Successful transformation the Czech Republic on knowledge-based economy is conditioned by high-quality incomes, especially by efficient investments and qualified human sources. Process of creation new knowledges very strictly influences on macroeconomic productivity and stability of economy. For that reason sufficient investment for research and development (R&D) are essentials. A serious deficiency of research and development in the Czech Republic is the insufficient linkage and cooperation of the business sphere with research and educational institutions, which hampers the effective transfer of research and development results into practice and their commercialization. The aim of the paper is to analyse R&D expenditure in the Czech Republic in the last period of time, and evaluate total, public and private R&D expenditure. The goal is also to identify basic activities which can stimulate cooperation of the public and the private sector in research, development and innovation and to commercialize research and development results.

**Keywords:** knowledge-based economy, research and development expenditure, Lisbon strategy

1. **INTRODUCTION**

Knowledge economy development results from competition mechanisms on highest developed markets. One of global challenges that integrating Europe should meet is intensive development of knowledge based economy. Lisbon strategy presented in 2000 should be seen as the most complex and the most important document related to knowledge based economy. The Strategy aimed at reducing gap between the EU and the USA with respect to knowledge based economy creation. The EU economy was supposed to become the most competitive and most dynamic knowledge based economy in the world. The Strategy determined some macroeconomic indicators that should be met by EU Member States. One of the most important necessity of fulfilment of the Lisbon strategy is to increase a total R&D expenditure up to level 3% of GDP till year 2010, of this one third from public sources.
The Czech Republic, as EU member state, must adopt recommendations of European Commission also with respect to knowledge based economy. At the same time, a dynamic development of “a new economy” in most technologically developed countries is both a challenge and a chance for the Czech Republic. Knowledge based economy development is a priority in longterm strategy of the Czech economy development. Therefore Lisbon strategy belongs to the main external factors which impact on a formulation of „The National Research and Development Policy of the Czech Republic“. The main goal of the R&D policy is to increase the outcome and efficiency of the R&D in the CR, to ensure a flexible renewal of the capacities, including the development of the human potential active in them and to put these resources into the solution of the future needs the economy in the Czech Republic.

The aim of the paper is to analyse R&D expenditure in the Czech Republic in the period of time 2000 - 2005, and evaluate total, public and private expenditure. The goal is also to identify basic activities which can stimulate cooperation of the public and the private sector in research, development and innovation, and to commercialize research and development results.

2. THE BASIC INDICATORS OF R&D USED IN THE CZECH REPUBLIC

The basic indicators of research and development (R&D) are periodically ascertained by Czech National Bureau of Statistics in accordance with the internationally renowned „Frascati Manual“ on measurement and evaluation of scientific and technological activities, which was prepared by the Organisation for Economic Co-operation and Development (OECD) as a handbook for standardization of statistical indicators of research and development at international level. On regular basis the renowned international organisations (Eurostat, OECD) collect these data which are further compiled into internationally comparable indicators. The Czech National Bureau of Statistics employs the „Frascati Manual“ from year 1995.

We need followed indicators of R&D to answer a question if the Czech Republic is able to fulfil the Lisbon Strategy obligations:

- Total R&D expenditures
- Public R&D expenditures and share of public funds in total R&D expenditures
- Private R&D expenditures and share of private funds in total R&D expenditures

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The growth of R&D expenditures

Total R&D expenditure (GERD – gross expenditure on R&D)\(^2\) is the most popular and most frequently used indicator in the international comparison of research and development. These expenditures represent the overall expenditures funded from public, private (business or non-business) and foreign sources. The indicator of total R&D expenditures in per cent of GDP gives only incomplete information. The really spent funds depend on the amount of GDP. Therefore the analytical materials use another indicator – total R&D expenditures in USD per one inhabitant of the country in question. As a rule this indicator is given in currency of the respective country converted to USD using the purchasing power parity (PPP). At this conversion a small distortion may occur because some inputs to research and development (apparatuses, materials, etc.) are generally bought in abroad according to the official rate of exchange of the currency in question. Nevertheless, the indicator is considered to be highly objective. Public expenditures are the expenditures of the state budget and budgets of lower administrative units of respective countries (federal lands, regions, counties, etc). The importance of this indicator is growing in context with evaluation of fulfilment of the Lisbon strategy, according to which the overall R&D expenditures should attain the level of 3% of GDP by 2010, of this one third from public sources.

Private R&D expenditures are the largest source of finance for the R&D support in many countries. The values of private funds shares in the total R&D expenditures for most of the countries, or more exactly for countries with low support of research and development from abroad and public funds, logically increase\(^3\). The foreign funds are the third most important source of R&D financing. The foreign R&D expenditures include both private funds and public funds (EU programmes, other international programmes, etc.).

3. THE ANALYSIS OF R&D EXPENDITURES IN THE CZECH REPUBLIC

Table 1 and Table 2 summarize development of R&D expenditures in the Czech Republic in a monitored period. Data from year 1995 help to demonstrate a growth of indicators in years 2000 – 2005. Graph 1 was created on the basis of statistic data both tables with a goal to give a simply orientation among R&D indicators during the monitored period.

\(^2\) The international OECD and Eurostat terminology knows total R&D expenditures under the abbreviation GERD (Gross Expenditure on R&D) representing the overall (gross) domestic expenditure on research and development in compliance with the Frascati Manual 2002 methodology.

Table 1: Total Expenditure on R&D in the Czech Republic (GERD) in mil. CZK

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</thead>
<tbody>
<tr>
<td>Government sector</td>
<td>4,626</td>
<td>11,789</td>
<td>12,351</td>
<td>12,433</td>
<td>13,488</td>
<td>14,695</td>
<td>17,248</td>
</tr>
<tr>
<td>Business Enterprise sector</td>
<td>8,824</td>
<td>13,564</td>
<td>14,866</td>
<td>15,876</td>
<td>16,590</td>
<td>18,530</td>
<td>22,825</td>
</tr>
<tr>
<td>Abroad</td>
<td>468</td>
<td>833</td>
<td>627</td>
<td>801</td>
<td>1,473</td>
<td>1,297</td>
<td>1,669</td>
</tr>
<tr>
<td>Other national sources</td>
<td>65</td>
<td>301</td>
<td>493</td>
<td>442</td>
<td>696</td>
<td>561</td>
<td>345</td>
</tr>
<tr>
<td>Total Expenditure</td>
<td>13,983</td>
<td>26,487</td>
<td>28,337</td>
<td>29,552</td>
<td>32,247</td>
<td>35,083</td>
<td>42,087</td>
</tr>
</tbody>
</table>


Table 2: Expenditure on R&D in sectors of performance by source of funds in % GDP (1995 – 2005)

<table>
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</thead>
<tbody>
<tr>
<td>Government sector</td>
<td>0.32</td>
<td>0.37</td>
<td>0.41</td>
<td>0.43</td>
<td>0.49</td>
<td>0.55</td>
<td>0.53</td>
<td>0.52</td>
<td>0.53</td>
<td>0.56</td>
<td>0.58</td>
</tr>
<tr>
<td>Private sector</td>
<td>0.60</td>
<td>0.58</td>
<td>0.65</td>
<td>0.70</td>
<td>0.61</td>
<td>0.63</td>
<td>0.64</td>
<td>0.66</td>
<td>0.65</td>
<td>0.67</td>
<td>0.77</td>
</tr>
<tr>
<td>Abroad</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0.06</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Total expenditure</td>
<td>0.95</td>
<td>0.97</td>
<td>1.08</td>
<td>1.16</td>
<td>1.15</td>
<td>1.22</td>
<td>1.20</td>
<td>1.21</td>
<td>1.24</td>
<td>1.28</td>
<td>1.41</td>
</tr>
</tbody>
</table>

Source: Author’s calculation based on data from The Czech National Bureau of Statistics

Graph 1: Expenditure on R&D in sectors of performance by source of funds in % GDP in the Czech Republic (1995 – 2005)

The total R&D expenditures in the Czech Republic experienced an increase from 0.95 % in 1995 to 1.41 % of GDP in 2005. In 2004, the total R&D expenditures in the Czech
Republic attained the level of 66 % of expenditures in EU-15. This value corresponds relatively well with the level of GDP per capita amounting in the Czech Republic to cca 63 % of the EU-15 value. It is generally known that the developed “richer” countries spend more on research and development than the countries less developed. Relatively close correlation exists in the OECD member states between the level of R&D expenditures in per cent of GDP and relative GDP per head.

The public R&D expenditures expressed as the standard indicator of per cent of GDP had been rising till 2000; between 1998 and 2000 their rise was a relatively dynamic one. In 2000, they reached 0,54 % of GDP. In 2002, the share fell down to 0,52 % of GDP and in 2003 it increased to 0,55 %. After a slight decrease to 0,54 % of GDP, the share increased again to 0,56 % being the highest value the monitored period so far. The stagnation in 2001 and falls in 2002 and 2004 resulted from the fact that the Government and individual departments started to prefer as their budgetary priorities solution of actual problems to creation of conditions for an economic growth in the future. If we evaluate the state R&D support by the expenditures growth in real amounts and in current prices, the situation looks much more favourable.

**Table 3: The growth of the state R&D expenditures (in % of expenditures of the preceding year)**

<table>
<thead>
<tr>
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<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15,1</td>
<td>10,9</td>
<td>27,6</td>
<td>8,7</td>
<td>-6,4</td>
<td>11,4</td>
<td>5,3</td>
<td>12,2</td>
</tr>
</tbody>
</table>

Source: Author’s calculation based on data from The Czech National Bureau of Statistics

With the exception of 2002, when a significant decline in comparison with the preceding year took place, in all other monitored years the expenditures experienced a dynamic growth, even in 2004 with the growth of 5.3 % against 2003. In the Czech Republic, the dynamics of the state R&D expenditures growth is higher than the dynamics of the GDP growth over the monitored period.

Private funds are the second most important source of R&D financing. Private R&D expenditures in the Czech Republic increased only from 0,60 % in 1995 to 0,77 % of GDP in 2005. The amount of private R&D expenditures is influenced also by the structure of tax systems. In many countries the expenditures of enterprises are motivated by indirect instruments of support, e.g. tax relieves. In the Czech Republic, a positive development can be expected with the possibility to include the R&D expenditures as an tax deductible.
The foreign funds are the third most important source of R&D financing. The foreign funds include both private funds and public funds (EU programmes, other international programmes, etc.). The Czech Republic belongs among countries with a low support of R&D from abroad. This situation is, produced by “administrative and technical” conditions for funding or co-funding from foreign sources (provision of a share from Czech sources, non-recognition of VAT as a cost item of research, etc.).

Graph 2 summarizes share of expenditure in total R&D in sectors of performance by source of funds. The values of private funds shares from 52% to 63% in the total R&D expenditures, the values of public funds shares from 34% to 45% in the total R&D expenditures, foreign funds partake from 2% to 5% of total R&D expenditure.


Is possible to establish that R&D expenditures increased in the monitored period, both total R&D expenditure (GERD – gross expenditure on R&D) and also total R&D expenditures in per cent of GDP. The importance of all indicators is growing in context with evaluation of fulfilment of the Lisbon strategy, according to which the overall R&D expenditures should attain the level of 3% of GDP by 2010, of this one third from public sources. As Tables 1 and 2 show R&D expenditure are totally insufficient for fulfilment of Lisbon criteria. Expenditure on R&D are not in accordance with Lisbon strategy in any sector of performance by source of funds. Total R&D expenditure come up to 48% of criterion,
public R&D expenditures come up to 58 % of criterion and private R&D expenditures approximately a third from desired amount (38,5 %).

4. COOPERATION OF PUBLIC AND PRIVATE SECTOR IN RESEARCH AND DEVELOPMENT IN THE CZECH REPUBLIC

A serious deficiency of research and development in the Czech Republic is the insufficient linkage and cooperation of the business sphere with research and educational institutions, which hampers the effective transfer of research and development results into practice and their commercialization. In advanced countries R&D findings are often transferred into practice by spin-off firms founded at research and educational institutions. However, all statistical data show that a minimum number of these firms are founded in the Czech Republic.

Another serious problem of the Czech knowledge economy is the lack of research workers and qualified professionals in the business sector, which limits the research and innovation activities of Czech businesses. One of the causes of this situation is also insufficiently developed horizontal mobility of research workers between academic sites and entrepreneurial entities. The mobility of research workers, university teachers, students and professionals between the academic sphere and the business sector helps to remove obstacles between these innovation process participants.

The study “Barriers to the Growth of Competitiveness of the CR“ identified several obstacles, which hinder commercialization of public research results. Among the most significant barriers and problem spheres could be included, for example, the following:

• low interest of research, education as well as business sphere in mutual collaboration
• insufficient demand of Czech firms for research results
• research institutions do not cooperate in accordance with requirements of businesses or do not conduct useful research from the businesses’ perspective
• in some cases – too high price of services of research organizations
• lack of technology transfer agencies or their insufficient services
• institutional culture orientated mainly on academic research.

Furthermore, negative impact in terms of spin-off firm foundation shows in the following:

• absence of programmes supporting foundation of spin-off firms from research and education institutions
• lack of capital for foundation of spin-off firms and their initial development
• insufficient counselling services and absence of relevant educational and training programmes
• low motivation of research workers, teachers and students to start their own business.

According to the Community Strategic Guidelines in order to increase cooperation of research and educational institutions with the business sphere and to implement research results in practice, it is necessary to:
• increase and make more effective public R&D expenditure with the aim to improve connection between the public research and the private sector
• reinforce cooperation of businesses with public research and educational institutions
• support transfer of knowledge
• support mobility of researchers
• support foundation and development of new innovative businesses including spin-off firms (e.g., provide information and supporting services, reinforce entrepreneurial knowledge)
• support link of new firms to R&D institutions.

What is necessary to do for support of horizontal mobility of R&D workers and PhD students between the research and educational institutions and the business sphere? The main objective is to stimulate cooperation of R&D and educational institutions with the business sector, focusing on the horizontal mobility of R&D workers and PhD students. Part of the supports should joint R&D projects of academic sites and companies, and ensurespecial study programmes at universities target-oriented on the application of R&D results in commercial practice. A specific part of the supports have to be aimed on horizontal mobility of young research workers and PhD students who become employees of small and medium-sized enterprises.

Strengthening competitiveness of the Czech economy by reinforcing R&D and innovation capacities in relation to the business sphere and forming conditions for cooperation between educational, research institutions and businesses should be one of goals of the priority “Support of R&D and Innovation Capacities” of the National Development Plan CR 2007-2013.
5. CONCLUSION

Reflecting the Lisbon criteria and the overarching objective of building the European Research Area, there is a need to develop more accurate understanding of the role of R&D with respect to the dynamics of companies and certain economic sectors, evidence-based support to policy making. Evidently, the Czech Republic will not be able to achieve the target set on the 2002 Spring European Council Meeting in Barcelona - to raise the overall R&D expenditures to the level of 3 % of GDP, of this 1 % from public funds and 2 % from private (corporate) funds - by 2010.

Every country and every government realises its R&D policy, every year during the preparations and approvals of the state budget. The real policy comes from the analysis of disposable resources. Czech stagnation of financial R&D support in 2001 and falls in 2002 and 2004 resulted from the fact that the Government and individual departments started to prefer as their budgetary priorities solution of actual problems to creation of conditions for an economic growth in the future. That's why is necessary to improve a realization of research and development results in practice, to motivate cooperation of the public and the private sector in research, development and innovation, and to create favourable conditions for establishment of spin-offs at educational and research institutions.

Next activities can help to stimulate a cooperation of the public and the private sector in R&D, and to commercialize research and development results:

- formation of favourable conditions at universities and research institutions for commercialization of R&D results and foundation and start-up of spin-off firms
- cooperation of research and educational institutions at developing spin-off firms in the first phases of their existence (utilization of R&D and other infrastructure)
- internal leading to commercialization of R&D results and establishment of spin-off firms (analysis of commercial potential of an invention, market analysis, feasibility studies, etc.)
- establishment of educational and training programmes for students and researchers, which would be aimed at increasing entrepreneurial skills, intellectual propertie protection, commercialization of R&D results, foundation of spin-off firms
- support of innovation in non-industrial sectors of the economy (for example, health care, education, culture, finance) including activities in the business sector.
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