied research and the organisation of R&D. These include the Ministry of Economic Development and Trade, the Ministry of Industry and Energy, the Ministry of Transport, and the Ministry of Defence.

The Legislative

The Federal Assembly (Parliament) consists of two chambers. The Federation Council (upper chamber) has a Committee on Science, Culture, Education, Public Health and Technology, while the State Duma (lower chamber) has a Committee on Education and Science as well as a Sub-Committee on Science.

Presidential Bodies

Three bodies provide consultative input to the Russian president's actions on science: The *Council on Science and High Technologies* informs the head of state about issues in science and technology policy and facilitates its integration with scientific organisations and scientists. It also develops priorities for science policy. Meetings are held at least every six months. The Council has also looked into issues related to preserving the welfare of Russian scientists. In addition, the *State Council* and the *Security Council* contribute to the development of high-level S&T policy.

ACADEMIC BODIES, RESEARCH COUNCILS, UNIVERSITY SYSTEM

Academy of Sciences

Russian science is characterised by the important role of the *Russian Academy of Science* (RAS)[6]. Most fundamental research carried out in Russia takes place within the Academy's branch institutions[7]. In 2002 RAS had more than 430 institutions, with a staff of more than 123,000 – including more than 57,000 researchers. The highest body is the *General Assembly,* consisting mainly of directors of RAS institutions. The General Assembly elects the *Presidium,* which is responsible for the operational management of the Academy. The Presidium allocates funding and material resources to the institutes and also approves their research plans. The main source of income is the state budget. In Figure 1 they are referred to as *'old academies'.*

From the 1990s, *new academies* of science were established, and there has been a conflict between the new and old academies. The revolutionary approach to reforming the Academy of Sciences system failed, and a more evolutionary approach gained the upper hand (Dezhina & Graham, 2002: 11). The Academy of Sciences' leadership has been opposed to shifting strength from the Academy to the universities, although many have supported moderate reform. New Academies have been established, but they function mostly as public associations and lack finance as well as the developed infrastructure, traditions and influence of the old ones.

State Research Institutes

In addition to the Academy of Sciences institutions, there are about 1200 state research institutes in Russia (UNESCO, 2005: 141). These are mostly technologically-oriented industrial institutes and other applied research institutes. Many of them are structurally subordinated to a specific sectoral ministry.

Research Councils

In the Soviet system, funding to research was distributed in block grants and contracts, and there was no peer review system for the distribution of grants. While most research in Russia is still funded on an organisational basis directly from the state budget, some new funding organisations were established in the early 1990s in order to make more use of competitive funding. The two main foundations for research which are supported by state funding are *The Russian Foundation for Basic Research*[8] and *The Russian Foundation for Research in Humanities*[9].

In comparison with base funding from the state budget, the amount of research funding that these institutions distribute through research grants is still relatively small. In 2002 the budgets to both these foundations amounted to about 7 per cent of all government funding to civilian research (Dezhina & Graham: 12).

Universities

In Russia there are 685 state institutions of higher education, of which 48 are universities. The Russian universities have traditionally been largely devoted to teaching, with a much lower priority given to research. Very few higher education institutions in Russia combine educational and full-scale research activities. Higher education institutions constitute only about 10 % of organisations that carry out research work (Kovaleva & Zaichenko, 2006: 2).

The Military-Industrial Complex

In the Soviet science system, the *military-industrial complex* played a huge role. A number of research institutes were subordinated to the various industrial and defence ministries, as well as several dozen secret 'close cities' in which research took place in a secretive and non-public way. The military received about

75 % of all resources (Dezhina, 2006: 1). Even though military funding plummeted after the collapse of the Soviet Union and the main bulk of research funding is currently channelled through the academies of science, the military-industrial complex continues to be important in allocating funding to research activities. Of the 195 billion roubles that are allocated to applied science in 2007, 125 billion (64 %) go to the military (Bakke & Overgaard, 2006). As in most other countries with a large military research base, this system is still severely restricted by secrecy and control.

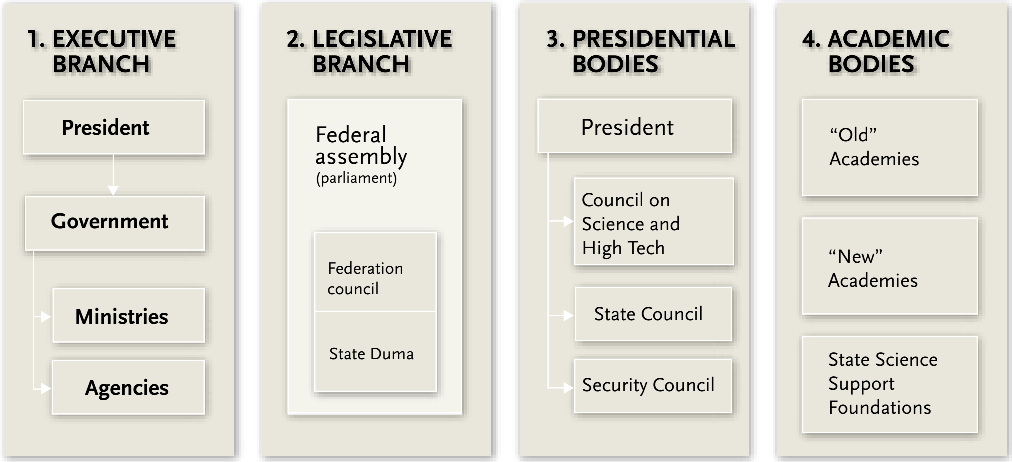
A schematic overview of Russian science is shown in Figure 1. For more detailed schemes outlining the different ministries, the Federal Assembly and the presidential bodies, see Global Watch Service web-page[10].

stronger than the pull from conservative forces, in Russia the Academy of Sciences had a very strong position and this powerful elite to a large degree obstructed attempts at drastic reform. After the collapse of the Soviet Union, the Russian Academy of Sciences was restored by decree of the President of the Russian Federation of December 2, 1991, inheriting all the USSR Academy of Sciences' facilities on Russian territory. The Russian Academy of Sciences initially seemed to develop into a reformist organisation in opposition to the Soviet Academy of Sciences, but it gradually backed away from such an orientation.

Integration of Research and Education

One of the most important reform efforts has been the drive for closer integration between

FIGURE 1. OVERVIEW OF THE RUSSIAN SCIENCE SYSTEM



Source: Global Watch Service[11].

REFORMS

Russia's post-Soviet science policies involve an interaction between preservation and restructuring elements. Russia continued and continues to have a science structure with different organisational principles than those found in Western Europe and North America and which resembles the old Soviet system in many ways.

Only Moderate Reforms within the Academy of Science

While in the Baltic States the push for radical transformation of the research system was

science and education. The establishment of a Ministry of Education and Science is to a large extent a result of such efforts. The Federal Target Program *Integration of Science and Higher Education in the Russian Federation* (Dezhina, 2006) also results from this work. The programme's main is to create an innovative core. This will allow for integration between the two camps and thereby contribute to resolving the problems in educating the scientific workforce, as well as to improve integration between science and industry. This in turn will help promote scientifically based production in the Russian market.

There have been quite fierce discussions between the Ministry of Education and Science and the Russian Academy of Sciences about the effects of this programme. Many acclaimed scientists have spoken out against it, arguing that the programme may have severe effects on basic science in the country.[12] Moreover, and with a few exceptions involving the universities of Moscow, St. Petersburg and Nizhniy Novgorod, the integration process has been disappointingly slow. The main reasons for this are said to be the deep-rooted tradition of isolating scientists from the Academy from their counterparts in the university sector, and also the persistence of inefficient bureaucratic structures dating from the Soviet Union (Ismail-Zadeh, 2004). If the efforts to integrate the RAS (and other state Academies) with the higher education sector in the field of basic sciences research are to succeed, state universities must receive a larger share of the available research funding than they do at present.

Improvement of Age Structure

It is noteworthy that a majority of the scientists working at the Academy of Science's institutes are older than 50. A number of government initiatives aimed at improving the age structure in Russian science have been launched, supporting young researchers (in their 30ies) mainly through bonuses and research grants. Also, the Academy has attempted to renew its ranks by introducing a special membership for younger scientists. However, some experts argue that the grants are too small to make a significant impact (Dezhina, 2004: 4) and that Academy reform has had little effect on the age profile of the organisation.

In 2003, the government launched the 'Conception of Measures for Preserving Manpower Potential in the R&D Sector'. At the same time, the federal target programme Scientific *and Research Staff of the Russian Federation,* (Dezhina, 2006) was developed. These programmes contained several measures to improve the age structure in Russian science through grants to young candidates and doctorate holders. However, young scientists from the most prestigious Russian universities, and especially mathematicians and physicists, have continued to leave the country (see section on brain drain below). There has been a continuous effort to repatriate successful Russian scientists based in Europe and the U.S.

Budgetary Reform

The financing of science constitutes another dimension of the Russian science system reforms. Formerly, financing was largely based on block grants to research institutions, but currently it is based on competition to a larger extent, primarily through a mechanism of so-called Federal Targeted Programmes (FTPs). Budgeting has also become more results-oriented. The establishment of the two large research foundations referred to in the previous section – the Russian Foundation for Fundamental Research (resembling the American National Science Foundation), and the Russian Foundation for the Humanities – has also contributed to a more competitive approach to science funding. These two foundations distribute research funding based on peer review on a competitive basis.

These measures are aimed at making government R&D funding more transparent, target-oriented and efficient. There are reports, however, that due to a slow increase in budgetary R&D, the situation has not improved to the extent intended by the authorities (Dezhina 2004: 5). There have been attempts to allocate financial support for institutions, as well as grants to individuals or teams of scientists, on a strictly competitive basis. For example, a new grant scheme for the biological sciences is based on such principles, but the scheme's project selection system still needs improvement (Ismail-Zadeh: 11).

CHALLENGES IN RUSSIAN SCIENCE TODAY

With *glasnost'* and *perestroika* in the late 1980s, a free discussion on the inefficiencies caused by the rigid Soviet research system and its centralised management was made possible. However, the country's social and economic collapse in the early 1990s lead to a common perception of the Russian science system as a system in crisis (Gerber & Ball, 2002). While ideological pressure on scientists has been removed, the Russian science community faces other serious constraints.

Funding of Science

The most serious challenge to Russian science in the post-Soviet period has been the dramatic decrease in funding. After the collapse of the Soviet Union, changing the political, social and economic systems was seen as much more important than changing or supporting science. Less economic support to the military and the ideology of demilitarisation also had serious implications for the state of science, as three quarters of all science funding came from the military.

In the Soviet Union, the prestige of science was higher than in most parts of the world. However, this situation has changed dramatically over the past 15 years. Following the disintegration of the Soviet Union, a rapid decrease in the status of science and the prestige of research work occurred, both among policy makers and among the general public (Graham & Dezhina, 2002). Expenditure on science was greatly reduced and ordinary research staff's salary levels dropped dramatically. The average salary of scientific workers soon ranked tenth among the eleven branches of the Russian economy – only workers in culture and the arts ranked lower. The meagre salaries did not meet minimal needs and scientists had to look for additional sources of income to earn a living (mostly outside the research and development sector).

In 1992 the share of GDP allocated for science was at its lowest (only 0.74 %) Despite a steady increase since then, in 2003 the total level still remained low – 1.28 % of GDP (Kovaleva & Zaichenko, 2006: 6). One should also take into account that GDP decreased during the 1990s, making the actual amount spent on science even lower than indicated by its share of GDP. In recent years the GDP has grown faster than the gross domestic expenditure on science.[13]

Although researchers actively protested against government cuts, many politicians saw research as a luxury in the 1990s and there were other more pressing concerns on both theirs and the general public's agenda.

Increased costs of utilities and community facilities following the elimination of price controls accompanied the economic difficulties. Most research institutes could no longer buy new equipment and had to work with increasingly obsolete infrastructure. With the decline of industrial output there were also fewer research commissions from Russian industry. In order to cope with the deteriorating conditions, many academic institutions entered into commercial activities. Their central location in many Russian cities made it profitable to rent out premises to business and other commercial activities. Some research institutions started to dismantle or sell equipment. This drew attention away from their prime activities of research institutions. It became necessary to cut back on staff. In the 1990s, many research institutions were privatised, leading to an increased focus on more profitable activities. Investment in long-term applied and basic research with no immediate commercial value declined considerably.

Even though Russian research institutions still face problematic economic conditions, important improvements have occured over the last few years. In 2005, the Russian GDP to R&D share (GERD) had increased to 1.53 % (Dezhina, 2006). Moreover, the government now allocates funding in a predictable and timely manner, in contrast to previous years' tradition of not paying research institutions what they had been allocated.

The state is the primary source of funding for Russian science. Industry's proportion of research investment has remained low, with about one quarter of overall R&D spending stemming from industry in the 1995–2003 period (Dezhina 2005: 4). Federal budget expenses on civil science have increased in recent years. In 2004 the annual growth was 15 % as compared to 2003, while in 2005 there was a 27 % increase from 2004. However, the growth in GDP has been more rapid than the growth in science funding. In relative terms, federal allocations to science have consequently not increased, and remained at 1.6 % of GDP in 2005. About 40 % of total science expenditure is financed from sources outside the federal budget.[14]

Brain Drain

The brain drain from research, which is caused both by a lack of funding and a lack of prestige of Russian science's low prestige, consists of two components. First, there has been a general exodus of Russian researchers to other sectors of the economy. Second, a large number of Russian scientists have left Russia to take up science position in other countries.

In the period from 1990–2002, the number of people engaged in science decreased by 55 % (UNESCO, 2005). Most of this decrease took place in the initial reform period in the early 1990s. Some of it can be seen as a necessary cut in excessive man-power resulting from inefficiencies in the Soviet system. However, a more important explanation of the drop is the economic crisis in Russian science described above. While Russia was among the countries in the world with the highest proportion of scientists in the population, this number was drastically reduced in the nineties. After 1998, however, the trend has been more positive. While in 1995 there were only 60 researchers per 100,000 population, by 2003, the corresponding figure was 75 (Dezhina, 2004: 1).

Russian scientists' tendency to work outside the science field has already been mentioned. It is estimated that only ten percent of all researchers in Russia work full time in science. The rest of Russia's scientists continue to list themselves as staff members but spend most of their time in activities outside science as part of a huge internal 'brain drain.'[15]

The exact amount of brain drain *out of* Russia is hard to estimate, because scientists generally do not announce in advance whether they are leaving the country permanently or just for a limited time period. There are several, sometimes contradictory, accounts of the number of scientists who have left Russia and taken up science work in other countries. According to the Ministry of Education and Science there was a rather stable outflow of researchers in the 1990–96 period of approximately 2,000 scientists per year, subsequently reduced to 1,200–1,400 per year from 1997 (Dezhina & Graham: 9). There are, however, both more conservative and more dramatic estimations.

Brain drain from Russian science has taken place in several more or less marked phases. In the early period (1991–94), it was mainly well established scientists within the areas of mathematics and physics who were offered and took up research positions in the West. Gradually there was a shift to the second wave (1994–98), consisting mainly of scientists in the field of biology and computer science. These researchers were on average younger than the researchers leaving the country in the first wave. The third wave, starting from 1999, is more mixed and harder to categorise, but low salaries and poor working conditions in the home institutions is still considered to be the main reason for people leaving (Dezhina & Graham, 2002: 9–10). *Pendulum migration* is another feature that characterises recent Russian migration. It refers to the process in which people leave Russia for a certain time period and then return to carry out research in a Russian institution. This can be seen as a sign that Russian science is improving, making it a more attractive place to work. Such *pendulum migration* may in itself contribute to further improvements, as Russian scientists obtain and bring back useful competence from institutions abroad, as well as a network of institutional contacts. It is noteworthy that there have been no attempts to halt emigration through administrative barriers, except in the military.

As a result of the reduction in scientific personnel in Russia, the age structure of Russian science changed noticeably (see section on reforms above). While in the 1980s the average age of Russian lecturers in tertiary education and senior scientists had been 40–45 years, this rose to 60 years in the 1990s. The reason for this is the worsening demographic situation in Russia, with a low inflow of young scientists, and an outflow of the middle-aged generation in science through internal and external brain drain. Normally scientists have their most productive years when they are in their 40ies. The changed age structure has consequently made the scientific community concerned about the effects on quality and output.

There are signs of progress, however. The


340 Hz
679 Hz
86 Hz
170 Hz
340 Hz
679 Hz

RUSSIA'S POST-SOVIET SCIENCE POLICIES INVOLVE AN INTERACTION BETWEEN PRESERVATION AND RESTRUCTURING ELEMENTS. RUSSIA CONTINUED AND CONTINUES TO HAVE SCIENCE STRUCTURES WITH DIFFERENT ORGANIZATIONAL PRINCIPLES THAN THOSE FOUND IN WESTERN EUROPE AND NORTH AMERICA AND WHICH RESEMBLES THE OLD SOVIET SYSTEM IN MANY WAYS.

number of researchers in Russia is on the rise. Furthermore, although brain drain still has an impact on Russian science, there is no longer a risk of the whole Russian science system collapsing due to an exodus of Russian scientists, as was frequently considered to be the case in the mid-1990s.

Industrial R&D and Innovation

Russian science has a low rate of innovation. Macro-indicators of the Russian innovation system and comparisons with other countries place Russia closer to those of the developing countries than for example most developed European countries. There has been a lack of ways to use and implement the results of research into new technologies. The main problem is the compartmentalisation of Russian science, with little fertilisation across different branches and between basic and applied research. As already mentioned, most Russian basic research was traditionally carried out by the Academy of Science research institutes, while the main responsibility for the industrial and applied R&D has remained with the Ministry of Industry. Today, national S&T programmes as well as programmes for international cooperation are the responsibility of the Ministry for Industry, Science and Technology. Russian research institutes were not modernised during the reform period of the 1990s, and the governing system is not conducive to modern state-of the art S&T (Kovaleva & Zaichenko, 2006: 3). They are, as a rule, not oriented towards market relations and competitive innovation activity. One additional concern is that the private sector has not increased its spending on externalised R&D in the research institutes.

In the Soviet system, industrial scientific research, project development laboratories, engineering and other similar organisations were subordinated to ministries and other departments that were in control of the various branches of the national economy (UNESCO, 2005). Industrial scientific institutions conducted applied science and were also responsible for implementing basic research results. The Soviet Union's industrial scientific sector was powerful and employed 75 % of the country's specialists in the field of scientific R&D (*ibid.*). Applied R&D in the defence industry was given top priority. However, the achievements in military engineering and technology were usually not taken up by industrial organisations, thereby excluding them from the process of civil economic development and S&T development growth. One of the problems was that the skewed price system did not encourage increased labour productivity, resulting in low demand for S&T to enhance production. The lack of civil liberties and freedom, in addition to excessive bureaucracy also contributed to limiting the scientists' creativity and motivation.

In the 1990s, R&D funding and organisations were transferred to private ownership. This did not increase efficiency, but rather had the opposite effect. Russia's economy deteriorated and industrial enterprises' demand for innovations and knowledge-intensive production fell dramatically. A main challenge was to make applied research and innovation better suited to the market economy. The establishment of techno parks – 60 such parks were founded by 1997 – was one rather successful measure. They integrated science, education and production at the same time as stimulating more intensive innovation. In a number of science and technological fields, so-called state scientific centres (SSC) were established in large industrial institutes and enterprises and given funding priority. In addition, both innovation-technological centres and financial-industrial groups (FIGs) were established.[16] The economic crisis in 1998 hindered the institutional reorganisation of science.

However, economic recovery has resulted in some improvements in the area of industrial R&D and innovation. Scientific institutions have been given new opportunities to adjust to the market. The increased federal budget has resulted in a rise in GERD both in absolute and in relative terms. Human resources are a crucial factor in realising the country's S&T potential.

In February 2004, a joint meeting of the Security Council and the presidium of the State Council of the Russian Federation discussed how to develop a national innovation system. An important aim for the Russian R&D sector is to enhance innovative activities and to create infrastructural and economic conditions for a more rapid implementation of scientific achievements. Representatives of the academy of science, however, have voiced scepticism towards what they consider uncritical commercialisation of Russian research and too much stress on short-term economic profit.

Major Strengths

While this section has focused on the challenges currently facing Russian science, Russian science also has some very important strengths which will be helpful in shaping policies to support and improve the situation. Russian basic and pilot research have produced some noteworthy achievements, and Russian scientists continue to win prestigious prizes, such as the Nobel prize. Furthermore, while the situation was quite critical in the 1990s, and Russian scholarship and science are still facing problems, the first signs of recovery are discernable and some positive developments can be detected.

PRIORITY AREAS

Although there are several key institutions involved in the Russian science system, the priorities outlined by the Russian President undoubtedly have a special weight and are taken into account by the various actors. The Russian President has identified the following priority directions for the development of science and technology in the Russian Federation:[17]

- Information and telecommunication systems
- Nanosystems and advanced materials industry
- Life sciences
- Rational exploitation of natural resources
- Energy and energy efficiency
- Transport systems
- Security and counter-terrorism
- Advanced weapons and defence technologies

The Russian President has also operationalised this list of science and technology areas with a 'list of critical technologies' setting out the priority directions for the development of Russian science and technology:

Information and Telecommunication Systems

- Navigation and control systems
- Transmission, processing and protection of information
- Distributed computing and systems
- Software development technologies
- Bioinformatics
- Electronic component technologies

Nanosystems and Advanced Materials Industry

- Nanotechnologies and nanomaterials
- Production and processing of elastomer and polymer materials
- Production and processing of crystal materials with special properties
- Mechatronics and microsystem technologies
- Production and processing of composite and ceramic materials
- Membrane and catalytic systems production
- Biocompatible materials production

Live Systems (Life Sciences)

- Bioengineering technologies
- Cell technologies
- Biosensor technologies
- Biomedical technologies of human protection and life support systems
- Genomic and postgenomic technologies for medicine production
- Biocatalysis and biosynthesis technologies

Rational Nature Use

- Monitoring and forecasting the state of atmosphere and hydrosphere
- Resources estimation and forecasting the state of lithosphere and biosphere
- Technologies for processing and recycling of industrial waste
- Technologies for decreasing risks and mitigating consequences of natural and technogenic disasters

- Technologies for ecologically safe development of natural deposits and extraction of mineral resources.

Energy and Energy Efficiency

- Nuclear energy, nuclear fuel cycle technologies; technologies for safe treatment of radioactive waste and spent nuclear fuel
- Hydrogen energy technologies
- New and renewable energy sources
- Organic material energy production
- Development of energy saving systems for transportation, distribution and consumption of heat and electric power
- Energy efficient engines for transport systems

Transport Systems

- Technologies for control of novel transport systems
- Novel aviation and space technologies

Security and Counter-Terrorism

- Basic and critical special technologies
- Technologies to protect potential target objects against terrorist threats; ensuring life support

Advanced Weapons and Defence Technologies

- Basic and critical defence and industrial technologies

INTERNATIONAL COLLABORATION

In the post-Soviet period, a very significant part of research in Russia has been funded through foreign foundations. The foreign share of funding to R&D in Russia has risen from virtually 0 % in the Soviet Union to up to 17 % in the late 1990s (Dezhina, 2006:1). The most successful Russian research institutions derived an even larger share of their funding from foreign foundations. International collaboration increased the pressure for peer review and competition for grants and resulted in a move away from the traditional Soviet centralized planning and hierarchical decision-making. Thus, many research foundations not only sought to help individual researchers participate in international co-operation projects, but also aimed to encourage reform and a transition to a more market-oriented model of science.

The first and most important foreign foundation providing grants to Russian scientists was the International Science Foundation (ISF), set up by George Soros. The foundation allocated about $100 million to Russian science over a three-year period in the mid-1990s (Ismail-Zadeh, 2004). ISF was closed down in 1996, but a new foundation for natural science and engineering was then established by George Soros through a donation of $5 million via the US National Science Foundation: the US Civilian Research and Development Foundation for the Independent States of the Former Soviet Union (CRDF).[18] Today, the Open Society Institute (OSI) founded by George Soros runs e.g. an International Higher Education Support Programme as well as a variety of scholarship programs providing support for fellowships and scholarships.[19] Recently, Soros has moved from a comprehensive system of Russian locally-run programs to one where Russians take part in regional Soros initiatives run out of Budapest and New York. Accordingly, George Soros' financing of Russian science is no longer at the 1990s level.

Recognising that Russian science was in a crisis situation, three American scholarly societies (Astronomical, Physical and Mathematical) transferred money as well as periodicals to scientists of the Former Soviet Union. This aid was carried out with the assistance of the Sloan Foundation, the National Science foundation and the above-mentioned George Soros foundations. Other U.S.-based foundations which have funded Russian science or exchange and mobility programmes include the Eurasia Fund[20], the International Research and Exchanges Board (IREX)[21], the Fulbright Programme[22], and a variety of private research foundations (the John D. and Catherine T. MacArthur Foundation, the Spencer Foundation, the Ford Foundation, and others). The Carnegie Foundation provides the main share of funding to the Centres for Advanced Studies and Education (CASE) programme. The programme was launched in April 2000 and offers both institutional and individual support to Russian scientists, concentrating mainly on the humanities and social sciences.[23]

Several other international and national non-profit organisations and foundations have supported Russian science and higher education. European assistance was mostly organised at the governmental level, either bilaterally or through European organisations. INTAS (The International Association for the Promotion of Cooperation with Scientists from the Newly Independent States – NIS – of the former Soviet Union) is an international non-profit association established in 1993, based in Brussels. The members of INTAS are the 25 member states of the European Union in addition to 7 other countries (including Iceland and Norway). The association's objective is to promote co-operation between scientists from its member countries and the NIS in all fields of the exact, natural and human sciences. The amount of funding has varied, but in 2003, 171 grants were awarded with a total value of approximately €23 million.[24]

Research contacts with the European Union have been an important aspect of Russian science reform. EU collaboration programmes facilitate the country's integration into the processes of science globalisation. The INCO-Copernicus programme was one such programme operating in the 1990s, and specifically involved assistance and training in the technology commercialisation area. The programme supported joint applied projects in selected areas, with three to six European partners from at least three countries for up to three years. The programme resulted in the signing of more than 300 contracts worth nearly €20 million in total and involving approximately 250 institutions in the newly independent states. Furthermore, the EU's TACIS programme launched an Innovation Centres and Science Cities of Russia Programme supporting innovation and technology centres in four Russian regions. In 2003, EU and Russia signed a new science agreement aimed at developing co-operative research projects in several branches of science and technology (Ismail-Zadeh, 2004: 11).

The Russian Federation has been a so-called 'third country' in the EU's 6th Framework Programme for Research and Technological Development. As a third country Russia has had to be invited to a research consortium by participants from a member country.

Another international funding agency with a European core is the International Science and Technology Centre (ISTC). The Centre was established by international agreement in November 1992 as a non-proliferation program. The ISTC coordinates the efforts of numerous governments, international organisations, and private sector industries, providing weapons scientists from Russia and the Commonwealth of Independent States new opportunities in international partnership. The ISTC contributes to fundamental research, international programs and innovation and commercialisation, by linking the demands of international markets with the exceptional pool of scientific talent available in Russian and CIS institutes.[25]

National funding agencies in Europe have also supported Russian science, with the British Council being one of the most prominent. The Council promotes linkages between Russian higher education organisations and British universities with the purpose of establishing joint research projects. The German Academic Exchange Services (DAAD) has provided individual grants to Russian university researchers for conducting research projects in Germany in all areas of natural and social sciences, as well as the humanities. The Netherlands Organisation for Scientific Research (NWO) initiated the Dutch Russian Cooperation programme in 1992 in collaboration with the Russian Foundation for Basic Research. Nordic collaboration programmes are described in the following section.

Dezhina and Graham (2004) have described how the forms and types of support provided by foreign organisations to Russian science have changed over time. At first, funding was primarily based on individual or group grants for scholarships of fellowships to be carried out outside Russia. However, being criticized for contributing to brain drain of Russian scientists, research collaboration and joint research projects between foreign and Russian researchers became more common. Financial contributions or matching funding are often required from the Russian side, but usually not on an equal footing with the foreign partner. Other common forms of funding consist of support to travel, libraries, ICT development and other infrastructure improvement, as well as direct institutional grants. Gradually there has grown for the idea of institutional funding and institutional reform, and for strengthening the bond between basic and applied science. In addition, contributions aimed at supporting the integration of research and education have also been made (*ibid.*). European research organisations have displayed a tendency to move from support of all areas of research to selected topics, as well as concentrating to a greater degree on certain sub-groups of researchers (young academics, women, certain regions, and others).

Research collaboration between Soviet and Nordic partners was very limited, but individual researchers and research groups took part in various scholarly societies and more informal research networks. However, after the break-up of the Soviet Union and the Russia's foreign policy change, research collaboration increased fast between the Russian Federation and individual Nordic countries. Gradually Russia was invited into existing or new research programmes within the Nordic Council of Ministers. Many Nordic countries saw the large country to the east as a priority area for international collaboration, notably Finland, Sweden and Norway. The research councils and research funding agencies of the three countries set up special programmes for research collaboration with Russia (sometimes in conjunction with the Baltic States and/or Central and East European countries).

North-West Russia was included in the Nordic (Council of Ministers') Programme for the Baltic States and North-West Russia (later it developed into the NordPlus Neighbour programme). Through this programme a large number of researchers, but also teachers and students, have received scholarships for shorter or longer research or study visits to the Nordic countries. The Nordic Academy for Advanced Study (NorFA) and later NordForsk has treated Russia on equal terms with the Nordic countries in their funding of research networks, mobility and research training activities. At the time of writing, the Nordic Council of Ministers has initiated a process of strengthening ties with research policy makers and research environments in North-West Russia, and NordForsk is closely involved in this endeavour.

The Science Systems in the Baltic Countries

Estonia, Latvia and Lithuania's R&D systems share many common characteristics. They all have a similar history as parts of the Soviet science system during the years of annexation by the Soviet Union. As was the case in the rest of the Soviet Union, the research system was organised around two central pillars: the academies of science and military research. The Baltic republics were among the most advanced science bases in the Soviet Union. Research achievements in high technology were particularly impressive, such as lasers, materials physics, pharmacology (Latvia), biotechnologies (Estonia) and semiconductors (Lithuania). Compared to many other countries in East and Central Europe, and in great contrast to the research system in Russia, the old systems in the Baltic countries were dismantled in their entirety and new ones were established.

This chapter contains a brief outline of the science systems in each of the three Baltic countries. It then describes the major science reforms that have taken place in the region since independence was regained in 1990–91. The major challenges to the further development of science in the three countries are then described, with particular emphasis on the links between science and innovation. After a presentation of the main research priorities in the three countries, the final section gives an overview of Baltic international collaboration in science, with special attention devoted to collaboration with the Nordic countries.

THE SCIENCE SYSTEM IN ESTONIA

In Estonia, the **Estonian Research and Development Council** (renamed in 1994 from the Estonian Science Council) is the main decision-making body for science affairs and innovation. It is headed by the Prime Minister. It consists of several ministers, the Rectors of the three major Estonian universities, the President and selected members of the Academy of Sciences, the Chairman of the Estonian Science Foundation and some representatives from business and industry. The activities of the R&D Council are based on two standing committees, one focusing on research, the other on industrial research and innovation policy. It acts as a consultative body to the ministries in their work on elaborating proposals. The council formulates the principles of funding and distribution between research areas, takes part in the formulation of the state budget on R&D, and gives advice to the Government on science policy.

The council's direct decision-making role in policy formulation and development is more limited, and remains the task of the ministries, most notably the **Ministry of Education and Research.** The Ministry is responsible for research policy and currently focuses primarily on supporting basic research in public research institutions and on enhancing the quality and capacity of Estonian research infrastructure. The Ministry's work is supported by its policy advisory body – The **Science Policy Committee**, consisting mostly of representatives from the universities.

There is also a **Science Competence Council** operating under the Ministry which acts as an advisory body based on peer review. The Council deals with target financing of longer-term (5 years) research projects carried out by research institutions. Such target financing amounts to approximately 50 % of the state budget for research (Kristapsons *et al.*, 2003: 38).

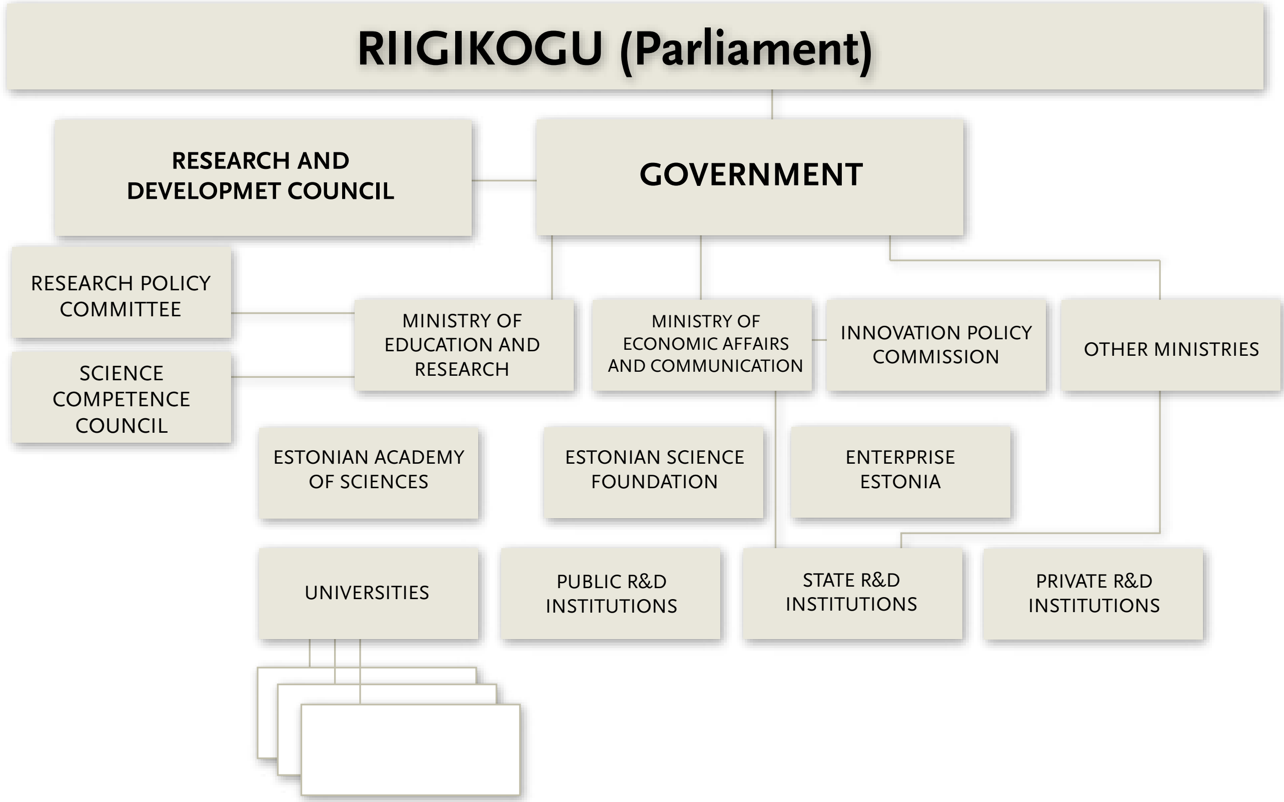
The **Estonian Science Foundation's (ESF)** main task is to provide small research grants to individual researchers. Estonia has achieved much progress in moving away from an institutional funding principle to one of competitive financing. This competitive grant system based on peer review has been introduced gradually, but the process started already in 1991. The reason for the gradual approach was to ensure the continuity of ongoing research as well as to protect Estonian researchers from the impact of an abrupt change. Already in 1997 the share of the state budget for research allocated to grants through the ESF reached 30 % (Kristapsons et al., 2003: 38).

There has been concern that the high share of project-based funding and the lack of more long-term institutional funding may affect institutional stability, lead to fragmentation and duplication of research as well result in a mismatch between investment in infrastructure and the prospects for long-term use of the facilities (Nedeva & Georghiou, not dated).

The **Estonian Academy of Sciences** lost the prominent role it had in the Soviet system and is now a western-style academy tasked with advancing scientific research and representing Estonian science nationally and internationally.[26] Most of the former research institutions under the Academy were transformed into independent research institutes. There are different types of ownership of the research institutes in Estonia: public, state, municipality and private. Many of the former research institutes are now integrated into the Estonian universities.

Other institutions with a role in the Estonian science system include the **Council of University Rectors**, the **Union of Scientists** and various scientific societies, as well as the **EU Framework Programmes' National Contact Point** and the **Patents Office** (see Figure 2).

FIGURE 2. THE R&D STRUCTURE OF ESTIONIA



Source: The ERA-MORE Visiting researcher's guide to Estonia, Tallin: Archimedes Foundation, 2006.

THE SCIENCE SYSTEM IN LATVIA

According to the Latvian **Law on Scientific Activity**, adopted in 1992, the **Science Council** plays a major role in the formulation of science policy. The semi-governmental Science Council was founded in 1990 and it has 20 members and 14 expert commissions. It differs from the science councils in Estonia and Lithuania in that it is elected and not appointed. The same is the case with the commission members.

One of the Science Council's major tasks is to distribute research grants) which are normally performed by 3–5 scientists, as well as large joint projects (programmes) which are based on research collaboration between a larger number of scientists from various institutions and higher education establishments. More recently more emphasis has been put on support to infrastructure maintenance and development as well.

Thus, the science system in Latvia is very much based on the independence of the research community. One could therefore argue that the **Ministry of Education and Science** (with its **Department of Science**) is less influential, and has a smaller staff, than the research ministries in the other two Baltic states. Nevertheless, the Ministry prepares the draft legislation and policy documents in the field of research; sets up criteria for the allocation of the state budget funds to research and development; prepares recommendations to the Cabinet of Ministers on establishment, reorganization and dissolution of public research organizations; organises monitoring, collection and analysis of information and preparation of reports on research system; and coordinates and promotes international cooperation in the fields of science, research and innovation. Furthermore, it coordinates international research and technological development programmes and projects; provides administration, expertise and funding for market oriented research programmes; and coordinates research programmes funded by the EU Structural Funds.

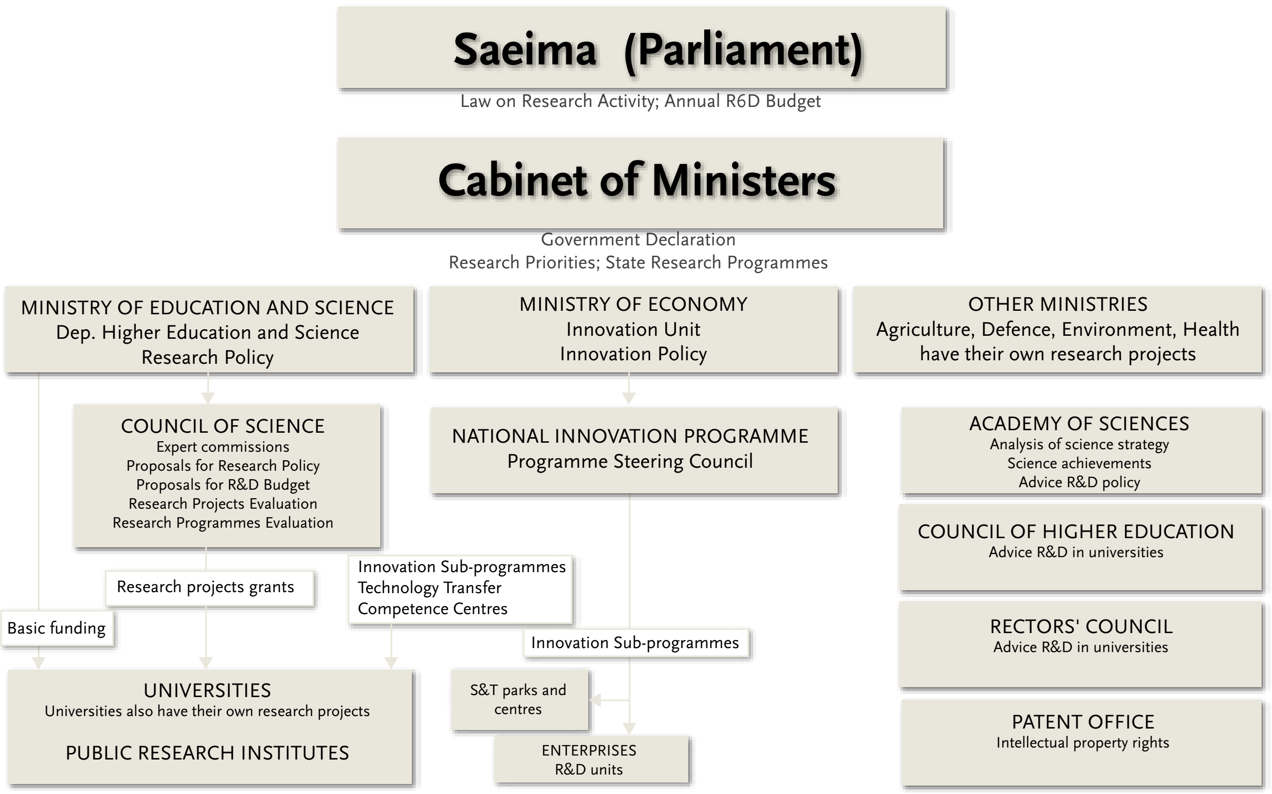
There are two types of projects supported by the Science Council. Small-scale projects (grants) are normally performed by 3–5 scientists, while large joint projects (programmes) are based on research collaboration between a larger number of scientists from various institutions and higher education establishments. More recently, the council has emphasised infrastructure maintenance and development as well.

The independence of the research community is a basic principle in the Latvian science system. The **Ministry of Education and Science** (with its **Department of Science**) is therefore less influential, and has a smaller staff, than the research ministries in the other two Baltic states.

In the 1990s the **Latvian Academy of Science** (LAS) was transformed into an academy of a West European type. While most research institutes until 1994 had been directed by LAS and the branch ministries, the transformation implied that most of the former LAS research institutes became independent research institutions. Subsequently they were transferred and integrated into the universities. Some independent research institutes remained. Today the main tasks of the LAS are the following: supporting research in basic and applied sciences, especially in disciplinary research; promoting studies in Latvian history, culture, and the development of the Latvian language; participating actively in establishing Latvian science policy and act as a consultation partner to the Government on scientific issues.[27]

Other relevant institutions involved in the Latvian research system are the **Council of University Rectors**, the **Academy of Agricultural and Forestry Sciences**, various scientific societies, the **EU Framework Programmes' National Contact Point**, and the **Patent Office.** Considerable changes in research governance, policy and funding systems are still ongoing and recently additional changes have been introduced through the new **Law on Research Activity** (2005) and its by-laws.

FIGURE 3. RESEARCH SYSTEM OF LATVIA



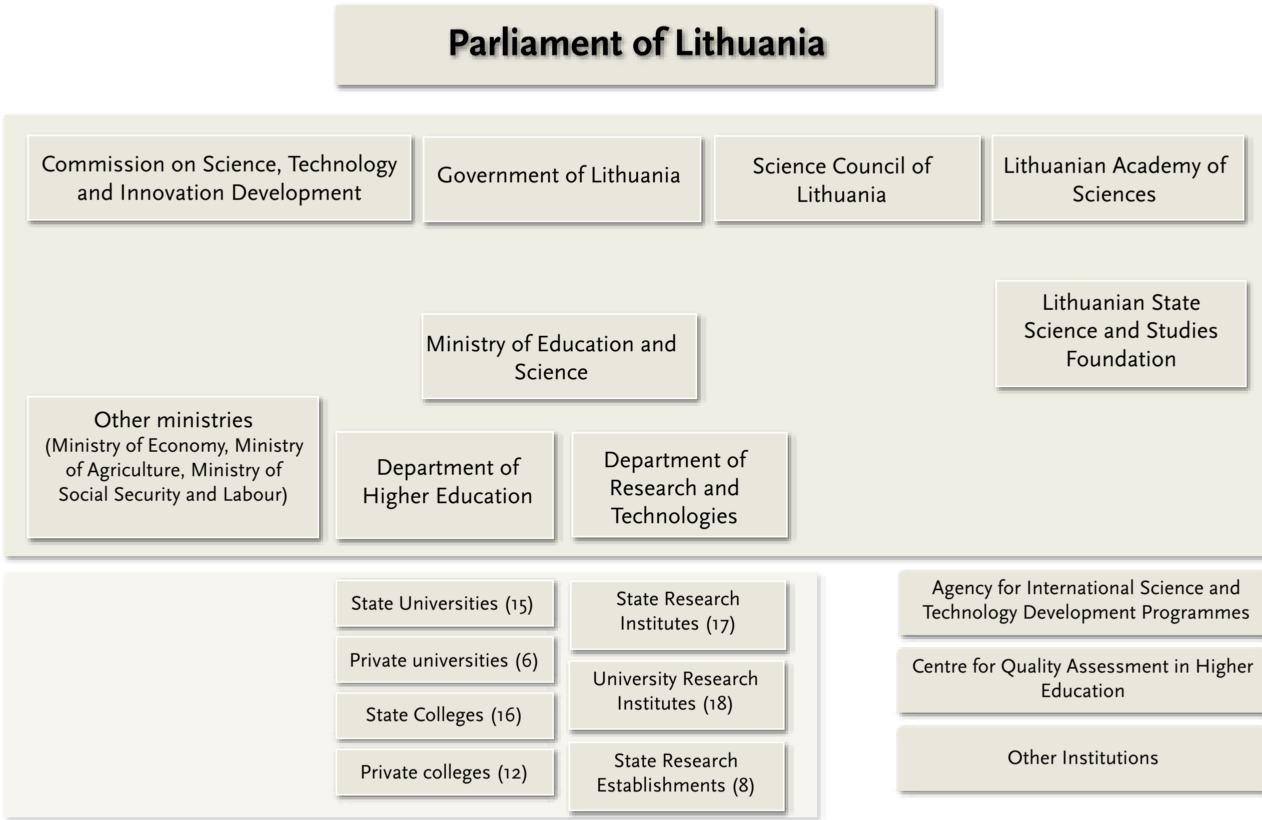
Source: (tinyurl): http://tinyurl.com/36xqz7 (accessed 31 January 2007)

THE SCIENCE SYSTEM IN LITHUANIA

In Lithuania, the **Commission on Science, Technology and Innovation Development**, headed by the Prime Minister, was formed in 2005 and replaced the former Science and Technology Commission. This expert institution represents a bridge between the legislative level (parliament – *Saeimas*) and the executive level (the government / the **Ministry of Education and Science**) on R&D issues. In addition, the **Science Council of Lithuania** and the **Lithuanian Academy of Sciences**[28] serve as scientific advisers and consultants to the Parliament and the Government/Ministry on strategic issues regarding research and higher education.

In contrast to Estonia and Latvia, Lithuania's system of financing research institutions has not changed fundamentally. Although the Law on Research and Higher Education stipulates that project funding should be prioritised over institutional funding, in practice the situation is still the other way around. In 2003, the **Lithuanian Foundation for Research and Studies** only received four per cent of the state budget funds allocated to research and higher education. The foundation provides funding for individual projects and research programmes based on peer review on a competitive basis. The intention has been that the foundation should absorb up to 30 % of total research funding but this goal has not been reached. The main bulk of research financing in Lithuania is still in the form of direct support to institutions. Correspondingly, and as a consequence, the institute sector in Lithuania has not been reformed to the same degree as

FIGURE 4. THE LITHUANIAN R&D SYSTEM.



Source: Lithuania: Your Partner in Research and Experimental Development, Vilnius: Ministry of Education and Science of Lithuania, 2006.

those in the two other Baltic States.

In Lithuania, Academy of Science research institutes were transformed into state research institutes which are guaranteed state financing, and research institutions which receive research funds from the ministries on a contractual basis. Many former institutes of higher education were reorganised into universities.

In addition to the institutions mentioned above, Lithuania also has some of the same institutions as the other two Baltic countries, such as the **Council of University Rectors**, the **Union of Scientists**, and various scientific societies. Other institutions include **the EU Framework Programmes' National Contact Point** and the **Patent Office.**

REFORMS

Reforms of the research systems in the Baltic States took place in parallel with a profound and three-fold transition, from totalitarian rule to democracy, from planned to market economies and from being part of the Soviet Union to renewed independent statehood. Thus, it was a major challenge to make the government and policy-makers aware of the importance of research at a time when public interest was directed towards much-needed economic and political reform.

The first stage of reforms was aimed at liberating science from political and administrative interference. The unions of scientists in all three countries were drivers of the profound reforms of the R&D systems from the late 1980s and into the early 1990s. However, after 1993 their role in the R&D systems diminished greatly. In 1990, new research councils were established based on democratic self-governance by scientists. The Academies of science's role in the reformed system changed substantially, resembling western-type academies of eminent scientists, rather than the resemblance of science ministries of the old Soviet system.

The research funding system was changed from one of block grants to research institutions to a competitive funding system based on expert reviews. Research councils were established already in 1990. According to Kristapsons *et al.* (2003) Western research systems served as a model for the new structures. However, Western countries show much variation in terms of their organisation of research and research funding, and the same is the case in the three Baltic countries. There was a widespread idea among scientists in the three countries that scientists themselves are the best governors and administrators of the science system, and that the only input they need from the state is money (Aaviksoo, 2003). Thus, state involvement was at first diminished in all three countries, but much more so in Latvia and Estonia than in Lithuania. One effect of this was a much reduced role in science affairs for ministry departments and officials. The Estonian analyst Jaak Aaviksoo described the situation in 2003 as follows:

The ministry [...] has only three full-time civil servants to handle all research-related questions, and they are clearly under-staffed, under-qualified and not even entitled (either formally or informally) to affect this decision-making in any reasonable way. [...T]he science community has taken the lead and power, since nobody else cares. (Aviksoo, 2003:34)

Gradually the state regained a more prominent role in science policy development in Estonia and Latvia as well, and the importance of the ministries increased. However, in both Estonia and Latvia the State's role in formulating and implementing science policy remained less significant than it is in most western countries.

Another important feature, more characteristic of Estonia and Latvia than Lithuania, was the transfer of former Academy of Science institutions to universities. In Estonia and Latvia most research and development is performed at universities. There are, however, also several independent research institutes that perform research at a high level.

CURRENT RESEARCH CHALLENGES IN THE BALTIC COUNTRIES

In some respects the Baltic countries are in a favourable position compared to other EU countries in terms of making use of their research potential. Despite their relatively modest financial contribution, Baltic researchers are involved in an increasing number of international research projects. Also, the gender balance is more even than in most other European countries. In Latvia more than 50 % of researchers are women.[29] The research systems in all three Baltic countries were evaluated by the three Nordic countries in the early and mid-1990s. A common recommendation from these research evaluations was that research and higher education in the three countries should be integrated more closely. This aim has to a large extent been achieved. Former Academy of Science institutions have largely been integrated into the university systems, especially in Estonia and Latvia.

However, despite having profoundly reformed their R&D systems, the Baltic countries still face challenges in meeting the research targets set out by the EU at the Lisbon summit in March 2001.[30] In this section we will present the three countries' major challenges under joint headings, although there is considerable variation among them regarding the characteristics and the gravity of the challenges.

Low Level of Financing of Research

Reforms of the research systems in the Baltic countries took place at a time when the countries experienced major economic setbacks and cuts in production. Politicians in all three countries focused mainly on measures for rapid economic recovery. Objectives for the longer term, such as science, were not prioritised. The share of GDP spent on research and development was significantly reduced in all three countries in the course of the 1990s. It is hard to estimate the exact reduction, due to the fact that comparative statistics on R&D in the Soviet period and the present Baltic economies are not completely accurate. In the Soviet period, statistics were collected according to Soviet standards. From the mid-1990s, the OECD standards were introduced and implemented. Only the figures collected after the OECD standard was introduced can be regarded as reliable and used for comparison with other European countries.

There can be no doubt, however, that the share of GDP spending on R&D dropped significantly in the early 1990s, finishing at a very low level at the end of the decade. The Baltic States were far off the Lisbon target of 3 % of GDP to R&D (GERD). In 2000, Estonia's GERD was 0.66 %, in Lithuania it was 0.60 % and in Latvia the GERD was as low as 0.41 % (Golob 2004). The EU 15 GERD average was 1.93 % (1999). One should also keep in mind that the Baltic countries' GDP was nearly halved in the same period, so real investment in research dropped even more dramatically.

This had a serious effect on the conditions for researchers. Many research institutes closed down or had to change or reduce their activity. Researchers' salaries dropped, and many top-class researchers took up work in business or other sectors of the economy. It became common for researchers to have more than one job, and hours spent at, and attention devoted to, work at the university or research institute were reduced. It was hard to combine work and family. Funding barely covered the modest salaries and the running costs of research, and there was only a marginal renewal of research equipment and premises due to a lack of funding for more costly investments (Aaviksoo, 2003: 37).

Largely as a consequence of the decline in research funding in the early 1990s, the traditionally high number of researchers in the Baltic countries was reduced. Latvia experienced the most abrupt decline in the years from 1991–99, while in Estonia and Lithuania the drop was more moderate. As a result, by 2000 Latvia had the clearly lowest number of scientists per 1,000 residents (11.1) while comparable figures for Estonia and Lithuania were significantly higher (21.6 and 21.2 respectively) (Allik, 2003:48). In the mid 1990s there was also a serious drop in the recruitment of new researchers as there were less than 100 doctoral degrees in all the three countries taken together.[31]

The situation has improved somewhat in the new millennium. All three countries have experienced rapid economic growth since the late 1990s and have had one of the highest economic growth rates in the EU in this period. This has also had positive implications for investments in research. The share of GDP for R&D is rising, although at a different speed in the three countries. In the 1998–2003 period the Estonian GERD rose with almost 12 % annually, the Lithuanian with 9 %, and the Latvian with 5 % (Ketels & Sölvell, 2005). Throughout the transition period, Latvia has been the Baltic country with the lowest share of GDP spent on research and development. There has been great concern among Latvian scientists that the government does not see the importance of research for the further development of the Latvian economy. However, the present Latvian government has increased research funding considerably from 2005 onwards.

Substantial changes have taken place in terms of research funding in recent years. The EU Structural Funds for R&D have significantly improved the financial situation and opened up new opportunities for the development of the national research systems in all three countries. While national research funding has been low in the transition period, funding from abroad has increased and accounted for a large proportion of total research funding in all three countries.[32] We will come back to this issue in the section on international collaboration below.

Industrial R&D and Innovation

In the Soviet R&D system there were weak links between research and innovation, and the state lacked a system for transforming knowledge into economic value and success.[33] It is often taken for granted that the Baltic countries will catch up and converge with the

West in terms of GDP and living standards. At the same time, there is common agreement that such a catch-up requires the establishment of knowledge-based economies in which science, technology and innovation form the core of progress. To what extent do the Baltic countries have the capabilities that are required to establish such knowledge-based economies? As will be shown in this section, there is diverging evidence and substantial differences between the three countries.

As referred to in the previous section, the Baltic countries spend a low share of their gross domestic product on R&D. At the same time, private investment in R&D is low. Of the three countries, Estonia has had the relatively biggest R&D budgets, but industry R&D expenditure still is very low compared to other European countries. In Estonia, 24 % of R&D expenditure was financed by business in 1999, while in Latvia, industry's share was as low as 16 %. The corresponding figure for the EU was 56 % (Golob, 2004). There is, in general, a very low R&D effort directed at qualitatively new product development (Aaviksoo, 2003: 35). The out-of-house private sector spending in research institutions, including research at the universities, also is very low in all three countries.

Many of the prerequisites for a knowledge-based economy are in place. While R&D was scarcely on the political agenda in the 1990s, with macroeconomic stability and the attraction of foreign investment being the main priorities, Baltic policy-makers today have a stronger commitment to developing advanced innovation-driven economies. There is a high level of education in all three Baltic States, and the proportion of the population with tertiary education is larger than in many other EU countries.[34] However, there is no automatic correspondence between the level of education, the quality of education, and the degree to which the educational system responds to the requirements of enterprises and business. The proportion graduating from science, mathematics and computing is, for example, lower in the Baltic states than in most other EU countries. Lithuania is the only country with a large share of graduates from engineering, manufacturing and construction.[35]

The Baltic innovation systems are small. The economies are investment driven and not innovation based. Industry has traditionally been raw-material intensive and produced little added value. In order to generate a critical mass of R&D, the three countries will therefore need to focus their R&D efforts in a few key areas. We will now look into specific challenges in each of the three countries.

Estonia

Research policy in Estonia is generally seen as covering university research, and innovation policy as covering private sector research. This is largely due to the fact that nearly all basic research is conducted in universities, while the industry sector focuses almost exclusively on product development and innovation. Thus, the national research/innovation system has been split into two independent parts: academic science and applied/commercial science, and according to experts the links between research and business innovation are fairly underdeveloped. However, some recent steps to promote inter-sector collaboration between R&D and innovation are yielding good results. In 2001 the Estonian Technology Agency (ESTAG) was established, and it offers direct financial support measures to market-oriented R&D projects and project preparation.

Estonia has, compared to Lithuania and Latvia, considerably better indicators on European innovation indexes. According to these figures, only Slovenia is ahead of Estonia among the new EU members from Central and Eastern Europe. A study of Estonian innovation capacity ranked the country top among the group of CEE countries. Even though these indicators are quite positive, several reports are somewhat more reserved when it comes to the development of Estonia's innovation performance. The number of patents is low, there are relatively few science and engineering graduates, and industry's R&D expenditure is also low.[36] R&D infrastructure is underdeveloped. While Lithuania and Latvia are located in the quadrant of countries 'catching up' in a figure of European countries' innovation trends

(2004), Estonia is in the quadrant of countries 'falling behind'.

According to a recent policy report 'Made in Estonia' the technological structure of industry is not growing more knowledge intensive and complex, and the distribution of labour is decreasing (Tiits *et al.*, 2006). Data on export structure and industrial competitiveness shows that Estonia is currently almost entirely specialised on wood processing activities (furniture, printing and paper industries). Furthermore, Estonia exports low value-added functions of Scandinavian information technology and electronics clusters. Among the policy advice of the report is to facilitate knowledge and technology transfer from foreign investment-based enterprises into domestic industries and service sectors, and to increase the capability of local enterprises to apply the knowledge created abroad as well as to invest in basic research to keep abreast of global research and technology trends.

However, the Estonian innovation governance system has a number of strengths that are of relevance for research and development in the country: The development of a new R&D strategy for 2007–10 is underway with measures to strengthen innovation capabilities. There is a well established network of innovation support structures, such as business incubators, technology/science parks, as well as technology transfer offices at the universities. There are programmes for promoting innovation in companies and for fostering industry-academia co-operation.

Latvia

Despite high and sustained level of GDP growth over the past decade (twice the annual growth rate of the EU15 and also considerably faster than the average for the new EU member states), Latvia is facing severe challenges in terms of maintaining and increasing competitiveness. Latvia is among the countries in the EU with the weakest innovation performance, according to the 2004 Summary Innovation Index.[37] It ranks among the bottom five countries in the EU25 for 9 out of 22 indicators. The business R&D expenditure (BERD) was as low as 13 % of the EU25 average in 2001, placing Latvia 21st. Latvia also scores very low in the field of patenting. Latvia's placement in the 'catching up' quadrant in the figure illustrating country trends is mainly due to a very low starting value.

A local expert on the innovation system in Latvia listed the following main problems to higher innovation performance in Latvia (Stabulnieks 2006):

- Lack of a developed business support infrastructure
- Lack of support programmes for new technology-based firms (start-up, seed money, early stage , venture capital, etc.)
- Gap between research and business community
- No co-ordination of technology transfer activities
- Slow implementation of the National Programme on Innovation Action Plan (2005)

In the 2000–03 period, little was done to increase R&D spending despite several reports about the alarming situation. However, in 2004, a special Steering Committee for the coordination of the implementation of the Lisbon strategy was formed, and a government declaration explicitly referring to the Lisbon and Barcelona targets was signed.

Despite the low funding of industrial R&D, and serious challenges facing the innovation system, several significant achievements, even of world scale, have been recorded. These are in areas such as methods of critic acid biosynthesis, medical preparations, heat and noise isolation materials, magneto hydrodynamic technologies, and plasma technology for inorganic materials, to mention a few (*ibid.*, see also Kristapsons et. al. 2001).

Lithuania

Lithuania shares many of Estonia and Latvia's strengths and weaknesses in terms of innovation performance.[38] Compared to other European countries, and taking into account the strong economic growth of Lithuania during the past decade, Lithuania performs rather poorly in terms of R&D and innovation indi-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THE BALTIC COUNTRIES' RESEARCH PRIORITIES LARGELY REFLECT THE LISBON 2000 SUMMIT'S RECOMMENDATION, WITH NATIONAL STRATEGIES IN ALL COUNTRIES EMPHASISING BIO-TECHNOLOGY AND INFORMATION AND COMMUNICATIONS TECHNOLOGIES (ICT).

cators. The main challenge lies in the low level of expenditure on industrial R&D. Despite being much higher than Latvia's figure and close to that of Estonia, Lithuanian industrial R&D expenditure is still very low compared to the EU average. The amount of patents is also far below the average for EU countries. Although the level of industrial R&D is also very low in a European context, the way R&D is calculated in Lithuania makes the figures somewhat unreliable. Recent trends are rather positive, and both public and business expenditure on R&D have increased since 2000. Lithuania has a low score on upgrading skills and employment structure, with a very small share of the workforce in medium to high-tech manufacturing and in high-tech services. On the other hand, the proportion of university graduates in science and engineering is higher than the EU average.[39]

The Lithuanian ICT sector has received much attention, contributing to a growth in labour productivity in the 2000–03 period. Other sectors are weaker and economic growth is largely attributable to increased export in the lower tech and lower value added sector and is not due to innovation. A very small part of Lithuanian SMEs are engaged in technology-intensive industries. The largest industries are involved in food and beverages and wood industry. The linkage between knowledge production and diffusion in the enterprise sector is weak. In the report Innovation Policy in Europe 2004 (*ibid.*), four challenges for the Lithuanian innovation system were identified:

- Developing modern skills for innovation
- Creating effective links between the R&D sector and firms
- Increasing the level of investment in public and private R&D
- Introducing a patenting culture

The second and third points are of particular concern for the topic of this report. Despite the declared need for applying a systemic concept for R&D and business competitiveness policy, experts judge that the existing national innovation system and R&D are not sufficiently integrated. R&D and innovation remain separate systems despite political declarations to link them.

The Lithuanian Ministry of Economy has declared innovation one of its top priorities. A programme on innovation development for 2003–2006 has been adopted by the ministry and operationalised through an action plan. Lithuania has a large number of support programs available for innovation development activities. However, experts assert that there is a significant lack of venture capital in the country.[40]

Brain Drain

As was the case in Russia, a considerable proportion of scientists in the Baltic countries left science to take up positions in other sectors of the economy or emigrated during the transition period. The main motivation was to find jobs with better salaries and improved material conditions. Reliable statistics to indicate the size of such brain drain are scarce. What is well known is the fact that the number of researchers in all three countries dropped dramatically in the 1990s. The situation was particularly severe in Latvia where it is estimated that the share of the workforce employed in R&D was reduced from 2.2 % in 1990 to 0.5 % in 1994. [41] The number of researchers in Latvia was estimated to 17,000 in 1990 but was reduced to 4,000 in 2000. However, based on these figures it is hard to assess who left science voluntarily because they were offered better work elsewhere, and who experienced pressure to leave due to lack of opportunities or cut-backs in their research institutions. While most researchers found work in other sectors of the economy or in public administration, some researchers became unemployed as a consequence of the structural changes. There are indications that brain drain from science was particularly strong in the early 1990s and that the internal brain drain has been larger than emigration (Eglite, 1996).

With the three Baltic countries' accession to the EU, Baltic researchers' job opportunities in the EU increased. As of yet, there are no statistics indicating brain drain from research institutes in the Baltic countries to west European research institutes. But international collaboration has increased and many researchers spend time abroad outside their own institutions. However, most such visiting scholars return to their home institution after a certain period. While some categories of research are well paid, most researchers still have low salaries. There is therefore a risk of so-called 'brain waste', with low-paid scientists from the Baltic states taking leave from their jobs in order to take up unskilled positions in Western Europe.

Quality and Productivity of Research

One reflection of research quality is publications in international refereed scientific journals. Jüri Allik has systematized bibliometric indicators of the quality of science in Estonia, Latvia and Lithuania in the 1992–2001 period (Allik, 2003: 40–52). In 2001, Estonia, with its 404 scientific publications per one million population, was clearly ahead of Latvia (166) and Lithuania (136). Comparing the costs of one published article, taking into account the expenditure on R&D in each country, the costs were lowest in Estonia and slightly higher in Latvia and Lithuania. Moreover, Estonia produced the largest number of high-impact papers and also registered the largest number reciting them. In an international perspective, all three Baltic States lag far behind the EU average in terms of the number of scientific publications per one million population. Moreover, in an international perspective, the productivity of researchers is not particularly high in the Baltic States. Only one published article per respectively 5, 7 and 14 researchers in Estonia, Latvia and Lithuania is a clear indication of this.

Jüri Allik is particularly concerned with what he describes as obvious signs of stagnation in Latvian science. During Soviet times, Latvia was the Baltic republic that produced the highest number of scientific publications. While Estonia and Lithuania have seen an increase in the number of scientific publications produced since 1990, the number of publications is approximately the same in Latvia. Three main factors are presented as plausible reasons for this stagnation. Firstly, the 100 % grant system (see section on the Latvian science system above) destroyed the existing scientific infrastructure, according to the author. Secondly, the number of researchers was reduced more drastically in Latvia than in Estonia and Lithuania, and a larger number of leading Latvian scientists went to work abroad. The effect of this brain drain can be observed in the number of scientific publications produced. Thirdly, in the period analysed by Allik, the state budget allocations to science were lower in Latvia than in the other two Baltic countries (and this is still the case). There was consequently a lack of both resources and incentives in Latvia, according to the author.

RESEARCH PRIORITIES

The Baltic countries' research priorities largely reflect the Lisbon 2000 summit's recommendation, with national strategies in all countries emphasising biotechnology and information and communications technologies (ICT). However, as shown in this section, the three countries differ somewhat when it comes to other research priorities.

Estonia

Estonian research priorities were outlined in the Estonian Research and Development Strategy 2002–2006, 'A knowledge-based Estonia'. It should be stressed that this strategy deals not only with R&D but also innovation. According to the strategy, there are three key areas that should be developed and that require an increased share of state resources:

- User-friendly information technologies (IT) and development of the information society
- Biomedicine
- Materials' technologies

National programmes are aimed at fostering R&D activities in these key areas. Other priority areas include the continuity and promotion of research related to the Estonian people, language, national culture and history. Furthermore, research related to Estonian statehood and the sustainable development of society, as well as research in the area of national security is given priority. Finally, research related to the everyday environment and the protection of nature, sustainable use of natural resources, and the development of rural areas are also singled out as important in the research strategy.

The three major key areas are in line with the EU's Research, Development and Innovation (RD&I) priorities, and the Estonian research strategy underlines the importance of international research collaboration. Such collaboration is also seen as an instrument for obtaining additional financing for the achievement of national priorities.

Latvia

Research priorities for the years 2002–10 were outlined in the Latvian Council of Science document 'Guidelines for the development of higher education, science and technologies 2002–10'.[42] The following key areas were singled out because of their application of advanced technology or their unique importance for social or cultural preservation and development:

- Information technology (system and software engineering of new technologies, telematics, multimedia and telecommunications);
- Organic synthesis and biomedicine (gene therapy, new technologies for synthesis of bioactive substances);
- Material sciences (nanomaterials, new materials for microelectronics, photonics and optoelectronics, bio- and other composite materials);
- Forestry and wood technologies (forest development; rational utilization of wood biomass, chemical processing of wood);
- Letonica (Latvian language, history and culture).

In addition to these research priorities, the document describes some necessary measures for developing R&D. It estimates that science and scientific technologies should be included in the National Development Plan and recommends state co-financing of EU and NATO research funding. Furthermore, the document highlight internationalisation. The establishment of scientific Centres of Excellence of outstanding scientific quality is another key priority. The links between research and technology development are highlighted, as is the application of research results in innovation. Finally, the document emphasises systematic research evaluation as a priority area, with the goal of evaluating all research institutions with no more than five year intervals.

On 30 May 2006, the Cabinet of Ministers approved the thematic priorities for 2006–09. The new priorities include all of the five previous priority fields in addition to four new ones: agro-biotechnology, energy, environment and health sciences. State research programmes in four new priority fields will be launched.[43]

Lithuania

Lithuania's R&D priorities were outlined by the government in July 2002:[44]

- Research to ensure quality of life:
  - genomics and biotechnology for health and agriculture,
  - qualitative, safe and ecological food technologies,
  - changes in ecosystems and climate.
- Research to promote a knowledge-based society:
  - information society technologies,
  - citizens and governance in a knowledge-based society,
  - protection of national identity under globalisation.
- Research to create nanotechnologies:
  - nanosciences,
  - nanotechnologies,
  - development of multifunctional nanostructure-based materials.
- Research on the nuclear safety of the operation and closure of Ignalina nuclear power station and management of radioactive waste:
  - nuclear safety,
  - radioactive waste management.
- R&D to increase Lithuanian industries' international competitiveness: development of biotechnologies, mechatronics, lasers, information and other high technologies.

At the end of 2003, the Government of Lithuania approved a long-term research and development strategy for Lithuania. The strategy's main goal is to analyse the strengths, weaknesses, opportunities and threats (SWOT analysis) facing the Lithuanian R&D system and to set out the strategic goal for the country's R&D sector. The strategy declares that the main goals are to strengthen the country's science and technology potential, ensure the speed and efficiency of R&D development and increase Lithuania's competitiveness to the best of it's ability and restricted resources. The strategy further outlines the strategic objectives which should be reached by 2015:

1. Develop Lithuania's science-industry cooperation into a system similar to European innovation development practice within 7 years.
2. Increase R&D spending to 3 percent of GDP by 2010; private sector investment in R&D should reach 2 percent of GDP.
3. Increase high-tech industries' share of GDP to 20 percent by 2010.
4. Raise the computer literacy rate to 70 percent within 5 years.
5. Integrate Lithuania's R&D system with the EU research area.
6. Use EU structural funds for research and development in Lithuania.

If necessary the programme can be corrected according to the priorities approved by the Government of Lithuania.

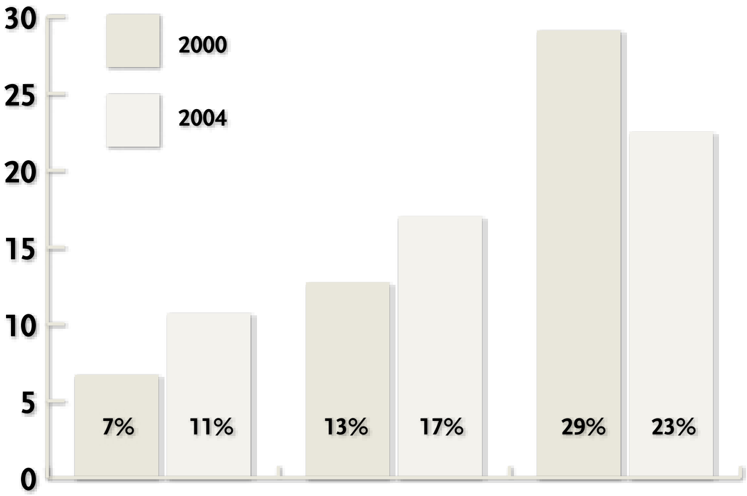
INTERNATIONAL (INCLUDING NORDIC) COLLABORATION

Before the late 1980s, contact between researchers in the Baltic republics and researchers and institutions outside of the Soviet Union had been limited due to severe restrictions by the Soviet authorities. The first liberalisation took place through the easing of restrictions on collaboration with émigré Baltic researchers that was introduced under Gorbachev's *glasnost'* period. Baltic émigré researchers were active in supporting reform of the Baltic science systems and in introducing Baltic researchers to international conferences and research milieus. The Association for the Advancement of Baltic Studies (AABS) was particularly active and invited researchers from the Baltic States to take part in their conferences.[45] Large international conferences were also organised in the Baltic countries themselves from the late 1980s. In general, the opening up of international collaboration resulted in a reorientation of Baltic research and science systems towards the west, and research contacts with research milieus in the countries of the former Soviet Union were downplayed. The Baltic countries' gradual integration into western economic and political structures, culminating with memberships in the European Union and NATO, strengthened research ties with Western European countries even further.

The science evaluation that took place in the first half of 1990s constituted a very important aspect of international collaboration, and particularly collaboration with the Nordic countries. The evaluation was carried out first in Estonia and Latvia in 1991–92, and then in Lithuania in 1995. Swedish experts evaluated Estonia, Danes evaluated Latvia and Lithuania was evaluated by Norwegian experts.[46] The two former evaluations were particularly significant in encouraging structural reform and introducing the peer review system. The evaluations were financially supported by the governments of the Scandinavian countries and the European Union and formed part of a strategy of integrating Baltic science into European and international networks. Project by project evaluations were carried out and some general recommendations were given on how to develop the Baltic science systems and the quality of Baltic research further.

Funding from international funding agencies, which had been close to non-existent during the Soviet period, became a valuable source of income for individual Baltic researchers and research institutions in the 1990s. This was particularly welcome at a time when national research funding was scarce. From 1992, the European Commission launched a number of programmes for scientific collaboration with countries in Central and Eastern Europe, including the Baltic States. These include the COST, TEMPUS, PECO/COPERNICUS and EUREKA programmes. Figure xx shows the share of the gross domestic expenditure on R&D that came from abroad in 2000 and 2004. We see that it is higher in Latvia than in the two other countries.

FIGURE 5. SHARE OF GROSS DOMESTIC EXPENDITURE ON R&D WITH DUNDUNG FROM ABROAD (IN PER CENT)



Source: Eurostat.

The Baltic States display rather different patterns of participation in the European Union Framework Programmes. The smallest of the three countries in terms of population size, Estonia, has by far the largest number of researchers involved in such projects, both in absolute and relative terms. According to the CORDIS database, Estonian researchers took part in 191, Latvian in 148 and Lithuanian in 145 of the 16,889 projects financed under EU's fifth framework programme.[47]

Another valuable source of Baltic research funding was the International Science Foundation (ISF) established by George Soros to support science in the former Soviet Union and the Baltic countries.[48] A number of programmes were established under this foundation, including support to researchers publishing in prestigious international scientific journals, support to participation in international conferences, and library assistance. The most important in terms of funding was the Long-Term Research Grants Programme.

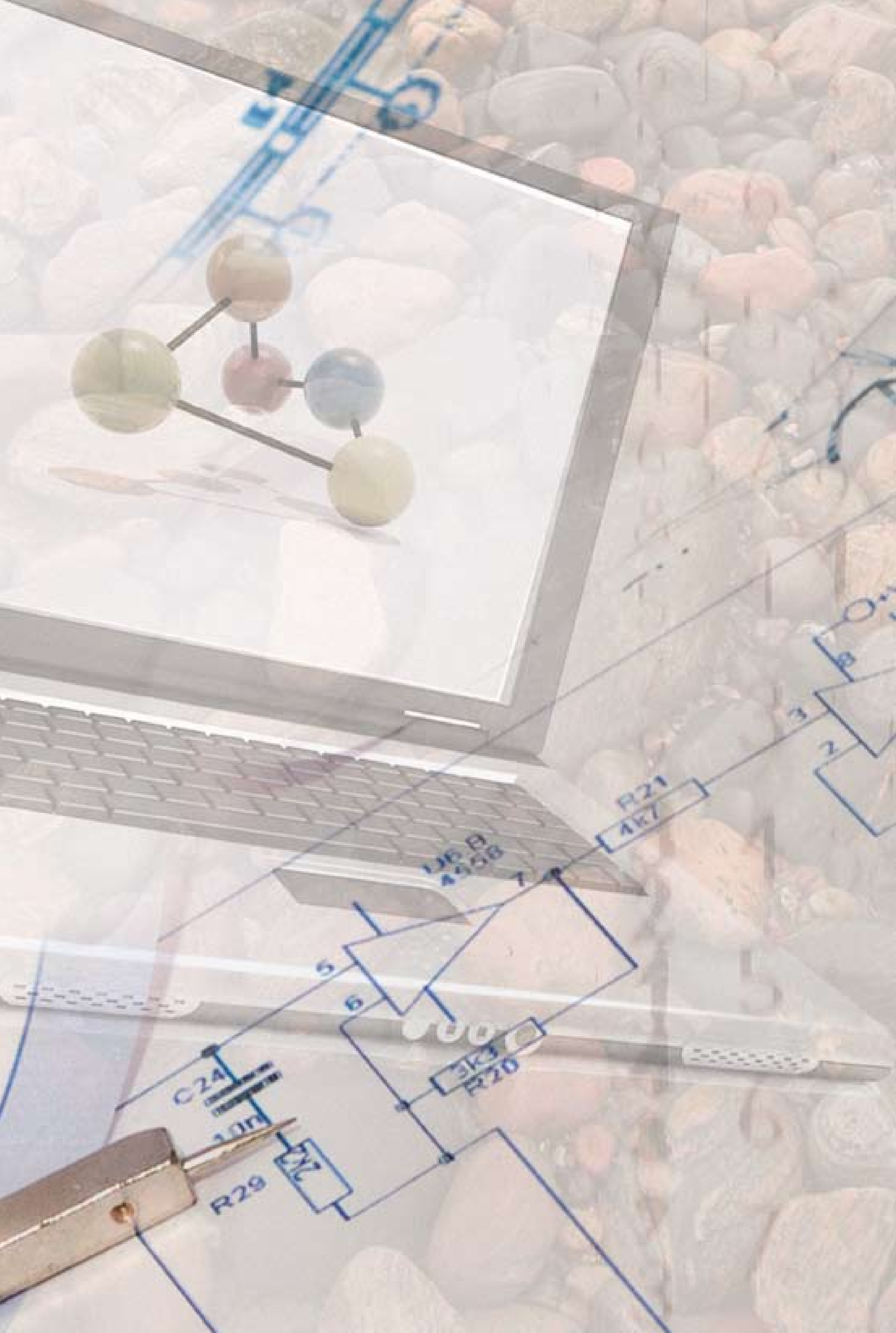
Baltic–Nordic research collaboration has taken place both bilaterally and within the framework of special Nordic–Baltic programmes. Already in 1991, the Nordic Council of Ministers launched the Nordic Scholarship Programme for the Baltic States (later it developed into the NordPlus Neighbour programme). This programme was broadened to include North-West Russia from 1994 (see chapter on Russia). Through this programme, a large number of researchers, teachers and students, have received scholarships for shorter or longer research or study visits to the Nordic countries. The Nordic Council of Ministers' guidelines for cooperation with Estonia, Latvia and Lithuania for the 2006–08 period highlights research and innovation since '[r]esearch and innovation work, as well as cooperation in the field of education, would provide natural continuity in the context of cooperation that has already been initiated and that is vital to the attractive force of the entire region'.[49] Joint Nordic–Baltic ministerial meetings between the ministers of research and education take place at regular intervals. The Baltic countries are gradually contributing financially to such research collaboration with the Nordic countries, and programmes with a character of development aid are being terminated.

The Nordic Academy for Advanced Study (NorFA), and later NordForsk, has financed Baltic participation in Nordic research networks and research training courses, as well as mobility scholarships for individual researchers. In NordForsk, Baltic research groups also are integrated into Nordic Centres of Excellence. NordForsk has included an observer from the Baltic countries in its Board. The Nordic Natural Science Research Councils (NOS-N) have involved Baltic researchers in its activities, and there have also been other forms of research collaboration with the Nordic research councils, for example ethics committee collaboration. The Baltic and Nordic Academies of Science have also collaborated quite actively in the post-independence period. Furthermore, bilateral contacts are well established both between research institutions and research funding agencies. For example, the Estonian Science foundation and the Academy of Finland have for a number of years collaborated on exchange of external reviewers for large applications for research funding.

Much of the Baltic–Nordic research collaboration takes place within the framework of EU and EEA. Both Latvia and Lithuania have singled out research as a priority area under the EEA financial mechanism scheme. Covering all the new member states of the European Union, the scheme is primarily funded by Norway, but Iceland and Lichtenstein also contribute.[50]

Ironically, internal research collaboration between the Baltic countries is underdeveloped, despite the geographic proximity, historical heritage and similar research structures. Most of this collaboration takes place within larger European or Nordic–Baltic research schemes and programmes. Nevertheless, Kristapsons *et al.* (2003: 65) list seven common Baltic scientific journals (published in English), indicating at least a certain degree of internal Baltic collaboration within certain scientific fields.

The number of publications co-authored by researchers in different countries gives an indication of the occurrence and distribution of international collaboration. Kristapsons *et al.* (*ibid.)* present figures for each of the Baltic countries on the number of publications co-authored with an international partner in 1990–2000. Estonia had the largest number of co-authored scientific articles involving international partners in 2000. Co-authors from Finland and Sweden were the most common, followed by Germany, Britain and the United States. In Lithuania, the co-authors were most frequently from the US, Sweden, Russia and Germany. In Latvia, which had the lowest number of co-authored articles, Germany, Russia, the United States and Sweden were the corresponding order of countries in terms of co-authorship.


R21
4k7
U6.B
4558
C24
10n
3k3
R20
R29


R22
56E
O-Vs
62.5
P8
10k
C3
2U2

Conclusions: From Isolation to Cooperation

This report has described the profound changes that have taken place in the science systems in Russia and the three Baltic countries. However, transformations of the Baltic and Russian science systems have not taken place in isolation from research developments in other parts of Europe. The past two decades have been characterised by increased internationalisation of research, and such internationalisation has climbed towards the top of the research agenda of most European countries, including the Nordic countries. These parallel processes in the post-Soviet and Nordic countries have thus increased the impetus for Nordic–Russian and Nordic–Baltic research collaboration. Increased regionalisation through Nordic, Barents, Baltic Sea and north European (northern dimension) settings also provide new arenas for joint research.

The Nordic countries need to apply different strategies for strengthening collaboration with respectively the three Baltic countries and Russia. The Baltic States are geographically closer, they are small in size, and to a considerable extent they look to the Nordic region for developing partnerships. Russia is a giant. The capital and much of the territory is more distant from the Nordic region, and the Nordic countries are not necessarily high up on Russian policy makers' agenda. The Nordic and the Baltic countries are fully integrated into the European Research Area (ERA), while Russia is only a partner country and has so far had a weak participation in the EU framework programmes.

In all the countries, however, there is a very high awareness of international cooperation as an asset for scientific performance. Both Russian and Baltic science communities have gained valuable experience from participation in European and international programmes. The improved economic situation in the Baltic States and Russia is likely to contribute to a shift in focus. Rather than concentrating solely on acquiring funds, they will to a greater extent focus on achieving closer integration with the international science community and engage in joint scientific work in order to get access to additional scientific knowledge. This is a development that the Nordic countries are likely to benefit from.

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Notes

1 Thorough analyses of Soviet science can be found in Graham (1990 and 1993), Balzer (1989), and Medvedev (1978).

2 The Ministry has the following web-page: http://mon.gov.ru/ (accessed 10 January 2007), in Russian.

3 Simultaneously another new ministry was established – The Ministry of Industry and Energy – which was a merger of the former Ministries of Energy, Atomic Energy, a variety of agencies, and the industry responsibilities of the former Ministry of Industry, Science and Technologies.

4 The Department of economy and finances; the Department of state policy in education; the Department of state science-technological and innovation policy; the Department of international cooperation in education and science; the Department of state youth policy, upbringing and social protection of children; and the Department of administration and state service.

5 In addition there is the Federal Agency for Education (ROSOBRAZOVANIE). Under the Ministry of Industry and Energy there is also the Federal Space Agency. For more on these agencies, the following web-page gives information: http://mon.gov.ru/structure/agency/ (accessed 10 January 2007).

6 For a brief institutional profile of the Russian Academy of Sciences, see http://www.oti.globalwatchonline.com/online_pdfs/33138X.pdf (accessed 27 January 2007).

7 These are the Russian Academy of Agricultural Sciences, Russian Academy of Medical Sciences, Russian Academy of Education, Russian Academy of Architecture and Civil Engineering, Russian Academy of Arts.

8 The foundation was established in 1992. In 2003 it had a budget of 2.386 mill. roubles (just over € 70 mill.).

9 The foundation was established in 1994. No information about the budget can be found on the web-page of the foundation.

10 See http://www.globalwatchservice.com/pages/ThreeColumns.aspx?PageID=393 (accessed 10 January 2007)

11 Based on figure downloaded from http://www.globalwatchservice.com/pages/ThreeColumns.aspx?PageID=393 (accessed 10 January 2007).

12 For more on this debate, see http://www.eed.ru/cover_story/c_25.html (in Russian) (accessed 10 January 2006).

13 See the Global Watch Service Web-page: http://www.globalwatchservice.com/pages/ThreeColumns.aspx?PageID=395 (accessed 10 January 2007).

14 See Global Watch Service web-page: http://www.globalwatchservice.com/pages/ThreeColumns.aspx?PageID=395 (accessed 27 January 2007). .

15 Karlis Kirsis, 2002, downloaded from http://tinyurl.com/37mns9 (tinyurl) (accessed 10 January 2006).

16 For more on FIGs, see UNESCO's report (2005) pp. 149-150.

17 It should be noted that the concept ' Science and Technology' looks at aspects of science directly linked to the relationship between science and technology. Other aspects of science, not directly involving technology, are not covered under this heading. The list has been downloaded from http://www.globalwatchservice.com/pages/ThreeColumns.aspx?PageID=647 (Accessed 15 December 2006).

18 See http://www.crdf.org/about/ for more on CRDF and its funding principles (accessed 10 January 2007).

19 See http://www.soros.org/initiatives/regions/russia (accessed 10 January 2007).

20 See http://www.eurasia.org/ (accessed 10 January 2007).

21 See http://www.irex.org/ (accessed 10 January 2007).

22 See http://www.fulbright.ru/ (accessed 10 January 2007).

23 The programme is implemented with the support of the Russian Ministry of Education and Research, the Carnegie Corporation of New York (USA), the John D. and Catherine T. MacArthur Foundation, and the Open Society Institute (Soros Foundation) in Russia. More on the programme can be found at http://www.iriss.ru/en_about (accessed 10 January 2007) .

24 More on INTAS can be fount on the organisations' web-page: http://www.intas.be (accessed 10 January 2007).

25 See http://www.istc.ru/ (accessed 10 January 2007).

26 The Academy has the following web-site: http://www.akadeemia.ee/en/academy/ (accessed 27 January 2007).

27 The Academy has a homepage: www.lza.lv.

28 The Lithuanian Academy of Sciences' homepage: http://neris.mii.lt/LMA/english/mokslo_.html (accessed 27 January 2007).

29 One could, however, ask whether the high proportion of women in research in the Baltic states is rather a sign of low prestigue and salaries in the science sector than an indication of highly developed gender equality. There are indications that the more teaching is involved, and the less prestigeous positions there are, the more women you find. There are few women among full professors in all three countries.

30 In March 2000, the EU Heads of States and Governments agreed to make the EU "the most competitive and dynamic knowledge-driven economy by 2010". Although some progress has been made on innovating Europe's economy, there is growing concern that the reform process is not going fast enough and that the ambitious targets will not be reached. One of the main issues for the realisation of the Lisbon agenda has been the necessary investment in R&D at 3 % of GDP.

31 Figures from NORBAL, providing statistics on doctoral degrees in the Nordic countries and the Baltic states. http://english.nifustep.no/norbal__1/eng/startpage .

32 In Latvia, for example, approximately one quarter of R&D funding came from foreign sources in 2000. Data from the Latvian Academy of Sciences, http://science.lza.lv/statistics.htm .

33 Already in the 1960s critics pointed to the inadequate linearity and fragmentation of the Soviet innovation system, and the need to strengthen the links between R&D and production (Högselius, 2003). The numerous attempts at reforming the Soviet innovation system have been accounted for in detail by Cooper (1982).***

34 See for example http://epp.eurostat.cec.eu.int/cache/ITY_OFFPUB/KS-NS-05-008/EN/KS-NS-05-008-EN.PDF (accessed 3 January 2006).

35 Ibid.

36 Annual Innovation Policy Trends and Appraisal Report, European Commission, downloaded from http://trendchart.cordis.lu/reports/documents/Country_Report_Estonia_2005.pdf (accessed 15 January 2007).

37 Annual Innovation Policy Trends and Appraisal Report, European Commission, downloaded from http://trendchart.cordis.lu/reports/documents/Country_Report_Latvia_2005.pdf (accessed 15 January 2007).

38 Annual Innovation Policy Trends and Appraisal Report, European Commission, downloaded from http://trendchart.cordis.lu/reports/documents/Country_Report_Lithuania_2005.pdf (accessed 15 January 2007).

39 Information from Cordis' web-page: http://trendchart.cordis.lu/annualreports/report2004/Innovation_policy_europe_2004.pdf (accessed 15 January 2007).

40 See the Teico-net report "Analysis of the innovation environment in the Teico-Net Regions, downloaded from http://www.teico-net.net/media_manage/uploaded_files/report_environment_final_100606.pdf (accessed 15 January 2007) .

41 Information from the Latvian Academy of Sciences downloaded from http://science.lza.lv/statistics.htm (accessed 17 January 2007).

42 See http://www.lzp.lv/latv/Vadlinijas5_Me.htm (in Latvian) (accesseddownloaded 17 January 2007).

43 See the web-page of ERAWATCH (tinyurl): http://tinyurl.com/2tedao (accessed 31 January 2007).

44 From a document on the Lithuanian R&D system written by Dr. Stanislovas Zurauskas, downloaded from http://www.tpa.lt/5FP/RTD/RTD_system.html (accessed 17 January 2007) .

45 The Association has the following webpage: http://depts.washington.edu/aabs/ (accessed 27 January 2007)..

46 The responsible institutions were respectively the Royal Swedish Academy of Sciences, the Research Council of Denmark, and the Research Council of Norway.

47 The number of projects co-ordinated by research groups in the three countries was as follows: Estonia: 23; Latvia: 33; and Lithuania: 18. See http://cordis.europa.eu/press-service/stats.htm#member (accessed 17 January 2007).

48 The Foundation provided USD 100 mill. to research in the republics of the former Soviet Union and the Baltic States.

49 See the Nordic Council of Ministers webpage http://www.norden.org/pub/miljo/naer/uk/US2004448.pdf (accessed 17 January 2007).

50 For more on the EEA financial mechanism, see www.eeagrants.org .

Russia and the Baltic states (Estonia, Latvia and Lithuania) have undergone profound changes in the years following the break-up of the Soviet Union in 1991. This NordForsk Policy Brief provides a policy relevant and up-to-date overview of the science systems of the four countries, and presents some of the major reforms which the countries have undergone or are undertaking. It also discusses some of the major challenges facing the four countries, like brain drain from research to other parts of the economy and to foreign countries, and a lack of mechanisms that feed science results into the economies at large. Furthermore it gives an overview of current research priorities in the four countries and presents some examples of international, including Nordic, collaboration.

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