PROMOTION OF TECHNOLOGY - BASED INNOVATIONS AND INVESTMENTS IN R&D IN LITHUANIA: AN OVERVIEW OF PROBLEMS

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Abstract. The investment in R&D activities as the development and implementing of technology – based innovations in economy is still very moderate in Lithuania. In addition, the growth of investments in R&D in private sector is still moderate excluding some partial cases. Based on statistical data main causes of such situation in private and public sector (especially in higher education and research institutions) are analyzed in this paper and provides some suggestions related to faster growth of R&D development and higher competitiveness of Lithuania.

Keywords: technology transfer, creation of innovations, R&D.

Introduction

Innovation is increasingly important for economic development. In general, innovation and the knowledge economy are seen as a tool that would help the developed countries to ensure competitiveness and a favorable evolution of the standard of living. Competitive economy ensuring the welfare of the residents is related to the promotion of innovation. In order to successfully innovate, it is necessary to ensure efficient transfer of knowledge, technology, organization, culture and so on.

The research of technology transfer is executed in various ways, for example, focus on the technology transfer in aeronautics (for more details, see Lal et al., 2013). There are different definitions and some models of technology transfer describing the international deals of "know-how" and reflecting the different approaches and different needs of partners acting in the creation of innovations. Commercial technology transfer may be defined as a mutually agreed upon, intentional, goal-oriented, and proactive process by which technology flows from an entity that owns the technology (the transferor) to an entity seeking the technology (the transferee). The transfer involves cost and expenditure that is negotiated and agreed upon by the transferee and transferor. The transfer is successful if the transferee can successfully utilize the technology for business purposes and eventually assimilate it (for more details, see Ramanathan, 2008).

Technology transfer from research institutions and universities can generate relevant benefits for economic development. Therefore the research has real effects on the economy by increasing the productivity of private sector R&D and the growth of productivity (Zuniga, Corea, 2012). Despite the fact that technology is one of the most important sources of innovation, technology transfer is complex process. Research-based technology transfer from research institutions to business is of great relevance for the whole innovation process. On the other hand, the scale of diffusion of the transferred technology depends to a large extent on existing technology infrastructure (Gurbiel, 2002).

Usually universities and research institutes are large beneficiaries of public investments in research and development (R&D). The development of technology-based innovation depends on the collaboration of the scientific and business communities in the field of technology transfer as research institutions developed technology is basically the most important source of innovation. One of the theories, which can be applied in technology transfer analysis, is the Vernon's product life cycle theory which argues that reasons for foreign trade are technological advantages, which are embodied in innovations. Since the access to the core technologies is limited, innovations are spreading gradually and differently across countries from country innovator to receiving country. One of the reasons for this is that countries differ in the levels of economic development and technology (Gurbiel, 2002, Vernon, 1993).

Technology commercialization, also known as research commercialization means the creation of technology based innovation and refers to the valorization of research and intellectual assets by industry and includes the selling, licensing of, or contracting of technology services, intellectual assets, and related-knowledge into spinoff creation and R&D collaboration. R&D collaboration is another form of valorization of research, enhancing industry innovation capacity. The narrower concept of the technology commercialization means the notion of technology commercialization through the exploitation of intellectual property rights and has become increasingly important in recent years (Zuniga, Corea, 2012).

There is also a problem concerning the concept of innovation, because in society innovation is very broad: innovations include various organizational and technological inventions the practical application of output of research on economics, bu-

siness, and the adaptation of the generated value added etc. This broad definition leads to misunderstandings between and within the government and business institutions in some cases.

There are only few exhaustive research on the problem concerning the technology transfer in Lithuania.

Data and Methods

The research is based on the analysis of Lithuanian higher education sector. The overview of related literature and statistical data concerning the innovations from Eurostat is applied. The data concerning R&D financing from Eurostat and from Statistics of Lithuania are used.

Transfer of technology: direct interaction between science and business

Technology transfer, particularly technology commercialization, does not flow itself from the research base to industries and markets. In principle, well-functioning "markets for ideas" constitute an appealing mechanism in which researchers can supply their inventions, and firms, entrepreneurs, and various investors demand them, applying a price that clears the market (Zuniga, Corea, 2012). In addition, markets for technology face a number of imperfections that affect their development. These imperfections are associated with the nature of knowledge, given that usually it is difficult to set limits for the uses of technology and procedures for its exploitation, then write respective specifications in the contract clauses. In addition, views about the value of technology differ between parties, and it leads to moral hazard situations. As a result, contracts are imperfectly defined, leading to high transaction costs. These in turn affect the pricing, market mechanisms, and diffusion of technology (for more details, see Arora et al., 2001 and Arora and Gambardella, 2011).

Technology transfer is a multifaceted phenomenon that includes both formal and informal process of integrating the different actors working in the fields. Technology transfer can take place in several formal ways, e.g., the development of new innovating businesses, acquiring licenses, by charter or shared with other partners in the research, establishing spin-off companies etc. Informal ways of technology transfer, such as informal social relations, staff exchanges programs, counselling, joint training programs etc. also are important. Technology transfer, as well as all other measures that could increase the innovation capacity of Member and actually installed in innovation must be at the core of public policy content components. However, the technology transfer policies often dissolves the joint promotion of innovation policy and therefore does not give practical results, because does not take into account the specific characteristics of the technology transfer process. General innovation policy measures are not adequate to technology transfer.

Some technologies fail to reach the market due to the struggle of doing deals. Collaborations and deals between research institutions and companies or venture capitalists involve transactions between people who live within different cultural frameworks: research institutions and universities have a culture primary focused on the creation and transfer of knowledge through research, teaching, and publications. On the other hand, corporate cultures are primarily focused on generating profits. These differences make collaboration and deals more complicated to negotiate (Escoffier et al.). In addition, the innovation creation and technology transfer can be characterized by the mutual information asymmetry: usually researchers have the know-how related to technology and entrepreneurs round more know-how in marketing and other organizational areas. In some cases, the most entrepreneurial researchers: do not agree to transfer knowledge about technology to others, but create their own business. On the other hand, the availability of financial support for innovation sector like the tax planning, can distort the fundamental rational economic behavior.

In Lithuania, there are some cases when cooperating business companies and research institutions lack of mutual trust between themselves.

Technology transfer from the Perspective of Business Company: Risk Avoidance, Too Low Capacity and Support of Investments

In some cases, the EU's financial support to entrepreneurs is treated not as a means necessary for innovation, but as a final goal quite easily picks up the money. This became fundamentally flawed thinking, rather than the weakness of the science and technologies institutions and the government's mistakes in implementing R&D and R&D-oriented policies, perhaps the most impedes innovation.

Even a favorable technological development policy is not sufficient and does not ensure a breakthrough in innovations. The typical problem is too small businessmen competence and only lingering appetite scooped profit by investing as little as possible. Another problem inherent in Lithuania in particular is the business reluctance to invest for long term and wait for the return on investment.

The main Lithuanian companies engaging for a large share of the workforce, successfully exporting, and high value added sectors – invest relatively little capital in R&D and innovation. Their competitiveness is based on lower costs of production, namely labor, and increasing productivity, which led to technological modernization (for more details, see Mosta, 2014).

The implementation of new technologies within the activity of an enterprise is not a simple process. First of all, this is related with high risks involved in processes of production and reorganization of organizational systems. When planning the implementation of new technologies, many factors must to be assessed. Some of them are related with the common economic standing of the country, the development of GDP and its structural changes, the shift of industrial production and the change of working conditions (for more details, see Vasauskaitė et al. 2011).

Following the assessment of external experts, one of the systematic problems of Lithuanian R&D sector is that in many areas the research and creation of new technologies does not fit the business context, which is shaped by low-tech industries and incremental innovation. On the other hand, many technologies fail to generate revenues because they only provide a partial solution to a commercially relevant problem. Business needs a methodology for delivering it into the body and storing it until they are ready to administer it (Escoffier et al.). A research-based model of innovation necessitates a matching industry capacity, especially in terms of absorptive capacity, that is in many areas simply not developed (for more details, see OMC Policy Mix Review Report, 2007).

From the private sector side, there is a problem of uncertainty regarding the value potential of scientific discoveries since in the most cases inventions developed by research institutions are embryonic and need further investment for development. Such investment generates high risk, since neither the practicality of the inventions nor their market utility has been proven (for more details, see Jensen and Thursby, 2001). In this case, the risk avoidance from the business side plays crucial role. Uncertainty due to globalization and the emergence of even newer technologies is partly determined by researchers focused to specific scientific problems, but can be „disturbed" by innovation installers. Looking from the business perspective, the farther away a technology is from being applied for hands on usage; the greater the likelihood something will go wrong before it attains market success. New technology may fail to perform as intended since the market conditions may change. On the other hand, someone may file a patent application earlier for the same invention. These and other risks are reflected in discount rates. Furthermore, the more immature the technology, the farther out the revenue stream, and longer lag times before revenues or profits are realized (for more details, see Escoffer et al.).

Ramanathan states some problems due to inadequate skills

Inability of the transferee to attract the required skills due to financial and industrial restrictions:

- lack of experience of the transferee's workforce and absence of required skills at the industry level;
- lack of training of transferee personnel;
- absence of incentive systems at the transferee firm for learning and assimilating new technologies;
- language barriers that inhibit effective communication between transferor and transferee personnel.

(for more details, see Ramanathan, 2008). It is possible to state that these features are also typical to Lithuanian business companies also facing the challenges of the labor market.

Role of the venture capital and financial innovations

At some point, cumulative impact due to uncertainty drive the discounting of the value of an immature technology down, and the low monetary values make it hard to find investors or licensees (for more details, see Escoffer et al.).

Investors managing venture capital are not inclined to invest in their little-known trends that are normally characterized by a strong dependence on the fundamental research, creation of technologies to them becoming commercially attractive innovations. Essentially, their goals are different, corresponded with the desire to invest in the fast-growing new businesses. The main problem of development of innovation based on technologies using risk capital is that the risk capitalists usually require a sudden and huge growth of the value of their (risky) investments. In addition, this requires lots of time and efforts to prove the potential of technology proposed. It distracts researchers from the main job, and on the other hand, scientific principles cannot be completely clear for entrepreneurs and potential investors. As a result, the future of innovation development can stop that from a risk perspective entrepreneurs are heavily dependent on researchers that sometimes lack entrepreneurial spirit. In the case of implemented "bottom-up" type research projects entrepreneurs and researchers are faced with great uncertainty: they are faced with great uncertainty caused by the potential demand; on the other hand, there is a risk that another more advanced technology and innovation will be created soon.

In the period of 2010-2012, Lithuanian technological innovative companies cooperated with a wide range of partners. The main fraction of technological innovators (more than 30 percent) collaborated with hardware vendors; i.e. bought from suppliers the technological solution. This shows that the Lithuanian economy necessities huge technological modernization, purchases or adaptation designed equipment from abroad. It is also a big fraction of innovators (more than 20 percent) coo-

perated with other businesses and universities. The lowest fraction of the technological innovators (11 percent) cooperated with public research institutions, i.e. almost 90 percent technological innovators in public research bodies were not relevant. On the one hand, this may be related to the fact that resources and activity of research institutes of resources are more focused on research than experimental development. On the other hand, it could be lead be the nature of demand of new solutions. Technology application possibilities in Lithuania are considered much more relevant than unique solutions based on research and knowledge. It depends on the business strategies and the competitive nature of innovation (for more details, see Mosta, 2014).

Research policy and support of investments

Following the recent statistical data, investment to Lithuanian R&D sector grew slightly in 2014 and amounted to 1.01% (see Figure 1) of GDP when EU average is more than 2% (data in 2013).

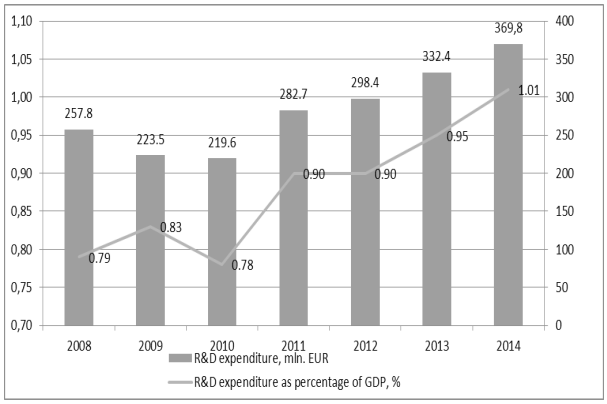

Figure 1. Dynamics of R&D expenditure (GERD) in Lithuania (Source: Statistics of Lithuania).

The EU has set itself the target that investment in this sector would be at least 3% of GDP in 2020 as Lithuania has set to reach only 1.9%. However it can state that it is virtually impossible to achieve this goal. Unlike as in EU, in Lithuania the majority of the investment in R&D sector is composed of public finances - about 33.3%, and the business sector - 26.1%. Most of the EU investment in this sector is composed of business funds - 54.9%, and only one-third of the investment comes from public money - 33.4% (for more details, see Mosta, 2014). Following the recent data of Eurostat on the share of high-tech exports in gross exports, the share of high-tech remains small and strong preconditions for change of this situation in the future are essentially are not developed (see Table 1). The main causes for that is the lack of funds for research and education sector and therefore decreasing and questionable quality of the study and research.

Lithuania can be characterized by relatively low business costs for R&D (see Figure 2).

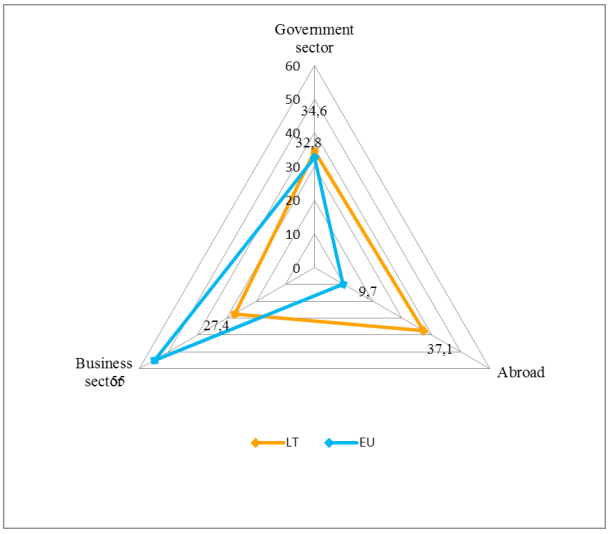

Figure 2. The structure of R&D expenditure (GERD) in Lithuania and in European Union, 2013 (Source: Eurostat, Statistics of Lithuania).

In 2014, Lithuania took only 24th place of the 28 EU countries in innovation and economic growth (for more details, see Innovation Union Scoreboard 2015). On the other hand, Lithuania formally looks like one of the EU countries that demonstrated one of the biggest growths of investments in the improvement of research infrastructure in recent years. Although the population formally looks skilled and well-educated and can contribute to the development of a knowledge-based economy is relevant in Lithuania the quality of studies of low-level universities, at best, looks only as very average due to the masked fundamental problems of higher education which has become systematic and chronic. This is one of the main reasons for which, according to innovations in business and their impact on economic growth Lithuania find themselves in the final EU Innovation Scoreboard positions.

Planning and strategy documents are in line with the lack of coordination and piecemeal approach to technology transfer, which leads to the moderate and limited Lithuanian innovation capacity and it is consistent with the main indicators still lagged in comparison with the respective EU level. Following Kraujelytė and Petrauskas, 2007, technology transfer in the field of innovation policy and support policy development in view of the principles developed is one of the possible ways to strengthen the effectiveness of innovative activities in Lithuania (for more details, see, for example, Kraujelytė, Petrauskas, 2007).

Systematic attention to the transfer of technology to promote the formation of a dedicated separate area must be given in Lithuanian innovation policy. The main principles of technology transfer policy are focused on informal social ties between the academic and business communities, strengthening of entrepreneurship promotion in EU research

space, the priority R&D areas of provision, targeted support for innovative projects, quality and quantity of the confrontation of the allocation of state support, financial and tax incentives business and effective application of the EU Structural Funds.

Purposefully technology transfer-oriented measures and policies must provide not only the effective transfer of technology, but also create the preconditions to achieve the end result, that is growth of innovative level. Lithuanian innovation policy lacks targeted and efficient measures to promote technology transfer, e.g. the lack of top-down approach of research and research financing from the Government of Lithuania. The Government can be one of the relevant financial investor to R&D. However demand-based competitive research funding practice is only beginning in Lithuania.

There is also the mismatch of core concepts in Lithuanian legal acts defining the research, technology and innovation development. The term "R&D stage" could be changed by the term "technology readiness level" which is much more in line with the R&D process, content and interfaces of applied research with basic research and technology to adjust the levels of detail defining concepts. This leads to the need for more complicated than usual imaginary transfers of technology innovation in the development process, which cannot be defined as a finite and irreversible sequence of stages, as at each stage of the innovation creation may arise the need of fundamental research and technological issues, whose decisions are inevitable and inseparable from innovation. In addition, some authors define five basic stages of the technology commercialization process that is not necessarily linear, as industry-science links can exist from the start and science firm interactions may arise at any stage, from conception through development (for more details, see Zuniga, Corea, 2012):

- STEP 1: Researchers generate discoveries of high quality.
- STEP 2: Discoveries are disclosed by researchers.
- STEP 3: Discoveries are further developed.
- STEP 4: Proof of concepts and prototype are 'sold' or transferred to spinoff companies.
- STEP 5: Product development and marketing.

In addition, it continues to impede the investigations, contributing to a technology and innovation in agriculture, medicine.

Recent statistics revealed that overall R&D expenditure, i.e. Gross Expenditure on Research and Development (GERD) grew rapidly in EU. This expenditure grew even faster than their gross domestic product (GDP) and economic growth in the long-term and low-growth years. Lithuanian expenditures on R&D look lower than the EU average (see Table 1) the past decade.

Table 1. Research and development expenditure in EU, % of GDP. Source: Eurostat.

Country\years	2009	2010	2011	2012	2013
EU (28 countries)	1,94	1,93	1,97	2,01	2,01
Euro area (19 countries)	1,99	1,99	2,04	2,09	2,09
Belgium	1,97	2,05	2,15	2,24	2,28
Bulgaria	0,51	0,59	0,55	0,62	0,65
Czech Republic	1,30	1,34	1,56	1,79	1,91
Denmark	3,07	2,94	2,97	3,02	3,06
Germany	2,73	2,72	2,80	2,88	2,85
Estonia	1,40	1,58	2,34	2,16	1,74
Ireland	1,63	1,62	1,53	1,58	
Greece	0,63	0,60	0,67	0,69	0,80
Spain	1,35	1,35	1,32	1,27	1,24
France	2,21	2,18	2,19	2,23	2,23
Croatia	0,84	0,74	0,75	0,75	0,81
Italy	1,22	1,22	1,21	1,27	1,26
Cyprus	0,45	0,45	0,46	0,43	0,48
Latvia	0,45	0,60	0,70	0,66	0,60
Lithuania	0,83	0,78	0,90	0,90	0,95
Luxembourg	1,72	1,50	1,41	1,16	1,16
Hungary	1,14	1,15	1,20	1,27	1,41
Malta	0,52	0,64	0,70	0,86	0,85
Netherlands	1,69	1,72	1,89	1,97	1,98
Austria	2,61	2,74	2,68	2,81	2,81
Poland	0,67	0,72	0,75	0,89	0,87
Portugal	1,58	1,53	1,46	1,37	1,36
Romania	0,46	0,45	0,49	0,48	0,39
Slovenia	1,82	2,06	2,43	2,58	2,59
Slovakia	0,47	0,62	0,67	0,81	0,83
Finland	3,75	3,73	3,64	3,42	3,31
Sweden	3,42	3,22	3,22	3,28	3,30
United Kingdom	1,75	1,69	1,69	1,63	1,63

This shows that both the government and businesses recognize the importance of R&D co-state and economic development (for more details, see Kraujelytė and Petrauskas, 2007). On the other hand, education of entrepreneurship of start-ups is becoming to be more systematic. Despite this fact it looks as the fashion cry and still do not generate a clear results.

Fragmented institutional structure and unclear institutional roles

The external reviewers remarked the fragmentation of the public science system. In addition, the number of universities and non-university institutes is regarded very high, indeed too high. This leads to a lack of critical mass, and a lack of visibility in

international scale. In addition, the division of activity between various institutions is not clear, especially as regards the role towards industry and the division between application oriented and fundamental research. On the other hand, the role of the nonuniversity institutes is unclear. Notwithstanding high quality of individual institutes, their overall role, profile, responsiveness to societal an economical needs and especially their interaction within the public science system needs clarification. The external reviewers remarked that many universities have quite inward-focused governance structures, and the overall interaction and cooperation between science, education and innovation industry is low (for more details, see OMC Policy Mix Review Report, 2007). Unfortunately, after 8 years including the period of financial crisis and some reforms in Research and Educational system in Lithuania the situation is completely unchanged.

Results and discussions

The poor financing of higher education and research sector is essential but not the only reason of the slow innovation creation in Lithuania and not very high competitiveness of this country. The problems related to transfer of technologies arise due to incomplete and not fully compatible regulation system and relatively slow demand from the business side. In addition, without the clear reforms of higher education sector concerning the quality of studies and research, there are not very clear recipes what to do substantially in the business and industry sectors. In addition, the situation is complicated by the willingness of Lithuanian business entities to compete in foreign market essentially by the lower labor costs. Lithuanian Government using EU financial support applies well-known means of promoting research transfer and creation of innovations: valleys, incubators, etc., but usually it means the growing regulation and bureaucracy for researchers and investors, decomposition and non-concentration of resources. This causes the weak potential of research institutions to compete in international research market. Also, it does not solve the problem of closeness of research institutions in Lithuania.

On the other hand, the high uncertainty related to research and creation of new technologies is the main causes of risk avoidance from the business side. Except some examples collaboration between Lithuanian research institutions and business entities it is not systematic and based on long-term relationship.

The system of public institution that coordinates and supports the creation of innovations is not fully transparent, some their functions are overlapping, and, in addition, some misunderstandings and different visions on the promoting the innovation development appear.

Conclusions

1. Despite the EU financial support the opportunities for technology based innovations are not very favorable and results are poor yet. In addition, despite the relatively poor financing there is an essential problem that causes the smooth growth of creation of technologies, innovations and knowledge economy. The main cause that creates slow development of innovations and knowledge economy is the structure of R&D sector of Lithuania: the human capital, the institutional resources and the projects implemented by governmental bodies executing the competitive funding of the research are decomposed. and the low level of higher education. On the other hand, Lithuanian business companies are focused rather on the low costs than on the creation of innovations and strengthening of competitiveness. Also, the uncertainty and the complexity of innovation creation and technology transfer repel some companies from collaboration.
2. Despite the slow but positive trends of research and innovations development, the necessary solutions as the reforms of structure of higher education and research system are long-term and strongly dependent on the political will.

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INVESTICIJŲ Į TECHNOLOGIJOMIS GRĮSTAS INOVACIJAS IR MTEP SKATINIMAS LIETUVOJE: PROBLEMŲ APŽVALGA

Santrauka

Technologijų perdavimas verslo subjektams, kuriantiems inovacijas, yra sudėtingas procesas, kuriame susiduria skirtingi verslo ir tyrimų institucijų interesai. Kita vertus, statistiniai duomenys patvirtina vis dar mažesnį nei vidutinį Europos Sąjungoje Lietuvos MTEP veiklos finansavimą ir iš esmės dėl to lėtą inovacijų diegimą ekonomikoje. Straipsnyje atskleidžiama, kad technologijų perdavimui tolesniam inovacijų kūrimui būdinga didžiulė rizika, neapibrėžtumas, pernelyg skirtingos potencialių partnerių vizijos ir informacijos asimetrija. Kita vertus, iš esmės tai lemia ir gana tyrimų institucijų uždarumas, gana konservatyvus verslo sektoriaus įmonių požiūris į inovacijas, vengimas rizikos, susijusios su inovacijomis, taip pat kai kurių ūkio subjektų polinkis naudotis ES finansine parama kaip tikslu, o ne kaip priemone vystyti inovacijas, nesuderinta vyriausybinių institucijų veikla ir ilgokai nereformuojama aukštojo mokslo ir tyrimų sistema Lietuvoje, vis dar nepakankamai reaguojanti į ekonominius pokyčius.
Raktiniai žodžiai: technologijų perdavimas, inovacijų kūrimas, tyrimai ir eksperimentinė plėtra.