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Assessment of Use of Scientific and Technological Potential of Lithuania under Conditions of Global Economy

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Abstract

The paper deals with the use of scientific and technological potential in Lithuania under conditions of global economy. After acknowledging that the need for innovations and scientific knowledge for the economic development becomes more and more relevant and the efficient science-business cooperation is necessary when solving relevant economic development and technology progress problems on the global scale the results of the research on science and technology development, funding, human resources and innovation development in Lithuania as well as in the EU-27 are presented in the article. Though currently a lot of research works dealing with the problems of the scientific and technological potential use appear some questions have not been analysed properly. In scientific literature there is no common opinion about the definition of the scientific and technological potential and the factors having the biggest influence on the scientific and technological potential development have not been identified, estimated and analysed properly.

The results of the research have shown that the science and technology development in Lithuania depends on the close cooperation between business and public sector; however Lithuania remains behind the others in context of the European Union countries. It is stated that not all possibilities to improve the country's competitive ability under conditions of global economy have been currently used.

Keywords: scientific and technological potential, estimation of scientific and technological potential, innovations, global economy.

Introduction

Research novelty and relevance. The ability to initiate and implement innovations determines the economic state of the country in the global context. The need for high technologies and scientific knowledge for the economic development becomes more and more relevant. The representatives of business, science and society more often consider that the country's modern economics, oriented to the future, relates its success with the technological progress as well as with the continual cooperation between scientists and businessmen. The efficient cooperation and development of the infrastructure for innovations is the essential condition seeking to improve the European Union economy as well as it is the most important factor in solving the relevant problems of economic development and technological progress in the global context (Melnikas, 2008). Global economic space often becomes the challenge for the development in every country, therefore it is necessary to orient the existing scientific and technological potential and fundamental science to the new tasks formed by economic and social needs on the world markets (Lietuvos mokslo ir technologiju baltoji knyga, 2001).

Recently in scientific literature some scientific works have been found where some different ways of the use of the scientific and technological potential were discussed. The questions of the scientific and technological potential development related with economic growth, which stimulates the creation of new jobs and new products, were discussed in the works by Friedman, 2005; Altvater, Mahnkopf, 1996; Boldrin, Canova, 2001; Calori, Atamer, Nunesw, 1999; Hofbauer, 2003; Melnikas, 2004; Redding, Venables, 2003 and others. The possible use of the scientific and technological potential was assessed and analysed in the works by Ploss, (2007); Cohendet, Stojak, 2005; Calori, Atamer, Nunes, 1999; David, Foray, 2002 and others as well as by the Lithuanian authors such as Bagdanavicius, (2002); Ciegis, Gavenauskas, Petkeviciute, Streimikiene, (2008); Melnikas, (2008); Cibulskiene, Butkus, (2007); Damasiene, Matuzeviciute, (2002); Dapkus, (2006) and others. Though there are no doubts about the influence of the scientific and technological potential on the country's economics, however *the way of manifestation of this influence has not been discuss*ed. The use of the scientific and technological potential is commonly assessed quantitatively, therefore the following questions have not been analysed and still stay relevant:

– what criteria are relevant assessing the use of the scientific and technological potential under conditions of global economy?;
– what factors have the biggest influence on the development of the scientific and technological potential?;

- what results have been obtained in different areas?.

Research aim: to analyse and assess the use of the scientific and technological potential in Lithuania.

Research methodology: systematic analysis of literature, mathematical statistics methods.

Theoretical aspects of the use of the scientific and technological potential

In the theoretical works there is no single attitude defining the scientific and technological potential (STP). Three main groups of the STP can be pointed out. *Firstly* the STP has been defined as the wholeness of the scientific-technical resources. *Secondly* a group of scientists defines the STP as an organic unity of the scientific and technical potential. *Thirdly* the scientists approach the scientific potential as the wholeness of the resources and define the STP as the result of scientific research. Therefore the methodological aspect of the STP is mostly based on the wholeness of the resources. The scientists supporting such attitude emphasize the potential possibilities of the scientific-technical development in the sources of social and economic development as the specific production (scientific-technical activities) factors (resources) (Пелецкис, 1987; Peleckis, 1988). The functioning of such resources allows gaining new knowledge, new information, and new scientific and scientific-technical results. It means that the dynamics of science and technology and technological progress can be found in the results of the production area, but not outside it (Пелецкис 1987; Paleckis; 1988, 2008a). In the scientific literature the STP has often been related with the approach of the scientific innovative potential, because the scientific innovative potential was defined as the entirety of the possibilities and conditions that determine the capability to implement the scientific innovative activity, to create the scientific and innovative production and to make the presumptions for the propagation of results of the scientific innovative activity and for their application in practice (Melnikas et al. 2000). Though *innovation* means complex creation, development, general incidence and efficient use of novelties in different activity fields, however in the very first scientific works dealing with the relations among knowledge, new technologies and economic and regional development, the innovation process was assessed as relatively simple. The dependence of innovations on the economic development was analysed according to the linear innovation model (Ballard, 1989), where this dependence was defined as linear and the science was emphasized as the fundamentals of economic development as well as it was thought that the transfer of the scientific achievements to the industry should guarantee long-time development. However this attitude is not correct, because the relations between science and innovation technologies as well as between technologies and economic development are complex, interactive and repetitive. According to the scientific research it has been proven that the economic growth depends on the technological progress (Solow, 1957; Abramowitz, 1986; Grilliches, 1995; Toole, 1999; Tijssen, 2001; McMillan, Hamilton, 2002; Martin, 2007 et al.) which is the synergy effect which is obtained through the cooperation and which brings the social and economic benefit to the country. The novelty of science and technologies has been assessed as one of the strongest direct influential factors stimulating the economic growth, increasing the industrial potential of the society and the country's gross domestic product (GDP). The quantitative use of science and technologies reflects the level of the expenses on one production unit, therefore in order to increase the influence of science and technologies on the economic growth it is necessary to develop scientific research and experimentation, design-construction work areas. The efficiency of these areas appears in the rates of profit maximization, new goods and service improvement as well as the environmental pollution improvement (Snieska et al., 2005).

In other words, science produces benefit that an individual or society can have by using the latest scientific achievements and creating new technologies that can improve life quality. In this way science sets the goals for humanity to seek and estimates the ways of their attainment. According to Ploss (2007), where science makes benefits from the technical achievement, there it is much more supported by the state as well as by the business structures with the purpose to get profit or to improve life quality of the society. Having analysed the experience of the scientific research of the last 30 years, Grilliches (1995) estimated that in different scientific research cases social economic return ranges from 20% to 50%. Having surveyed the USA companies, Mansfied (1991) estimated that more than 10% of all innovations could not have been realized without the state supported scientific research. According to his counts social economic return of the scientific research was up to 28%. Having surveyed German companies, Tijssen (2001) estimated that 20% of the private sector innovations could have been realized without state supported scientific research. Toole (1999) calculated that the return of the scientific research can range from 12% to 41%. The results of McMillan and Hamilton (2002) research showed that as much as two thirds of all patents in the USA were obtained because of the state supported scientific research. Some researchers defined a positive touch between the number of private sector patents and the scope of the state supported scientific research. According to the results of Eurobarometer research (2007) it was estimated that a large part of Europeans agree that science and technology improve their life quality; 76% of them support the government funding the scientific research; 50% think that the fundamental research is necessary for the development of new technologies (Eurobarometer, 2005).

According to Martin (2007), seven channels where investment in scientific research brings the state social and economic benefit can be defined:

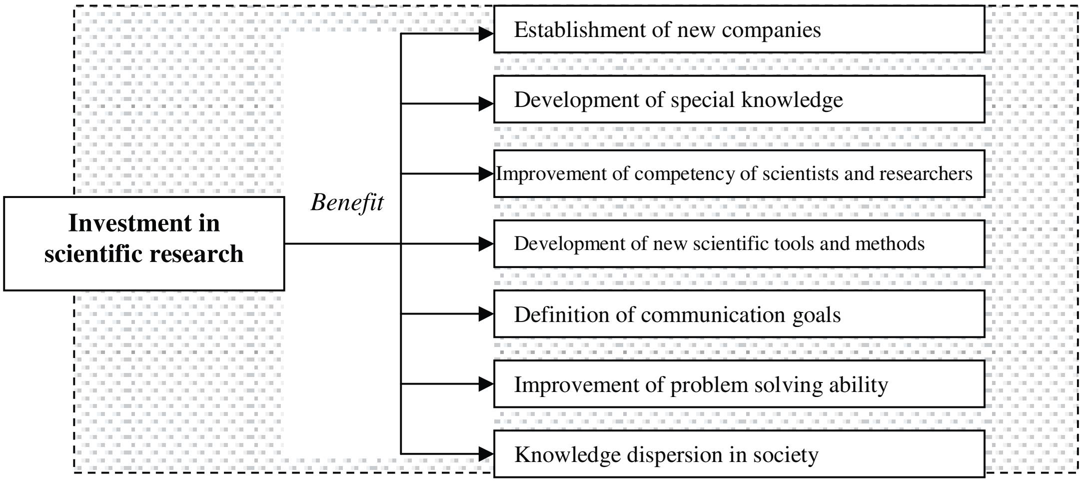

Fig.1. Channels of benefit from investment in scientific research

Assessing the benefit of the investment in scientific research the globular integrity of the process expression should be pointed out, which means that if the research is carried out in one field (or country) it promotes the development in another country (or region). In other words the synergy effect can be reached because of the communication and efficient knowledge as well as the technology transfer channels. Specific knowledge guarantees the technological progress, which determines the development of new products. Finally, it brings social and economic benefit (Martin, 2007).

One of the knowledge-based characteristics is the efficiency of the national innovation policy, involving research centres, higher schools, science and technology parks and business incubators as well as cooperation among the public institutions in order to implement innovative ideas (Kriksciunas, Daugeliene, 2006). Every company's activity directly depends on the described cooperation as well as on the competitive environment. A big number of competitors stimulates the growth of company's productivity and the development of new activity ways. Competition creates pressure among the market participants; yet it is the main driver of progress and welfare growth (Vilpisauskas, 2003). In such situation market leaders become transnational corporations that are advantaged among the other companies by their ability to find proper and cheap resources and to devote a part of their profit to the scientific research and innovation development.

Relation of the scientific and innovative potentials and their inter-integration are fundamental in discussing the issue of the scientific innovative potential as the element of the harmonious innovative process in the management system. The concept of the scientific innovative potential can be defined analysing this problem. The scientific innovative potential can be defined as the entirety of possibilities and conditions determining the ability to implement the scientific innovative activity, to create the scientific and innovative production and to make presumptions for spreading the results of the scientific and innovative activity and implementing them in practice (Melnikas, 2000). The scientific innovative potential is approached as a multi-stage system with its variety of internal structures. The scientific innovative potential emphasizes the topic of diversity of the scientific and innovative development. One of the elements in this potential structure, differential and oriented to different functions, *is social, political, economic, cultural, informative, technological and other environment* determining the scientific innovative development. The scientific innovative activity always progresses in the particular environment, the content and influence on the scientific innovative development of which is determined by multiple social, economic, political, technological, informative and other conditions. These conditions and their expression can be defined as the element of the particular scientific innovative potential, which means that this environment can be estimated in relation to the scientific innovative potential structure. The environment the scientific innovative activity progresses in essentially forms the scientific innovative activity content and its main orientations. In such attitude this environment can be described as a part of the scientific innovative potential.

Substantiation of the research methodology

Assessing the use of scientific and technological potential in one country or particular region (in this research the EU) one faces a problem of measurement. In the theoretical works as well as in the practical scientific research it is often discussed whether the quantitatively estimated scientific and technological potential in different countries can describe the peculiarities of the European Union as of a single unit with the complex cultural, economic, technological, political and social system. What estimation instruments can be used assessing the scientific and technological potential in different countries considering their cultural variety, openness and democracy traditions?

One of the main indicators in estimating a country's attitude to the development of science and technologies is GERD index that allows defining private and state financial resources invested in scientific research and innovative technologies as part of the gross domestic product (GDP). In the European Union innovation is measured by total innovation index (TII). The generalized total innovation index (TII) is obtained counting 19 common statistical indicators (including studies, science, business, finance and other areas), and it is used to compare different innovative scale in different countries. According to the generalized total innovation index counting methodology, the lowest rate in the group of the 27 EU countries can be 0 and the highest can be 1. Estimating the innovation of Lithuania in the global context, the global total innovation index (GTII) has been used. The authors of this index are professor Dutta and INSEAD Research Association. The GTII index is derived estimating contributions as all possible means to stimulate innovations in economics and get benefit that is the result of economic innovative activities. The contribution to innovation depends on the institutions and policy, human resources, general infrastructure, market and business complexity. The benefit from the innovations appears through their application in economics: knowledge development, competitiveness and welfare improvement. This index has been prepared according to the data of the World Economic Forum, the World Bank and the International Telecommunication Union (Global Innovation Index 08/09 Report). Double and multinomial correlation regression analysis has been used to assess the dependences of the rates.

Analysis of the factors stimulating the scientific and technological potential

The results of the analysis of the expenses on science and technology development. Assessing the country's attitude to the science and technology development, the GERD index is used. This index is the main characteristic of the country's innovation policy, involving expenses on the scientific research and technology development (SRTD) from the national and foreign countries funds however it does not estimate the expenses in foreign countries. According to the data of Eurostat and UNESCO Institute for Statistics the GERD index can be described as the total rate of five financial resources: foreign capital, state funds (GOVERD), business funds (BERD), higher education funds (HERD) and private non-commercial funds (PNRD). The following funds make the main weight for the total GERD index:

1. Business funds. These are funds of firms, organizations, offices, where the main activity is production and services and these funds are devoted to science and technology development.
2. State funds founded by the central government. They include all departments, offices and other institutions, which supply but not directly sell services to society, except higher education.
3. Foreign funds that are behind the country's political boarders and that are devoted to science and technology development (for example, PHARE).

The science and technology development in the European Union, OECD and others has been estimated using the mentioned and other indicators. After emphasizing that the GERD index defines a part of private and state financial resources invested in scientific research and technology innovation as proportion of the general gross domestic product (GDP), it is noticed that the increase in this rate up to 3% is one of the 2010-2013 Lisbon strategic goals, which enables a country to remain on the competitive market where the less developed countries such as Brazil as the World market centre, Russia as controlling large oil resources, India as home of software, and China as the world's factory, start to dominate. Fig. 2. shows the dynamics of the GERD index for 2004-2008.

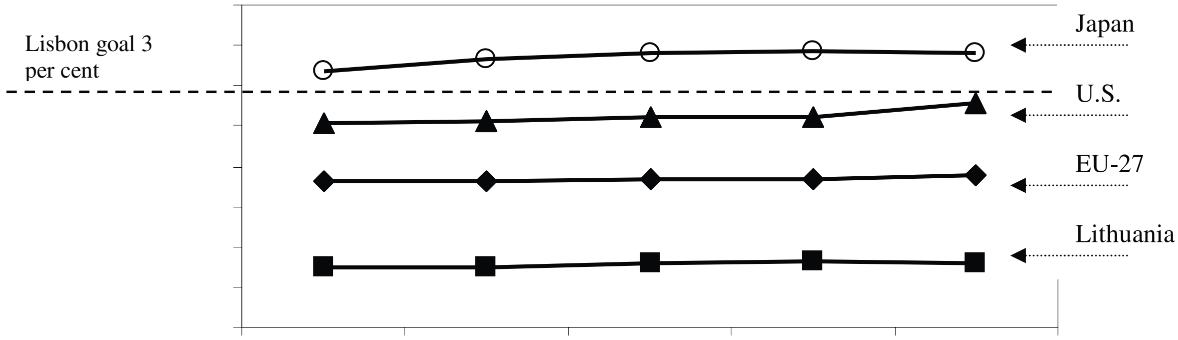

Fig. 2. Dynamics of the GERD index of expenses of the EU-27, Lithuania, the USA and Japan on the scientific research and development for 2004-2008

Upon completion of analysis of distribution of the expenses on scientific research and development in the EU-27, Lithuania, the USA and Japan, it was noticed that the situation in Lithuania was one of the worst (in 2008 the expenses made only 0.8% of the whole GDP created by the country). After considering that Lisbon strategic goal is to reach the spending of 3% of GDP on science and technology development in the EU-27, it was noticed that it is necessary for Lithuania as well as for all EU-27 countries to reach the USA level, where the expenses on science and technology development are much higher (in 2004-2008 it was 2.53% and 2.79% of all GDP). Currently new rivals in science and technology (such as Singapore, South Korea, and Taiwan) were integrating themselves into the market. It is difficult for the EU-27 as a single unit to seek the mentioned goal, because there is great inequality inside the community in the countries' economic activities as well as the science and technology levels. The expenses on science and technology in Lithuania are twice smaller than the average rate of the EU-27, therefore the goal for Lithuania is to reach that the expenses on scientific research and development would make 1% of the GDP.

Fig. 3 shows the dynamics of expenses on scientific research and technology development (SRTD) in Lithuania in 2004-2008.

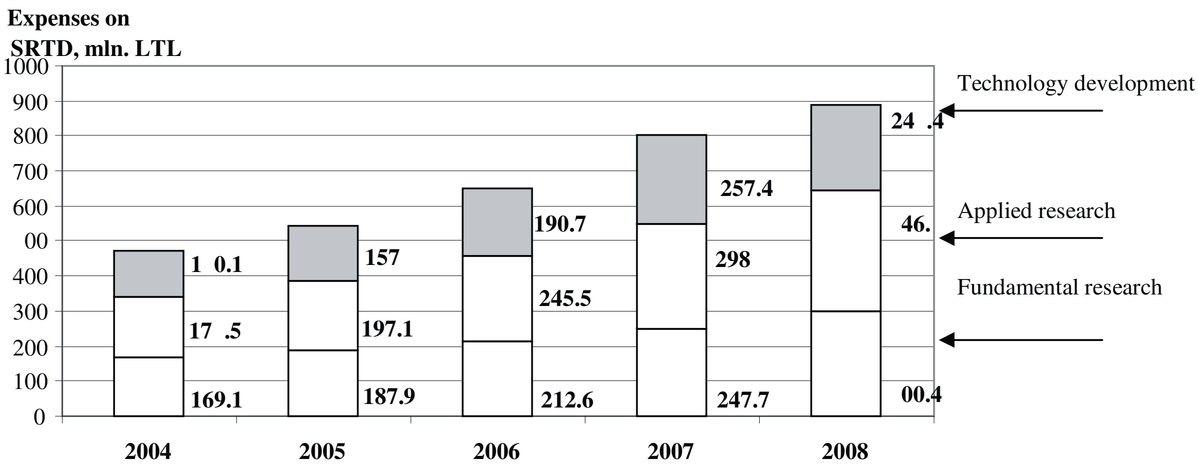

Fig. 3. Dynamics of expenses on SRTD in 2004-2008

Upon completion of analysis of the SRTD and GDP ratio in 2004-2008 it was found that during the analysed period this rate increased by 0.5% points and in 2008 reached 0.8% of the country's GDP. In 2004-2008 the expenses on SRTD increased from 472.7 mln LTL to 890.1 mln LTL. In the primary technological process stage (that is, in the fundamental research) the expenses increased up to 77.6 mln LTL, however the part of these expenses in the total costs decreased by 2.02%, and this slowed down the primary science and technology development. The expenses on the applied research increased up to 172.8 mln LTL, or approximately twice. The increase in this rate was determined by transferring the expenses on the fundamental research to the applied research, which determined the innovation creation, because only the consistent and finished research foundation can create the scientific product and bring benefit. The expenses on the technological development decreased by 0.18% and in 2004-2008 it made the smallest part

(27%) in the total expenses. This rate shows that the study system is funded more (for example, the number of higher school students) than the experimental development what depends on the public and private sector cooperation.

When Lithuania became a member of the EU the expenses on science and technological development increased a lot, because this is required by the EU general development strategy. The positive growth of this rate was influenced by the increased *direct foreign investment* in Lithuania. After completion of analysis of the dynamics of the direct foreign investment in Lithuania, it was estimated that during the researched period it increased by 21804.5 mln LTL (what makes 6571 LTL per one citizen), that is, more than 2.5 times. This investment was directed at the high and medium-high technology sector, especially at office equipment production and computer and electrical machinery and equipment as well as medical, precision and optical instruments manufacturing, and different types of clock industry. Foreign investors invested in traditional industry branches in Lithuania.

After completion of estimation of the *public expenses on* SRTD, it was determined that in Lithuania this rate is lower than the EU average. The public budget expenses made only 0.18% of the GDP, while the EU-27 average rate during the researched period was 0.24% and the rate of the old member states was 0.25%. After completion of analysis of the distribution of the expenses of EU-27 states on SRTD, it was noticed that the general public expenses difference among the countries is not so big compared with the general expenses, the difference in which between Cyprus and Sweden made up to 3.24%, and estimating the public expenses between Germany and Malta they made only 0.33%. These differences show that the use of the business sector financial resources is much more efficient than use of the public financial resources, where the main goal is to invest in general science and technology level of the country with a view to improve the general condition of science system. The finances of business sector are often oriented to the most perspective area of activity in order to earn the maximum profit. According to the budgetary funding rate Lithuania stays behind the tendencies in the European Union. After estimation of the public funding proportion according to the GOVERD index, Lithuania goes to the 13th place among the EU-27 countries.

The business sector input is shown in Fig. 4, in per cent of all the GDP (BERD index).

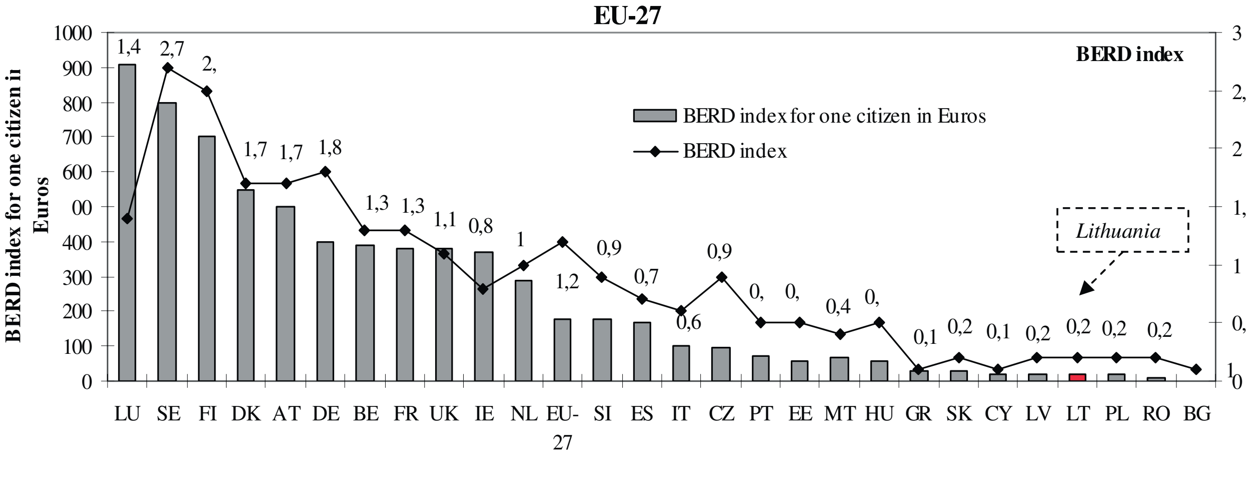

Fig. 4. The expenses on STD in business sector, in per cent of the GDP of all EU-27 member states in 2004-2008

After completion of analysis of the possibilities of funding the STD it was noticed that funding from the business sector is much more efficient than from the public sector (Fig. 4). The business sector funds more science and technology areas in the strong, economically developed countries (in Sweden – 2.704%, in Finland – 2.524%, in Germany – 1.768%). This high funding level from the business sector is determined by the activity of big companies. Innovative corporations such as Nokia and IKEA work in Sweden, in Germany the science and technology have been funded by “Jacobs”, “Deutsche Post” and others. It is noticed that in 2004-2008 the business sector investment in scientific research and technology development decreased in the developed countries, but it increased in the developing countries. The structure of the expenses according to the financial resources is shown in Table 1.

Table 1

Expenses on STD according to the financial resources, in per cent

	2004	2005	2006	2007	2008	Change
Public resources	63.1	62.7	53.6	47.9	55.6	-7.5
Business companies resources	19.9	20.8	26.2	24.5	21.4	1.5
Foreign investors resources	10.7	10.5	14.3	19.6	15.5	4.8
Higher education sector resources	6	5.7	5.3	7.5	7.2	1.2
Non-profit institution sector resources	0.3	0.2	0.6	0.5	0.3	-

Summarization of the results of the expense distribution being done it can be claimed that the resources of the Lithuanian budget are more oriented to fund necessary life areas but not science and technology development. After estimation of the investment of the business sector in science and technology development it was noticed that the business sector resources did not grow as fast as the public sector resources fell down (in 2004-2008 a part of the business sector resources decreased by 7.5%).

Human resources are one of the factors representing the country's competitive ability, therefore after estimation of the SRT development possibilities this rate shows the potential of the country's economic welfare. After consideration of the dynamics of the number of specialists educated in natural sciences, technology and applied research areas (these specialists create the biggest value-added innovative products), it was noticed that in Lithuania as well as in other EU countries this rate was increasing. It means that there is a sufficient number of specialists, though after completion of analysis of distribution of people working in scientific research and technology development in the general labour power of the EU-27 it was noticed that that part of such people ranged from 3.2% to 0.5% (the average part in the EU is 1.5%; in the EU-15 it makes 1.7%). In Lithuania the specialists of the mentioned area make (on average) 1.1% of all labour power. During the five-year time this rate has increased by 0.5 point only and in 2008 it made 1.2% (for example in Japan this rate was 1.78%, in South Korea – 1.56%, and in Iceland it was even 3.41%). *Summarization of the results being done it can be claimed that only a small part of the highly educated specialists join the team of scientists and researchers. Therefore the presumption has been made that a part of this potential leaves the country or works in other fields.*

The results of the innovation development rate analysis. In order to estimate a country's *innovation level on the global scale* some different innovation indexes have been applied, which let modularly estimate the preparation to stimulate innovations creation and their application for the country's competitive ability improvement. After estimation of preparation of Lithuania to create innovations the total innovation index (TII) proposed by the European Commission "European Innovation Rate Board 2009" has been used. The results of the TII index are shown in Fig. 5.

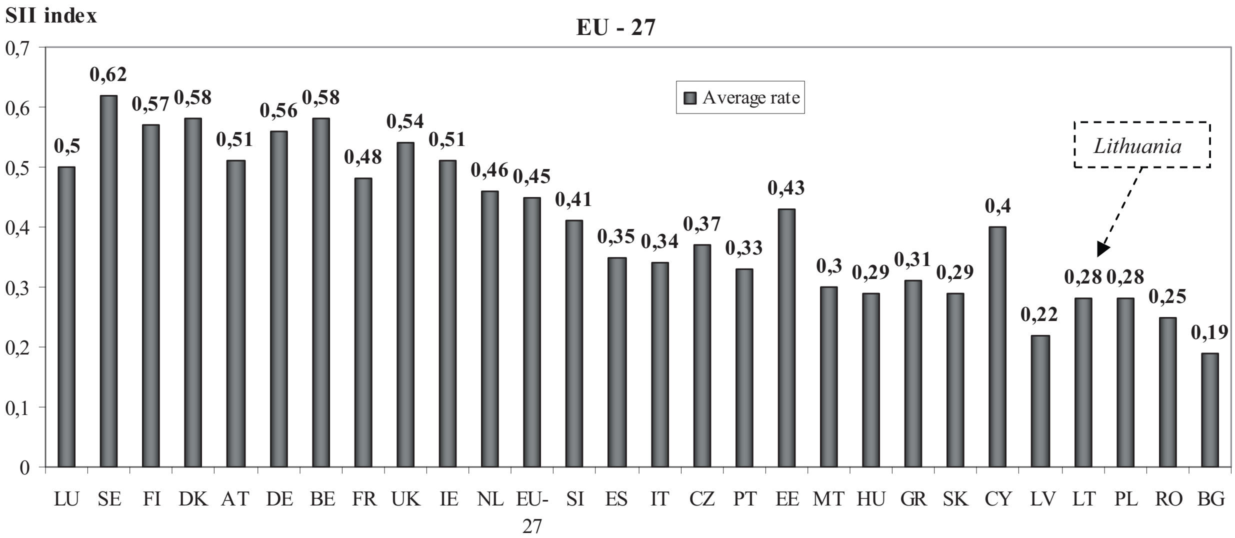

Fig. 5. The average rate of the total innovation index of all the EU-27 member states in 2004-2008

Source: European Innovation Rate Board 2009

Sweden reached the highest score in the rating of innovations (0.62 points), Bulgaria was on the lowest level (0.19 points). The average rate of innovations in Lithuania was only 0.28 points, which is lower rate than the EU-27 average. This rate put Lithuania only in the 24th position among the EU-27 countries; this rate was a little higher than in such countries as Latvia, Bulgaria, and Romania. As it is claimed in the program of Economic Growth Activities of 2007-2013, Lithuania positively differs from the other EU-27 countries only according to one innovation rate – companies' cooperation in the innovative activity in the country.

Upon completion of assessment of the innovation level of Lithuania on the global scale the global total innovation index (GTII) has been used, which involves institution rate, human resources, general communication and telecommunication infrastructure, complexity of the market and business conditions. The benefit has been assessed in the scientific achievements through the high technology export, patents and the number of scientists, competitive ability and capital as the result of innovations. The results of the research being summarized it was estimated that the USA, Sweden, Finland, Switzerland, Japan, Singapore and Israel appeared as the world leaders in innovation (NSEAD, 2009). Lithuania goes to the 42nd position in the world rating of all 130 countries according to the GTII index (3.43). According to the rates of innovation stimulation Lithuania goes only to the 37th position and consideration being taken of the index of innovation output Lithuania's rating is only the 46th.

The innovation development index was first applied in 2007 by Economist Intelligence Unit and CISCO. This index is being applied to give ratings for 82 countries considering their ability to implement innovations and to forecast their activities until 2013. Innovation is considered a competitive tool at company level as well as at state level therefore the innovation production is defined by summing up patents. This index estimates the direct and indirect innovation stimulation means. Upon generalization of the results of the research it was estimated that:

- According to the innovation activity index Lithuania goes to the 38th place (6.07 points in ten-point scale, where the average rate of 82 countries is 6.28 points). Japan is in the first place (10.0), Switzerland goes next (9.71), it is followed by Finland (9.5), the USA (9.5), Sweden (9.44) and Germany (9.40). In the mentioned rates Estonia overtakes Lithuania and goes to the 30th position.
- According to the index of direct expenses on innovations Lithuania (6.56) is in the 32nd position and exceeds the general average index (6.31). In this rating Sweden (10.0) goes to the first place, it is followed by Israel (9.94), Germany (9.94), Switzerland (9.94), Finland (9.94), Denmark (9.94) and France (9.94). Estonia (7.94) is in the 25th position.
- The countries having been sorted by the innovative environment index, Denmark, Singapore, Finland, Ireland and Great Britain appear on the top places, while Lithuania is in the 40th place in this rating. Estonia holds the 19th place after Belgium (17.0), Austria (18.0), Spain (20.0) and France (21.0).
- The countries having been grouped by the index of modular innovation implementation means, Denmark, Sweden, Finland, Switzerland and the USA take the highest positions. Estonia (7.84) overtakes Lithuania and goes to the 23rd position (Lithuania gets 6.52 points and goes to the 31st position and its index is 0.21 points above the general average of the countries).

The results of innovation ratings have been used in forecasting the innovation level for 2009-2013. According to these predictions the positions of the countries on the world innovation rating would not change much, however it is predicted that Germany and Austria will rise by 2 positions, while Malaysia and the United Arab Emirates will fall by 4 positions. The Czech Republic is predicted to go down by 3 positions, and Sweden, Slovakia and Lithuania – to fall by 2 positions. The fall is also predicted for Latvia and Bulgaria, which now are on the other side of the ratings (Economist Intelligence Unit Report).

Estimating the competitive ability, the country's position on the world and international markets is defined by applying the competitiveness index. Fig. 6 shows the technological preparedness index of the EU-27 countries.

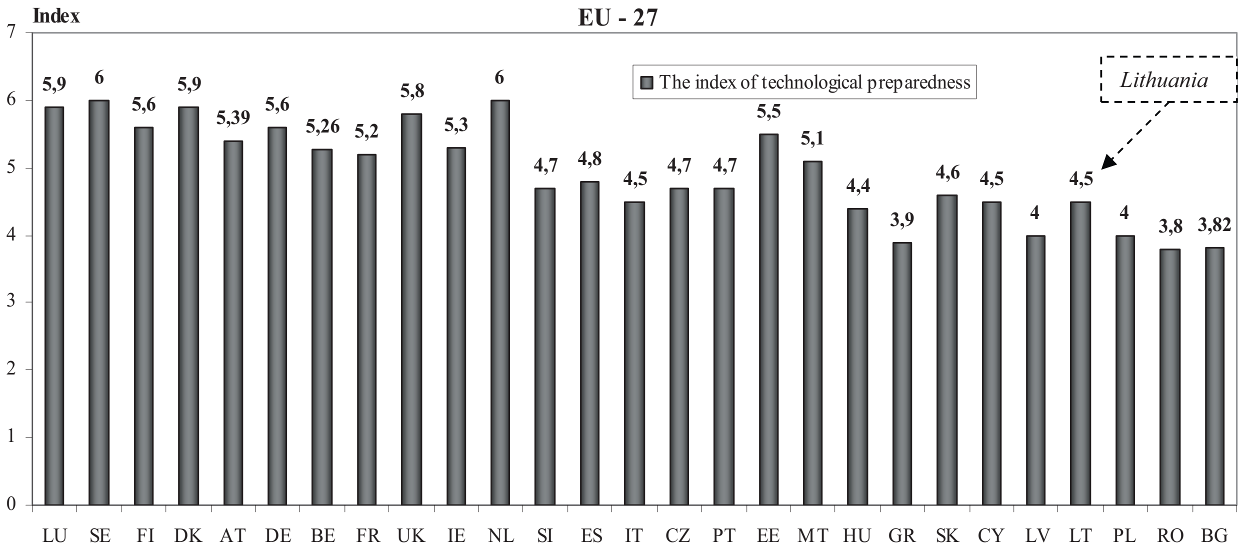

Fig. 6. The indexes of technological preparedness of the EU-27 member states in 2009-2010
Source: Global Competitiveness Index 2009-2010

Estimating the situation according to *the competitiveness index* Lithuania (4.3) takes the 53rd position in the world, while in the EU-27 it goes to the 22nd position. After estimating all the innovation rates it was noticed that Lithuania stays in the third ten of the rating. According to the innovation index Lithuania is in the 23rd position and according to the technological preparedness it is in the 20th position among the EU-27 countries and in the 36th position in the world. Sweden, Finland and Denmark are the best technologically prepared countries.

The results of the research having been processed it was defined that according to *the competitiveness rates* Lithuania has got 73 disadvantages and 47 advantages. The competitive ability advantages in Lithuania have been estimated according to the world competitiveness rating: the institutional quality of the scientific research (46); the cooperation among the universities and industrial companies for the STD (45); the accessibility to the latest technologies (50); the law considering the IRT (46). By quality of mathematics and natural sciences Lithuania is in the 37th place; by local possibilities to use specialized scientific research and teaching services it is in the 51st. The *disadvantages* of the competitiveness in Lithuania were assessed according to the world competitiveness rating: the expenses on STD in business sector (52); the state purchase of advanced technology production (100); the availability of scientists and engineers (70); the application of precise technologies (64); the transfer of direct foreign investments and technologies (80). One of the factors decreasing Lithuania's competitive ability is the expenses on STD in the business sector (51), the transfer of direct foreign investments and technologies (80), the squander of the public financial resources (177).

The results of the analysis of the scientific and technological potential and economic rates correlation

After evaluating the factors (the expenses on STD in public sector for 1 citizen in Euros, the expenses in business and public sectors) determining the scientific and technological potential development influence on the macroeconomic rates in the EU-27 it was established that:

- The general expenses on SRTD positively correlate with the gross domestic product for one citizen *($r = 0.85$; $p = 0.05$)*. Assessment of the EU-15 and the EU-12 having been done it was determined that the dependence of these factors for the EU-15 is stronger *($r = 0.7$; $p = 0.05$)* than for the EU-12 *($r = 0.56$; $p = 0.05$)*.
- Assessment of the influence of the business sector expenses on GDP for one citizen having been done greater dependence on the size has been established for the EU-15 *($r = 0.74$; $p = 0.05$)* than for the EU-12 *($r = 0.53$; $p = 0.05$)*. The results of the research allows validating the presumption that the older member states of the EU use their financial resources for SRTD more efficiently than the new states, therefore Lithuania has to look for new ways for closer business and science cooperation seeking to implement innovative ideas.
- A positive significant dependence has been found between the expenses on SRTD and the competitiveness index *($r = 0.72$; $p = 0.05$)* as well as between the expenses on SRTD and total innovation index *($r = 0.87$; $p = 0.05$). The existing correlation allows validating*

the presumption that science and technology development supplies the competitive ability to the country or the region which depends on the investment in innovative activities.

– After analysis of the influence of the proportion of expenses on SRTD in GDP in Lithuania the important correlation *($r = 0.93$; $p = 0.05$)* was detected, however after assessment of the influence of the expenses on SRTD on the total innovation index no significant correlation was found. Defined significant dependence allows validating the theoretical presumptions that the scientific technical potential can be defined as a factor of direct influence group stimulating the economic growth.

Conclusions

The country's innovative activity under conditions of global economy is considered to be a particularly relevant problem for further social economic development and science and technology progress, and efficient solution of it creates preconditions for the country's worthwhile integration into the world's high value-added development chain. The integration of creating the consistent scientific activity results and supplying a new innovative product to the market determines the SRTD continuance and at the same time it determines the country's successful solving of social-economic and environmental problems.

It was estimated that the new EU member states (including Lithuania) seeking competitive ability under conditions of global economy have faced a problem – a gap between economic and science sectors, their weak interrelations. Inefficient cooperation among the state, business, and higher education does not ensure the efficient creation of the scientific and technological knowledge for the value-added use in business sector.

It was estimated that in Lithuania the fundamental and basic scientific research is mostly funded from the state budget and the European Union financial resources, while the part of the private sector is very small. Though Lithuania invests mostly in applied scientific research, it does not reach the final purpose because of the weak cooperation among state, business, and higher education. By financial rates Lithuania is one of the weakest countries in the EU and holds the 19th position.

The results of the research have shown that the number of masters and doctors of exact sciences does not match the demand in the labour market. The consequence of it is that in Lithuania most of the young specialists leave the country, therefore the intellectual capital is diminishing. Consideration having been taken that the accumulation rates of the real (physical) capital and human resources have the biggest influence on the economic growth process, it is necessary to involve all the parties concerned (governmental institutions, employers and employees) into the human resource development and renewal process with a view to adapt to the labour market needs.

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Lietuvos mokslinio ir technologinio potencialo panaudojimo vertinimas globalios ekonomikos sąlygomis

Santrauka

Straipsnyje analizuojamas ir vertinamas Lietuvos mokslinio ir technologinio potencialo panaudojimas globalios ekonomikos sąlygomis. Įvertinus tai, kad inovacijų ir mokslo žinių poreikis ekonomikos vystymuisi tampa vis aktualesnis, o efektyvus mokslo ir verslo bendradarbiavimas būtinas sprendžiant aktualias ekonominės raidos ir technologijų pažangos problemas globaliu mastu, šiame straipsnyje pateikiami Lietuvos bei EU-27 šalių mokslo ir technologijų plėtros finansavimo, žmogiškųjų išteklių, inovacijų plėtros tyrimo rezultatai. Nors pastaruoju metu publikuojama nemažai mokslinių darbų, kuriuose aptariamos ir analizuojamos įvairios mokslinio technologinio potencialo panaudojimo problemos, tačiau kai kuriems aktualiems klausimams aptarti skiriama nepakankamai dėmesio. Mokslinio technologinio potencialo plėtros, siejamos su ekonomikos augimo varomąja jėga, skatinančia naujų darbo vietų kūrimą, naujų produktų atradimą problemos analizuotos Friedman (2005), Altvater, Mahnkopf (1996), Boldrin, Canova (2001), Calori, Atamer, Nunesw (1999), Hofbauer (2003), Melniko (2002); Redding, Venables (2004) ir kitų autorių darbuose. Mokslinio ir technologinio potencialo panaudojimo galimybes savo darbuose analizavo ir vertino Ploss (2007), Cohendet, Stojak (2005), Calori, Atamer, Nunes (1999), David, Foray (2002), Stein-

mueller (2002) ir kitų užsienio šalių bei lietuvių autoriai (Bagdanavičius (2002); Čiegis, Gavėnauskas, Petkevičiūtė, Štreimikienė (2008); Melnikas (2008); Cibulskienė, Butkus (2007); Damašienė, Matuzevičiūtė, (2002); Dapkus (2006) ir kt.). Nors mokslinio technologinio potencialo poveikiu ekonomikai neabejojama, tačiau nepakankamai dėmesio skiriama aiškinantis, kaip šis poveikis pasireiškia. Dažniausiai mokslinio technologinio potencialo panaudojimas vertinamas kiekybiškai, todėl lieka aktualūs ir menkai analizuoti šie klausimai: kokie kriterijai yra svarbiausi vertinant mokslinio technologinio potencialo panaudojimą globalios ekonomikos sąlygomis? Kokie veiksniai turi didžiausią poveikį mokslinio ir technologinio potencialo plėtrai? Kokiose srityse ir kokie rezultatai yra pasiekti?

Mokslinėje literatūroje pasigendama vieningo požiūrio ne tik apibrėžiant mokslinį technologinį potencialą, bet ir nepakankamai dėmesio skiriama veiksniams, turintiems didžiausią poveikį mokslinio ir technologinio potencialo plėtrai identifikuoti ir vertinti. Apibendrinant atliktos mokslinės literatūros analizės rezultatus galima teigti, kad daugelyje darbų mokslinis inovacinis potencialas yra traktuojamas kaip daugiapakopė sistema, pasižyminti savo vidinių struktūrų įvairove. Mokslinio inovacinio potencialo daugiapakopiškumas atspindi mokslinės ir inovacinės raidos problematikos įvairovę. Vienas šio potencialo struktūroje išskiriamų į įvairias ir gana skirtingas funkcijas orientuotų elementų yra mokslinę inovacinę raidą lemianti *socialinė, politinė, ekonominė, kultūrinė, informacinė, technologinė ir kitokia aplinka.* Mokslinė inovacinė veikla visada vyksta tam tikroje aplinkoje, kurios turinį ir poveikį mokslinei inovacinei raidai lemia daugialypės socialinio, ekonominio, politinio, technologinio, informacinio ir kitokios aplinkybės. Šių aplinkybių buvimą ir jų raišką galima traktuoti kaip tam tikrą mokslinio inovacinio potencialo elementą, o tai reiškia, kad ši aplinka gali būti vertinama ją siejant su mokslinio inovacinio potencialo struktūra. Aplinka, kurioje vyksta mokslinė inovacinė veikla, iš esmės formuoja mokslinės inovacinės veiklos turinį ir pagrindines jos orientacijas. Būtent šiuo požiūriu tokia aplinka gali būti suvokiama kaip mokslinio inovacinio potencialo dalis.

Vertinant šalies ar atskiro regiono (šiame tyrime – Europos Sąjungos) mokslinio technologinio potencialo panaudojimą susiduriama su išmatavimo problema. Tiek teoriniuose, tiek praktiniuose moksliniuose darbuose dažnai diskutuojama, ar kiekybiškai įvertintas atskirų šalių mokslinis technologinis potencialas gali atspindėti Europos Sąjungos kaip vientiso darinio bei sudėtingos kultūrinės, ekonominės, technologinės, politinės bei socialinės sistemos ypatumus? Kokius vertinimo instrumentus būtų tikslinga naudoti vertinant šalių mokslinį technologinį potencialą atsižvelgiant į kultūrų įvairovę bei susiklosčiusias atvirumo ir demokratiškumo tradicijas. Vienas svarbiausių rodiklių, įvertinančių šalies požiūrį į mokslo ir technologijų plėtrą, yra GERD indeksas, kuris leidžia įvertinti, kokią dalį bendrajame vidaus produkte sudaro privačių ir valstybinių lėšų investicijos į mokslinius tyrimus ir inovatyvias technologijas. Europos Sąjungoje yra priimta šalių inovatyvumą matuoti vadinamuoju suminiu inovacijų indeksu. Apibendrintas inovacijų indeksas gaunamas perskaičiuojant 19 labiausiai paplitusių statistinių rodiklių (apimančių studijų, mokslo, verslo, finansų ir kitas sritis), naudojamų inovacijų padėčiai skirtingose šalyse palyginti. Siekiant Lietuvos inovatyvumo lygį įvertinti globaliame kontekste, naudojamas globalus suminis inovacijų indeksas.

Apibendrinus atlikto tyrimo rezultatus galima teigti:

– Globalios ekonomikos sąlygomis inovatyvi šalies veikla vertinama kaip ypač aktuali tolesnės socialinės ekonominės raidos bei mokslo ir technologijų pažangos problema, kurios efektyvus sprendimas sukurtų prielaidas visavertčiam šalies įsitraukimui į pasaulines aukštos pridėtinės vertės vystymo grandines. Nuosekli mokslinės veiklos rezultatų integracija, kuriant ir rinkai pateikiant naują inovatyvų produktą, lemia MTTP tęstinumą, kartu prisideda prie sėkmingų šalies socialinių-ekonominių bei aplinkosauginių problemų sprendimo.
– Nustatyta, kad Europos Sąjungos naujokės (tarp jų – ir Lietuva) siekdamos konkurencinio pranašumo globalios ekonomikos sąlygomis, susidūrė su problema – šalies ūkio ir mokslo sektorių atskirtimi, menkais jų tarpusavio ryšiais. Nepakankamas valstybės–verslo–aukštojo mokslo sektorių bendradarbiavimas neužtikrina efektyvaus šalyje ir už jos ribų sukuriamų mokslo ir technologinių žinių pridėtinės vertės versle kūrimui panaudojimo.
– Nustatyta, kad Lietuvoje fundamentalieji ir baziniai mokslų tyrimai daugiausia finansuojami iš valstybinio biudžeto bei Europos Sąjungos lėšų, o privataus verslo dalis yra labai menka. Nors Lietuva daugiausia investuoja į mokslo taikomuosius tyrimus, tačiau jie nepasiekia galutinio tikslo dėl menko valstybės–verslo–aukštojo mokslo sektorių bendradarbiavimo. Pagal finansavimo rodiklius Europos Sąjungos Lietuva yra tarp atsiliekančiųjų ir užima tik 19 vietą.
– Tiksliųjų mokslų magistrų ir mokslo daktarų skaičiaus pasiūla Lietuvoje neatitinka jų paklausos darbo rinkoje. Todėl daugelis gabių jaunų specialistų išvyksta iš šalies, todėl mažėja Lietuvos intelektinis kapitalas. Įvertinus tai, kad ekonominio augimo procesui didžiausios įtakos turi realaus (fizinio) ir žmogiškojo kapitalo kaupimo tempai, būtini žmogiškųjų išteklių plėtros bei atnaujinimo procesui, siekiant prisitaikyti prie darbo rinkos poreikių, įtraukti visas suinteresuotas puses (valdžios institucijas, darbdavius ir darbuotojus).

Pagrindiniai žodžiai: mokslinis technologinis potencialas, mokslinis technologinis potencialo vertinimas, inovacijos, globali ekonomika.

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