Haridus- ja Teadusministeerium
Estonian Ministry of Education and Research

RESEARCH AND DEVELOPMENT IN ESTONIA

OVERVIEW AND STATISTICS

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GENERAL DATA ON RESEARCH AND DEVELOPMENT IN ESTONIA

This brochure sets out the key facts and elements of the research and development (R&D) system in Estonia. It provides a condensed overview of the R&D performance in Estonia.

GENERAL DATA ON R&D IN ESTONIA

Population in 2010	1.34 million
Gross domestic product (GDP) in 2009	13.9 billion €
Gross domestic expenditure on R&D (GERD) in 2009	197 million €
R&D intensity (percentage of GDP) in 2009	1.42 %
Average annual growth of GERD (2000-2009)	20.4%
Average annual growth of business enterprise R&D (BERD, 2000-2009)	30.0%
Total number of researchers full-time equivalent (FTE) in 2009	4314
Researchers (FTE) per thousand total employment in 2009	7.24

CONTENTS

FOREWORD

There is a strong belief among Estonians that education, research and innovation are the main drivers of development. That is why the Estonian government has made continuous efforts to support investments in education and research. Estonia is the leading country in the European Union in terms of annual growth of R&D investments (over 20% in 2000-2009). This intensive growth creates favourable conditions for capacity building activities in R&D and successful catching-up.

Improvements cannot be achieved only by increased funding but also by continuous attention to education and young people. Very good results of the Estonian pupils in the OECD PISA 2006 and 2009 surveys inspire hope for further development of top-quality higher education and research in Estonia. Smart and entrepreneurial young people are the basis for developing competitiveness. Therefore the recently adopted new curricula for basic school and gymnasium and the new Basic School and Gymnasium Act pay special attention to mathematics, science and technology and entrepreneurial competencies. For the first time gifted students are included in the concept of special education needs and they are entitled to respective support measures and attention.

Large investments from the state budget and structural funds of the EU recently made in the infrastructure of higher education institutions, curricula development, teacher training and internationalisation of higher education and research have contributed significantly to the continuation of the scientific and academic excellence in Estonia.

A good indicator of academic excellence is the international competitiveness of Estonian researchers. Estonian research organisations and companies are very successful in the European Union's 7th Framework Programme, as in 2007-09 Estonia had the highest EU contribution to retained projects per GDP unit.

Estonia strongly supports the Europe 2020 growth strategy and Innovation Union initiatives. In order to be a trustworthy partner in the European Research Area, Estonia takes these initiatives seriously and we are committed to reach the agreed goals. Although investing in research and innovation requires great effort and difficult decisions, and it takes time until the investments will pay off, it is worth the effort and there is no alternative to this path.

Tõnis Lukas
Minister of Education and Research

RESEARCH AND DEVELOPMENT AND INNOVATION STRATEGY

The main objectives of research and development activities are specified in the Estonian Research and Development and Innovation Strategy **"Knowledge-based Estonia"** 2007-2013 (RD&I strategy)[1] that was approved by the Estonian Parliament *Riigikogu* in 2007. The RD&I strategy stipulates that resources have to be directed preferably to those areas of RD&I, that have potential for outstanding performance in frontier research on global scale, whose outcomes and top specialists are essential for economic growth and which support socio-economic objectives as well as preserving Estonian culture and language. The strategy sets out three main objectives:

- Competitive quality and increased intensity of research and development;
- Innovative enterprises creating new value in the global economy;
- Innovation friendly society aimed at a long-term development.

These objectives will be achieved through:

- Development of human capital;
- Organising the public sector RD&I more efficiently;
- Increasing enterprises' innovation capacity;
- Policy-making aimed at long-term development of Estonia.

The **key technologies** that will be prioritised by initiating and implementing national research and development programmes in supporting R&D and innovation include:

- Information and communication technologies;
- Biotechnology;
- Materials technology.

Estonian Research Infrastructures Roadmap[2] was prepared by the Ministry of Education and Research and Estonian Academy of Sciences and approved by the Government in 2010. Following research development trends in the world and in Estonia, the need for upgrading already existing research infrastructures as well as the initiatives for setting up new research infrastructures were mapped. A roadmap is a long term (10-20 years) planning instrument which will be updated regularly (at an interval of 3 years).

The roadmap lists 20 research infrastructures of national importance, either new or in need of upgrading. The list of investment objects defines also Estonian priorities in pan-European partnership projects. Five objects are directly linked with ESFRI[3] objects (CLARIN, BBMRI, INSTRUCT, European Spallation Source, European Social Survey).

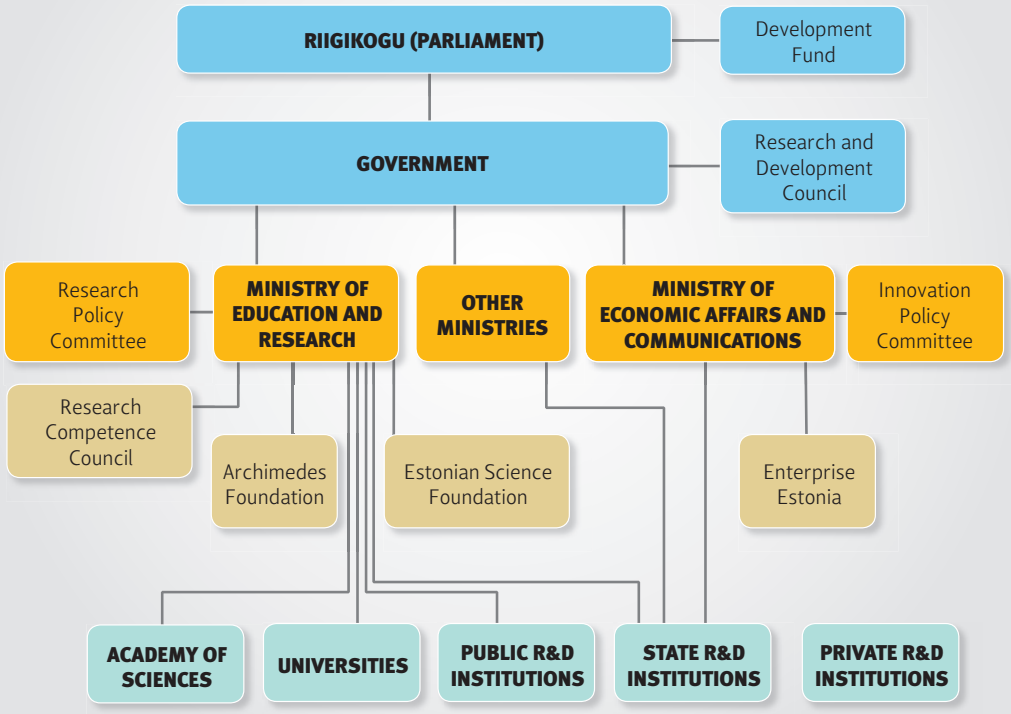
[1] *http://www.hm.ee/index.php?popup=download&id=7669*

[2] *https://www.etis.ee/Portaal/includes/dokumendid/Teekaart.pdf*

[3] *European Strategy Forum on Research Infrastructures*

RESEARCH AND DEVELOPMENT SYSTEM IN ESTONIA

FIGURE 1.
R&D SYSTEM IN ESTONIA



The Organisation of Research and Development Act provides the structure and functioning of the Estonian R&D system. The Government of the Republic establishes national R&D plans, submits them to Parliament (*Riigikogu*), approves national R&D programmes, ensures cooperation between Ministries and enacts legislation. The Research and Development Council provides consultation to the Government of the Republic on the matters of R&D. The Estonian Development Fund supports equity investments in knowledge and technology intensive Estonian enterprises in the start-up phase and organises foresight activities in Estonia, required for assuring sustainable economic development.

The functions in the Estonian R&D system are divided as follows:

- **policy and decision makers** are the Parliament and Government, advised by the Research and Development Council;
- **policy preparation and managing organisations** are the ministries, advised by the Research Policy Committee and the Innovation Policy Committee;
- **main financing and supporting organisations** are the Ministry of Education and Research (advised by the Research Competence Council), Estonian Science Foundation, Archimedes Foundation, Enterprise Estonia;
- **R&D performing organisations** are universities and other public and private R&D institutions.

RESEARCH ORGANISATIONS

There are **18 R&D institutions** in Estonia that have passed the research evaluation – six of them are **public universities**. The largest public research university is the University of Tartu[4], followed by the Tallinn University of Technology[5], Tallinn University[6] and the Estonian University of Life Sciences[7]. Nearly two thirds of Estonian undergraduate students study at public universities and over half of research and development is done at these universities. For example the University of Tartu accounts for more than 50% of Estonia's scientific articles and citations in ISI Web of Knowledge and trains ~60 % of new PhD-s.

The largest state research organisations are The Estonian Biocentre[8]; Tartu Observatory[9]; Estonian Literary Museum[10] and The Institute of the Estonian Language[11]. There are, however, also several independent research institutes that perform research at high level (i.e. The National Institute of Chemical Physics and Biophysics[13]). Today nearly all basic research is conducted in the public sector; the private sector focuses mainly on product development and innovation.

Internationally highly regarded research groups that work under common leadership and have clearly defined common goals are financed through the **Research Centres of Excellence (CoE)** measure. The aim of CoE's is to create preconditions for strengthening cooperation in the field of research as well as improving the competitiveness of Estonian research in the European Research Area through supporting top scientific research. Currently there are 7 CoE's in Estonia:

- Frontiers In Biodiversity Research (FIBIR), University of Tartu;
- CoE in Genomics, Estonian Biocentre;
- CoE for Translational Medicine (CETM), University of Tartu;
- CoE in Computer Science (EXCS), Tallinn University of Technology;
- CoE in Chemical Biology, University of Tartu;
- CoE in Cultural Theory, University of Tartu;
- Centre for Integrated Electronic Systems and Biomedical Engineering (CEBE), Tallinn University of Technology.

4 *www.ut.ee*
5 *www.ttu.ee*
6 *www.tlu.ee*
7 *www.emu.ee*
8 *www.ebc.ee*
9 *www.aai.ee*
10 *www.kirmus.ee*
11 *www.eki.ee*
12 *www.kbfi.ee*

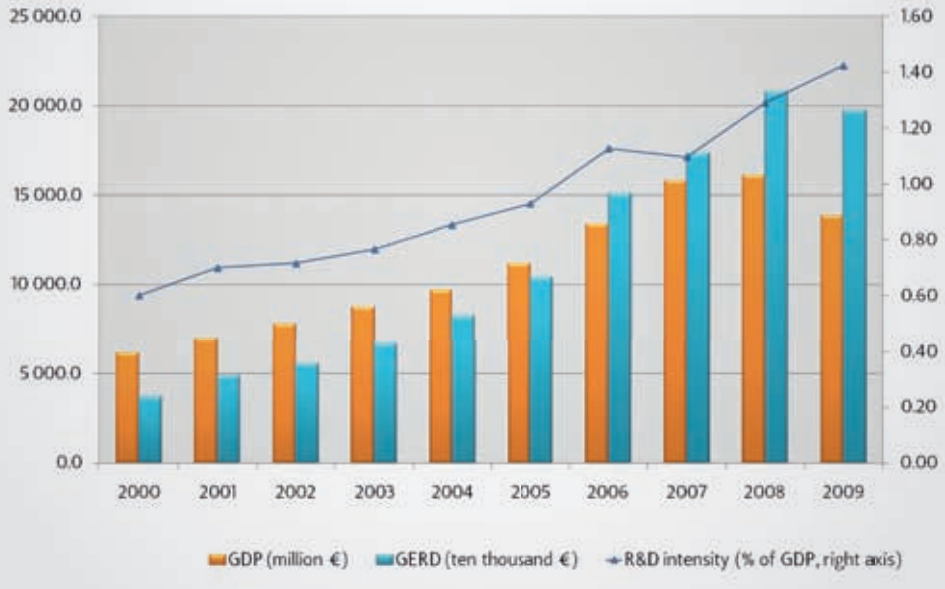
RESEARCH AND DEVELOPMENT EXPENDITURES IN ESTONIA

Over last decade the R&D intensity in Estonia has grown from 0.6% of GDP in 2000 to **1.42% in 2009**. One has to take into account that this has happened in the context of very fast growth of GDP. The total R&D expenditures have grown every year during 2000-2008, but the economic crisis had many effects on R&D expenditures. In 2009 the total level of R&D expenditures decreased 5% compared to 2008. But as the GDP fell even more - 14% - total R&D intensity grew from 1.29% in 2008 to 1.42% in 2009.

FIGURE 2.

ESTONIAN GDP AND GENERAL EXPENDITURE ON R&D (2000-2009)

SOURCE: STATISTICS ESTONIA

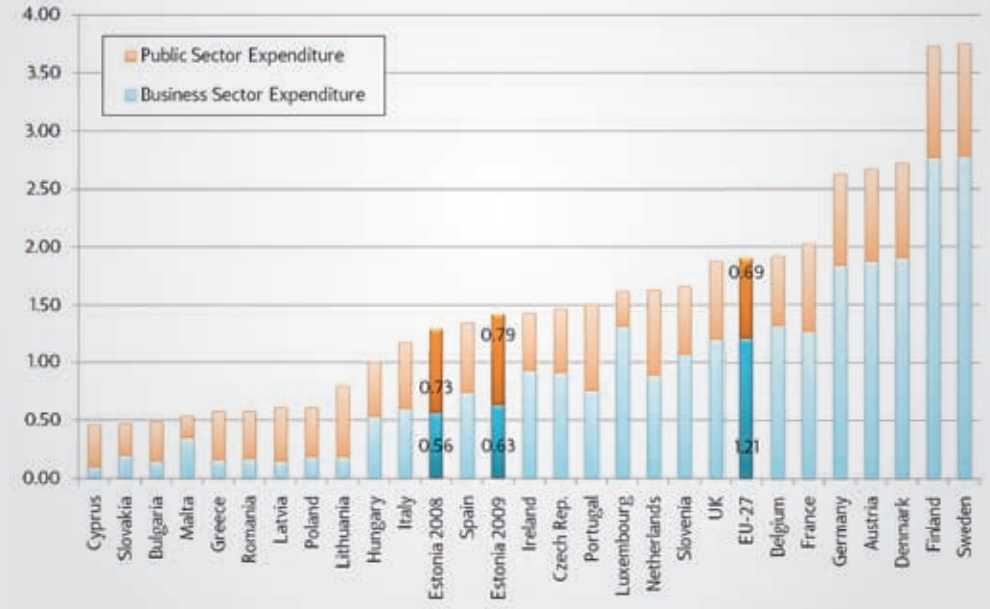


The Estonian RD&I strategy includes an objective of R&D expenditure growth in Estonia, which is 1.5% in 2008, 1.9% in 2010 and 3% of GDP in 2014, while private sector R&D intensity in these years should be 0.7%, 0.9% and 1.6% respectively. Due to the economic crisis, these goals will be reached with a delay of a few years.

FIGURE 3.

R&D EXPENDITURE BY SECTORS OF PERFORMANCE IN 2008

(% OF GDP)
SOURCE: EUROSTAT. *(GREECE 2007)*

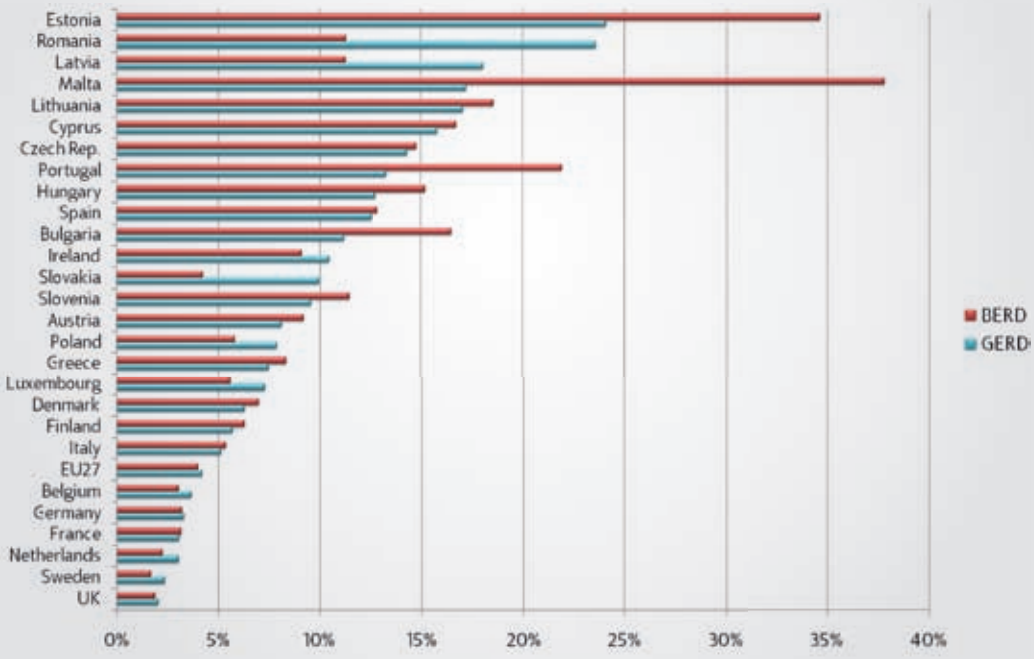


Compared to other EU countries, Estonian general R&D intensity performance is still below the EU27 average. Currently the share of Estonian public sector expenditure exceeds the EU average, but the share of private sector (BERD) is much below the EU27 level. The share of private sector expenditure (BERD) in Estonian general expenditure (GERD) was 43% in 2008, but the corresponding EU27 indicator was 64%. As the investment environment has deteriorated due to the economic crisis, it is increasingly important for the public sector to support and facilitate innovation investments of enterprises. As can be seen from the Figures 3 and 4, the catching-up speed of Estonian R&D expenditures is one of the highest in EU.

FIGURE 4.

AVERAGE ANNUAL GROWTH OF R&D EXPENDITURES

(%, GERD AND BERD, 2000-2008)
SOURCE: EUROSTAT. *(GREECE 2000-07; SWEDEN 2001-08; MALTA & AUSTRIA 2002-08)*

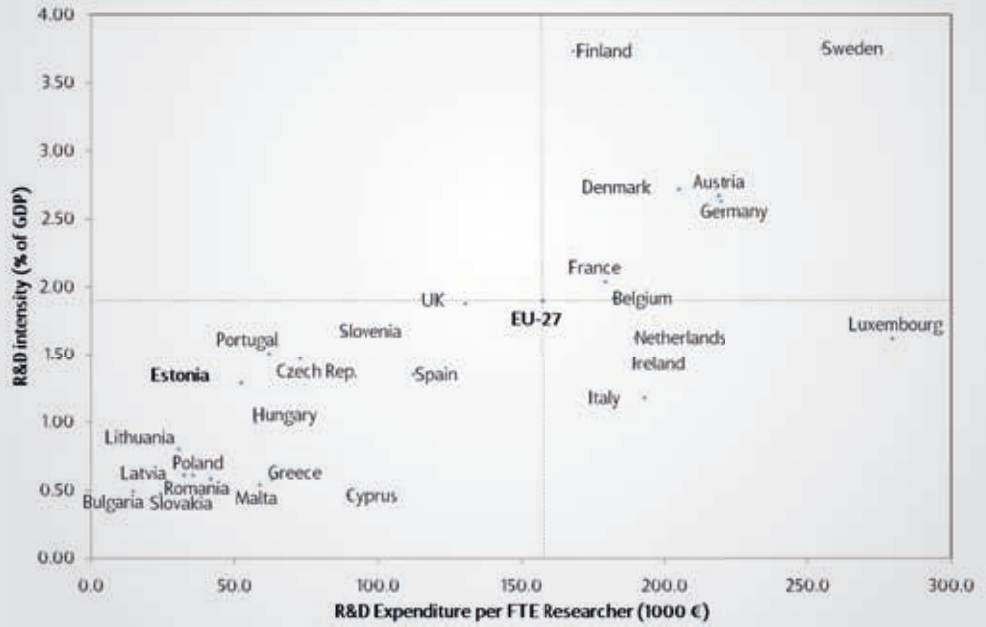


According to the Figure 3 Estonia is among the countries with moderate R&D intensity (together with Spain, Ireland and Czech Republic), but the Figure 4 demonstrates that Estonian catching-up speed is one of the highest in EU. Estonia is the leading country in the EU concerning the growth of R&D expenditures as the average annual growth of total R&D expenditure (GERD) was 24,1% in 2000-2008. The average annual growth in business sector R&D expenditures has been even higher (34,6%). Intensive growth of R&D expenditures clearly demonstrates that conditions for successful catching-up and capacity building activities are good.

FIGURE 5.

R&D INTENSITY AND EXPENDITURE PER FTE RESEARCHER (2008)

SOURCE: EUROSTAT. *(GREECE & FRANCE 2007)*



This figure shows the correlation between R&D intensity and R&D expenditure per researcher (full-time equivalent). As can be seen from the graph, Estonian R&D intensity is 68% of the EU27, but R&D expenditures per researcher (FTE) is only 33%.

This means that Estonia has to push forward the funding per researcher (including salaries) in order to maintain the growth of number of researchers and to motivate doctoral students and junior researchers to continue their careers in research.

HUMAN RESOURCES IN RESEARCH AND DEVELOPMENT

FIGURE 6.
TOTAL NUMBER OF RESEARCHERS (FTE) BY SECTORS OF PERFORMANCE

(% OF PER THOUSAND TOTAL EMPLOYMENT (2008))
SOURCE: EUROSTAT. *(GREECE & FRANCE 2007)*

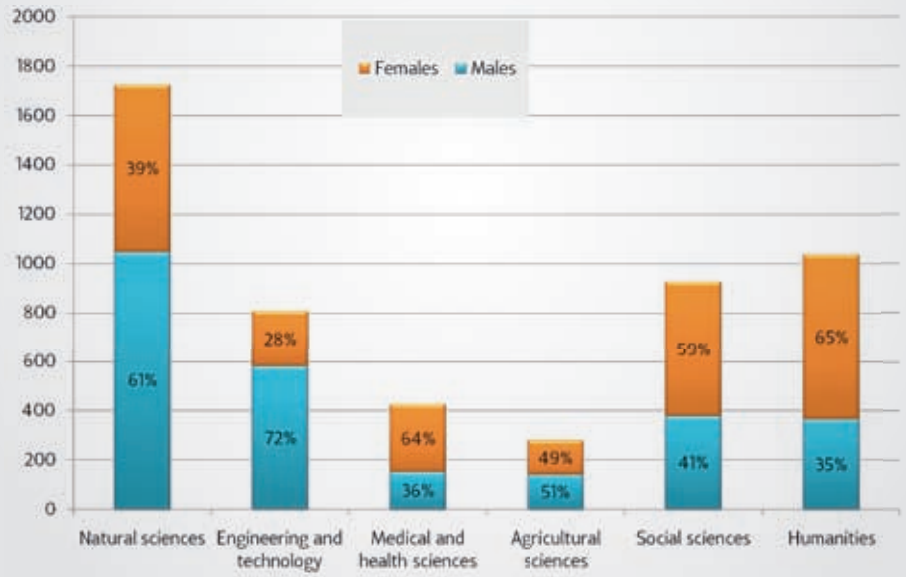
One of the most important objective of the Estonian RD&I strategy is to reach the proportion of 8 full-time researchers and engineers per 1000 employees (age 15-74) by 2013. But according to the current data, Estonia might reach this goal even earlier, as in 2009 the corresponding indicator was already 7.2. Comparing 2008 and 2009, the number of total FTE researchers increased 8.4% (in absolute terms from 3979 to 4314 FTE researchers). Although the growth of total number of researchers refers to the stability and reliability of the Estonian R&D system, it is important for Estonia to continue its efforts to achieve a sustainable situation in R&D human resources.

Since 2008 Estonia has implemented a more systematic approach towards human resource development in R&D. Estonia has initiated activities to improve the quality of higher education and research training and skills, facilitate active participation of Estonian universities in international circulation of knowledge, foster R&D cooperation between universities and business, create an attractive career model for doctoral candidates.

FIGURE 7.

NUMBER OF RESEARCHERS IN ESTONIA BY GENDER AND FIELDS OF SCIENCE (2008)

SOURCE: EUROSTAT



Compared to other European states, Estonia is using the full potential of human resources in research. The feminization of the higher education enrolment has increased during several years (from 51% in 1993/1994 to 60% in 2009/2010). Now first signs of this trend are noticeable also in the R&D personnel gender distribution. From 1996, the share of female researchers has continuously increased, and their number is nearly equal to that of male researchers.

In 2008, the share of female researchers in Estonia was 48,5%, compared to the average of 32% in the EU. This trend is also observable in traditionally "masculine" areas like engineering, manufacturing & construction where the share of women among graduates has grown, but still the share of female researchers in these fields is lower than in other fields. But at the same time the share of females on higher executive positions in R&D is modest.

FIGURE 8.

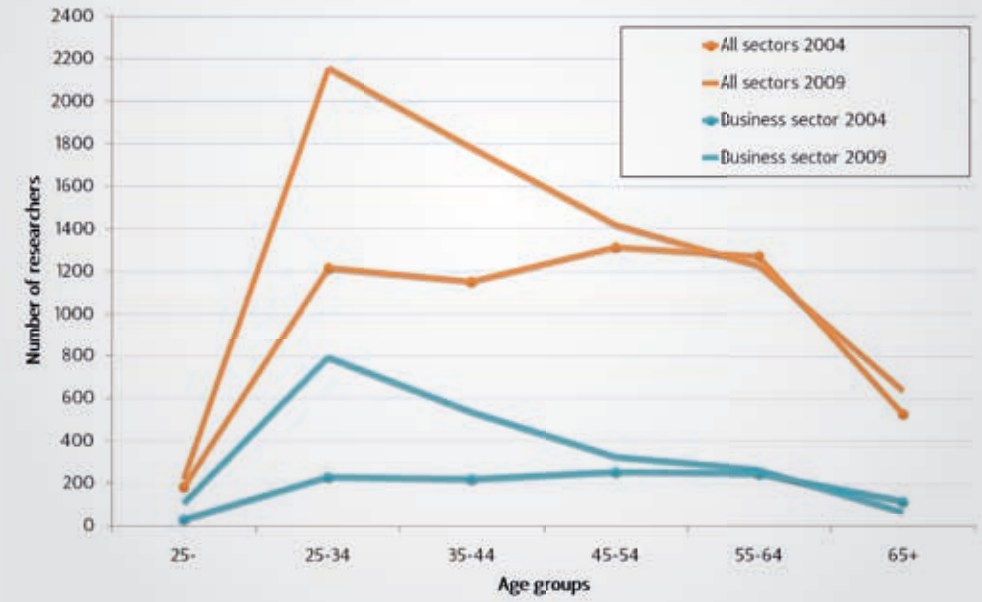
R&D EXPENDITURES BY FIELD OF SCIENCE IN PUBLIC SECTOR (2008)

SOURCE: STATISTICS ESTONIA

FIGURE 9.

TOTAL NUMBER AND AGE STRUCTURE OF RESEARCHERS BY PERFORMING SECTOR (2004 AND 2009)

SOURCE: STATISTICS ESTONIA



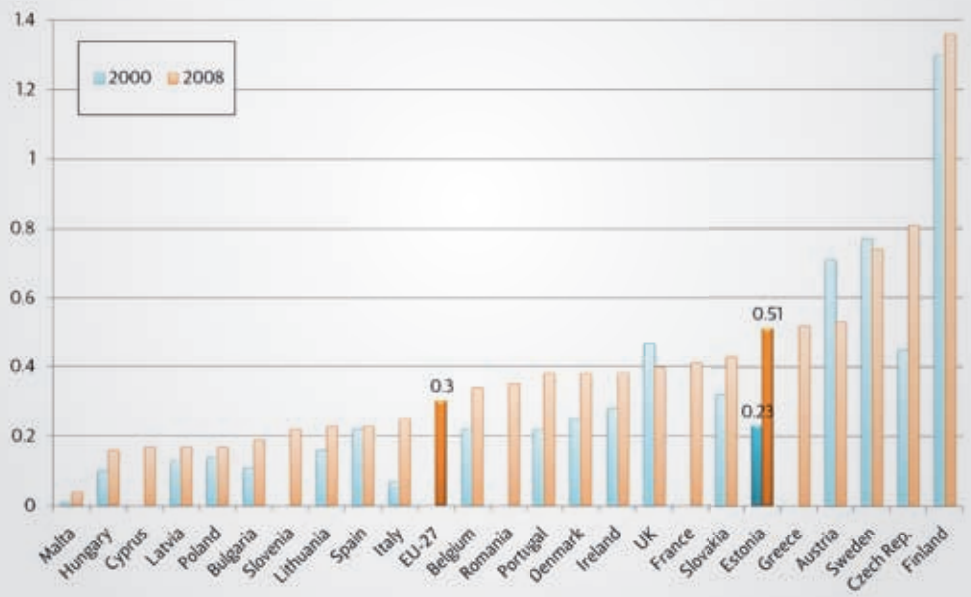
Recent years have shown signs of improvement in the age distribution of Estonian researchers, as the share of young researchers is growing and as was planned in the Estonian RD&I strategy. For example in the business sector the number of young researchers (age group 25-34) has grown from 231 in 2004 to 794 in 2009, in the age group 25-44 the corresponding growth is from 220 to 536. Similar, but not so fast improvements have been also in public sector, which means that the overall age distribution across all sectors has improved noticeably.

But at the same time the number of new PhD graduating yearly is still low to fulfil the needs of Estonian public and private sector and to secure the sustainability of teaching personnel in higher education sector.

FIGURE 10.

DOCTORATE STUDENTS IN SCIENCE AND TECHNOLOGY FIELDS

(% OF THE POPULATION AGED 20-29)
SOURCE: EUROSTAT. *(EU27 & ITALY 2007; GERMANY, LUXEMBOURG, NETHERLANDS - N/A)*



Development of science and technology fields is a national priority and these fields are also preferred in funding of higher education (including doctoral studies) and other human resource development measures. The number of new PhD graduates is one of the challenges in developing R&D human resources in Estonia. The number of doctoral students has risen considerably in recent years (including in science and technology fields) and currently there are 2928 doctoral students in Estonian universities. But at the same time the number of PhD graduates in 2009/10 academic year was only 175. The Estonian Higher Education Strategy and the RD&I strategy have set a target of reaching 300 PhD graduates per year by 2015 and to attain the internationally recognized efficiency of doctoral studies (ca 60%). Currently the Estonian efficiency is below that level - around 40%.

To improve effectiveness and efficiency of Estonian doctoral studies, several measures have been implemented in order to equip young researchers with skills and experiences necessary to participate in the knowledge economy. Currently, the most complex issue is to improve the career model of researchers by changing the status of doctoral students to early-stage researchers from admission in 2012.

INTERNATIONAL CO-OPERATION

There is a long tradition of international co-operation in the field of science and technology in Estonia. Estonia has concluded international framework agreements for scientific and technological cooperation with more than 40 countries including USA, China, India, Mexico, Ukraine, etc and major organisations such CERN, ESA, EMBC, ESF. The Estonian government supports the participation of scientific organisations in the work of international organisations.

Estonian research is internationally competitive. Estonia is participating successfully in the EU Framework Programmes, with above average success rates and ranking high among new member states. Estonia had the highest retour in FP6, exceeding twice the input[13] and similar tendencies can be seen in the FP7[14]. The EC contribution per applicant has been growing from programme to programme, but in FP7 it still remains at the level of ca 200 €K (as the other new member states) while for the best rewarded countries the EC contribution per applicant is at the level of 350-450 €K. The size of a grant is also connected to the role of a partner in project and the type of project, which to some extent seems to be correlated with the size of country. At the same time approximately 11% of successful Estonian proposals are coordinated by Estonian organisations and the success rate of Estonian coordinated projects is also higher than the EU average.

TABLE 11.

ESTONIAN PERFORMANCE IN THE EU FRAMEWORK PROGRAMMES

SOURCE: EUROPEAN COMMISSION

FP	Applications	Contracts	Success rate	MEUR
FP4 (1994-1998)	316	86	27%	3.9
FP5 (1998-2002)	809	216	26.8%	19.1
FP6 (2002-2006)	1509	332	22.0% (EU25=20.4%)	33.8
FP7 (2007-2010)	1207	286	23.7% (EU27=22.5%)	46.5
Estonia as a coordinator in FP7				
FP7 (2007-2010)	131	32	24.4% (EU27=21.9%)	11.7

Participation in Framework Programmes and other international R&D programmes is very important for the funding of Estonian R&D, as 11-15% of Estonian general R&D expenditures have been funded from abroad in recent years.

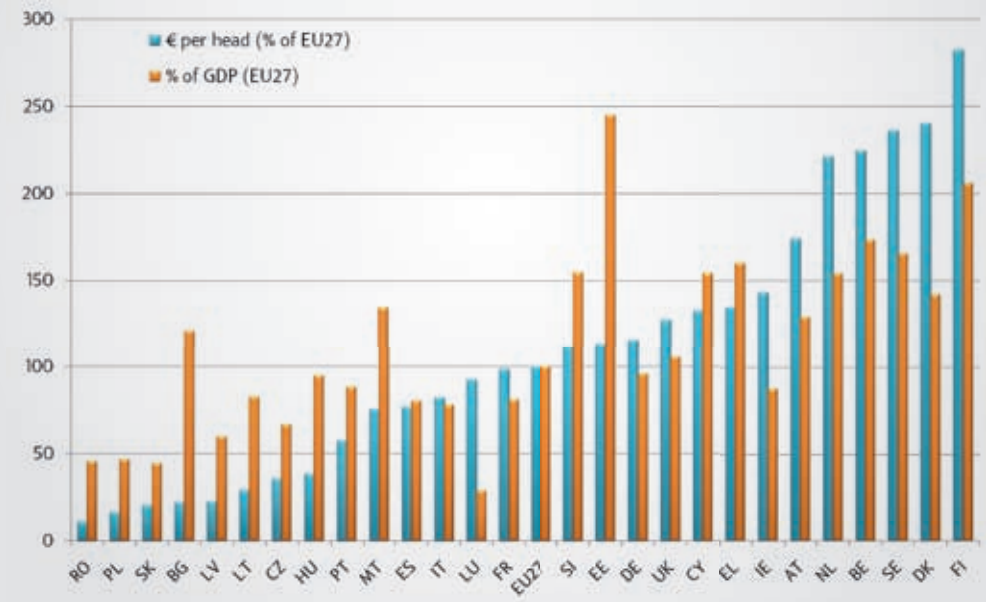
[13] Ex-post *Evaluation of the Sixth Framework Programme, Report of the Expert Group, 2008.*

[14] *Evaluation of the Seventh Framework Programme* Report of the Expert Group *Final Report 12 November 2010 and Third FP7 Monitoring Report „Monitoring Report 2009", 13 July 2010.*

FIGURE 12.

EU CONTRIBUTION TO RETAINED PROJECTS IN FP7

(2007-2009, EU27=100%)
SOURCE: INTERIM EVALUATION OF THE SEVENTH FRAMEWORK PROGRAMME *REPORT OF THE EXPERT GROUP FINAL REPORT 12 NOVEMBER 2010*

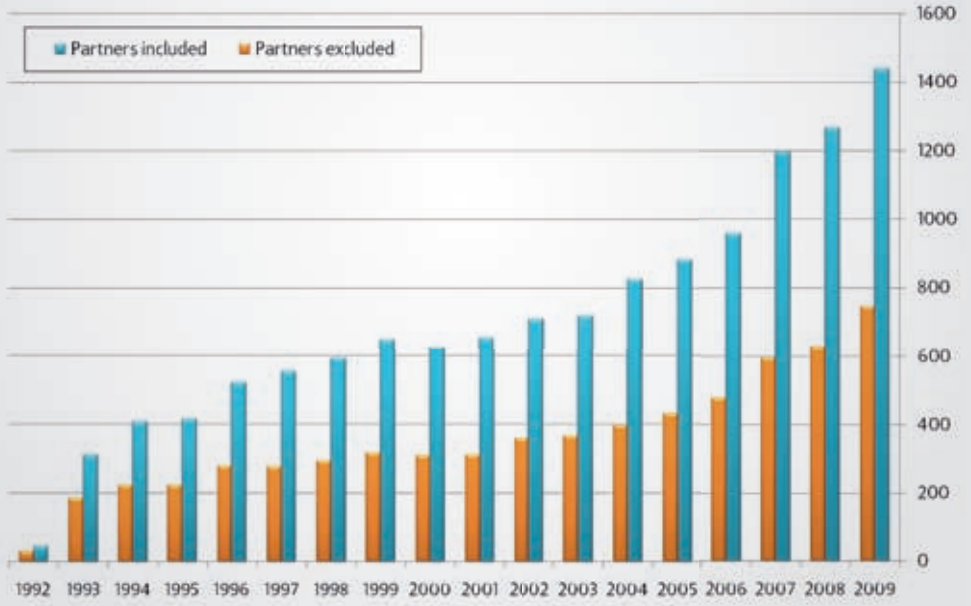


The chart shows that Finland and Estonia are the Member States that, respectively, score highest on the 'per head of population' and 'per unit of GDP' ratios. Concerning these indicators Estonia differs significantly from the other Central- and Eastern European Countries.

PUBLICATIONS

FIGURE 13.
NUMBER OF PUBLICATIONS BY ESTONIAN RESEARCHERS (1992-2009)

SOURCE: ISI WEB OF SCIENCE (SCI-EXPANDED, SSCI, A&HCI, ALL DOCUMENT TYPES, ALL LANGUAGES)



Several research studies and reports on national and European science and technology indicators show intensification of international scientific cooperation in practically all areas of science. Considerable quantitative and structural changes have occurred, especially during the last decades of the 20th century. The extent of international cooperation differs significantly among small and large countries. Small and less developed economies engage more actively in international collaboration (about half of all outcomes are the result of international cooperation).

More than half of the publications of Estonian researchers are co-published with foreign researchers. In terms of more intensive international co-operation it is important to develop existing links with traditional partners. Estonian researchers have traditionally very close links with the Nordic region and Central European countries. For example in FP6, the main partners for Estonian researchers were Germany, United Kingdom and France[15]. Estonia is the third among the Eastern European states in terms of scientific publications per million populations, according to *Nature*[16].

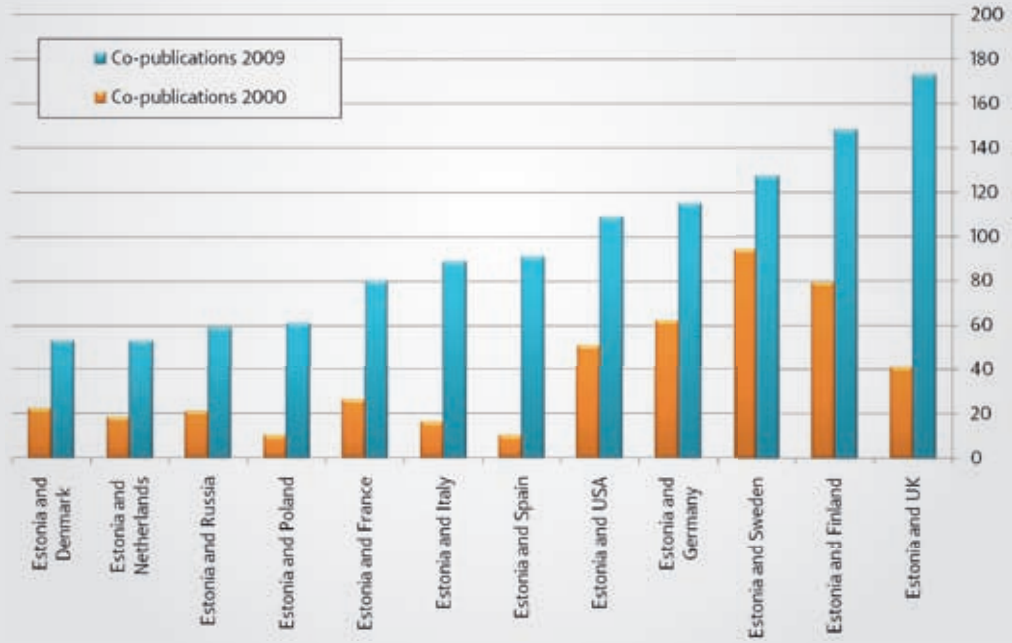
[15] *Archimedes Foundation (2007) „Eesti osalemine 6. raamprogrammis", Tartu, Estonia.*

[16] *Shiermeier, Quirin. Beyond the Bloc. NATURE, Vol 461, 1 October 2009, p 590-591*

FIGURE 14.

NUMBER OF CO-PUBLICATIONS WITH MOST IMPORTANT PARTNERS IN 2000 AND 2009

SOURCE: ISI WEB OF SCIENCE (SCI-EXPANDED, SSCI, A&HCI, ALL DOCUMENT TYPES, ALL LANGUAGES)



One potential factor behind the relative success of Estonian science could be its partnership with scientifically more advanced countries, particularly with Sweden, Finland, and Germany. A considerable number of publications are prepared and published in co-authorship with colleagues from countries ahead of Estonia in terms of both intensity and impact of research[17].

TABLE 15.

ESTONIAN PUBLICATION OUTPUT BY SCIENTIFIC FIELDS 2005-2009

SOURCE: ISI REUTERS INCITES

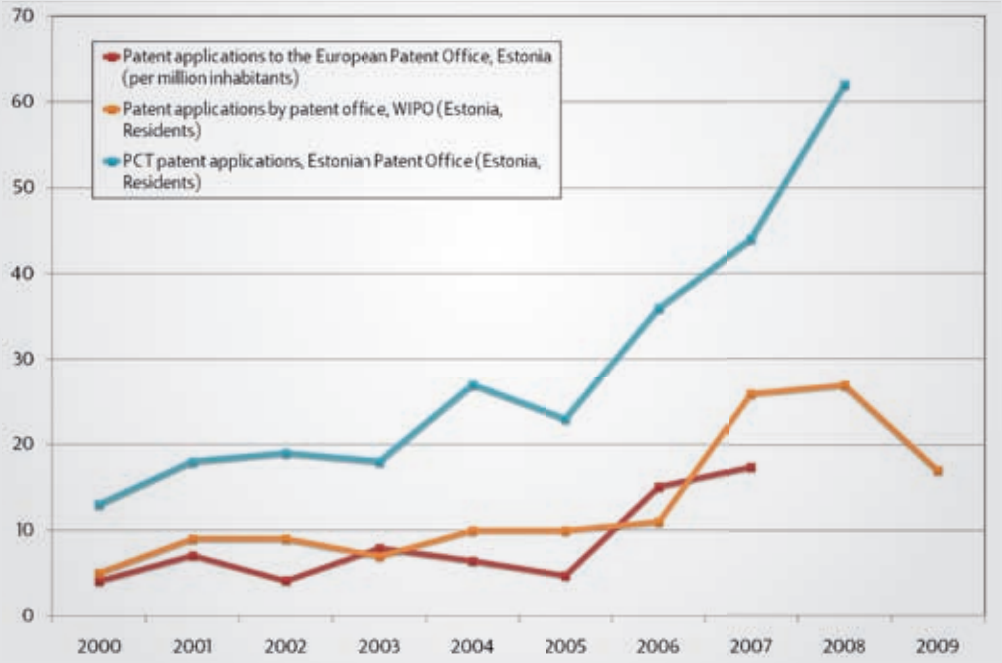
Scientific field	Papers	Citations	Citations per Paper	% of Papers Cited
Agricultural Sciences	292	911	3.12 (EU27 3.09)	62.7%
Humanities	181	53	0.29 (EU27 0.48)	15.5%
Medical and Health Sciences	1 043	7 103	6.81 (EU27 6.56)	70.2%
Natural Sciences	3 023	14 732	4.87 (EU27 4.99)	67.3%
Social Sciences	435	946	2.17 (EU27 2.13)	44.8%

[17] *Allik, Jüri (2008) „Quality of Estonian science estimated through bibliometric indicators (1997–2007)". Proceedings of the Estonian Academy of Sciences, 2008, 57, 4, 255–264.*

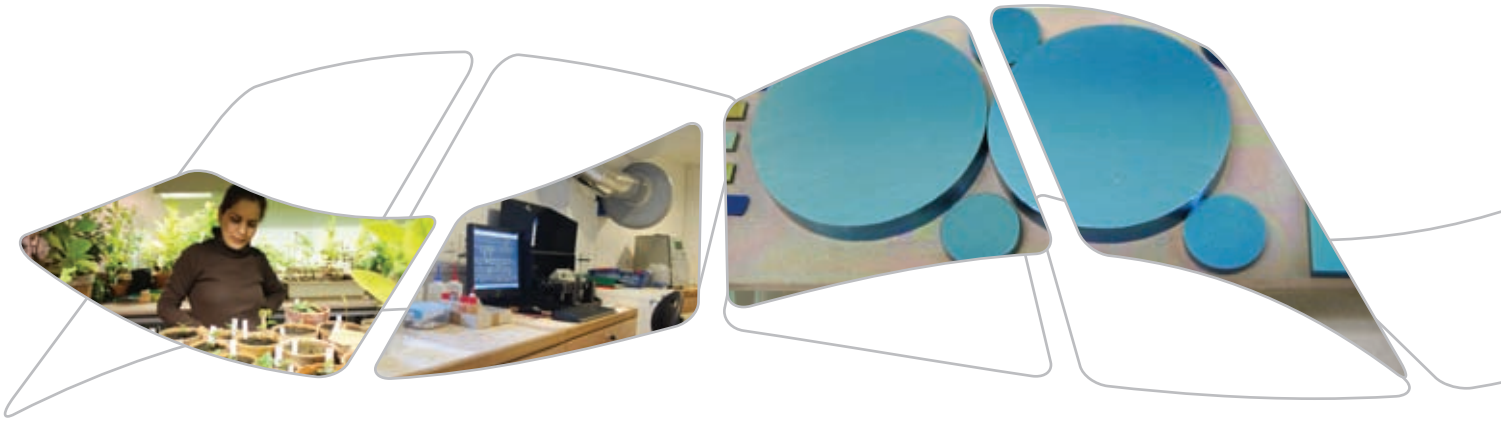
PATENTS

FIGURE 16.
PATENT APPLICATIONS BY ESTONIAN RESIDENTS (2000-2009)

SOURCE: EUROSTAT; ESTONIAN PATENT OFFICE; WIPO STATISTICS ON PATENTS



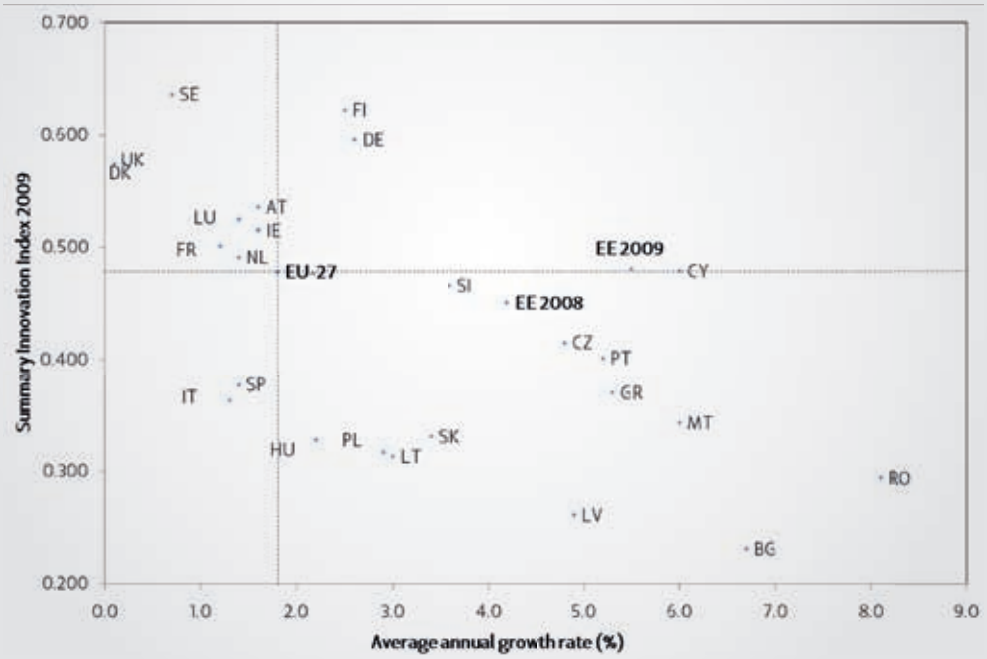
The activity of patenting in Estonia is low compared to more developed European states. According to Eurostat 2007 data, the new member states (NMS12) are almost 10 times less active in patenting per million inhabitants than the old member states (EU15). The main reasons of this phenomenon are less favourable structure of the economy and industry, high costs of patenting (procedural validation, renewal fees), complexity and legal uncertainty. Since 2005, the overall patenting activity in Estonia has been increasing. Many innovation support instruments were started in 2004-2006 and the results can be seen from the graph. In case of patent applications, it takes 2-3 years until taken measures will give results.



INNOVATION SCOREBOARD

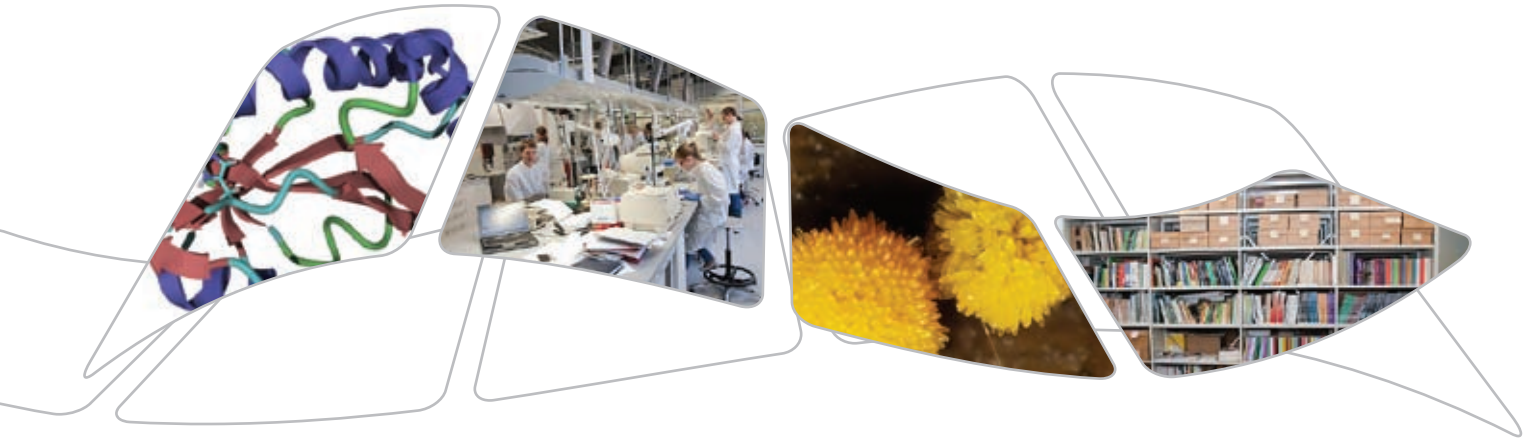
FIGURE 17.
EUROPEAN INNOVATION INDEX SUMMARY 2009

SOURCE: EUROPEAN INNOVATION SCOREBOARD



Since 2009 Estonia is among innovation followers with Austria, Belgium, Cyprus, France, Iceland, Ireland, Luxembourg, the Netherlands and Slovenia. A fast annual growth rate over the last five years has led Estonia to catch up with the EU27 average innovation performance in 2009.

Estonia has improved its performance from below the EU27 average in the EIS 2008 to an above average performance in the EIS 2009. For Estonia strong growth in 'economic effects', 'finance and support' and 'human resources' have been the main drivers of improvement in innovation performance.



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