The innovation and economic growth: the situation in Baltic States?

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Abstract
A number of recent investigations on innovations and economic growth have been performed in Mykolas Romeris University in Lithuania. They are investigating a large scope of innovative activities from the gross domestic expenditure on R&D and learning capacities up to the final innovative production in Baltic countries and especially in Lithuania, including the original theoretical approach and model. The present paper is a first introductory in series "The innovations and economic growth" and surveys the empirical evidence on the link between innovation and economic growth. It considers a number of different measures of innovation, such as R&D spending. The dynamic structure of high-tech commodities export has been analysed and presented to make the comparisons of Baltic States. The econometric models on Lithuania have been applied and linear regressive relation between the R&D spending and innovative export has been discussed. The main conclusions and suggestions for practice are presented.

Keywords: innovations, economic growth, knowledge spillovers, gross expenditure on R&D, export structure.

1. Introduction

The knowledge-based economy has become an important concept of modern economic thought. The pervasive features of knowledge are now evident everywhere in the economy, in terms of new jobs, new products, new industries and new trading links created. Over the last 20 years or so, researchers have systematically theorised, empirically explored and developed further the idea of the knowledge based economy, marking the advent of a new intellectual shift that places knowledge at the centre of economic analysis (Harris, 2001). On these grounds the knowledge in overall and the innovation or new technologies especially have been seen as the major sources of economic growth and development. However, a little progress has been done so far in measuring and assessing the factors of knowledge-based economy and the degree of economic dynamism that it brings forward, i.e. the **rational to investigate** is clear.

The economic growth can basically be attributed to the following fundamental forces: an increase in factors of production, improvements in the efficiency of allocation across economic activities, knowledge and the rate of innovation. Given the full employment and efficient allocation, a growth is thus driven by the knowledge accumulation and innovation. The process of innovation is typically modelled as a function of the incentive structure, i.e. institutions, assumed access to the existing knowledge, and a more systemic part.

An innovation also implies that the stock of economically useful knowledge increases. In other words, innovation is one vehicle that diffuses and upgrades an already existing knowledge, thereby serving as a conduit for realizing the knowledge spillovers. The process of innovation is consequently considered to be one of the most critical issues in comprehending the economic growth. One of the important lessons of the past two decades has been the pivotal role of innovation in the economic development (EU Comm., 2013), so, the **practical importance** of present research is clear and evident.

The present paper is the first and introductory in series "*The innovations and economic growth*" that examines a large scope of innovative activities from the gross domestic expenditure on R&D and learning capacities up to the final innovative production in Lithuania, including the original theoretical approach and model. It refers certainly to the **innovation of present research effort** and the first paper in series too. The present paper delineates the introductory part of research, the dynamics of spending on R&D and innovative production in Baltic States inclusive.

The objective of present research is to provide the statistical data on the structures of gross domestic expenditures on the Research and Development (R&D) and export in Baltic countries, and a statistical model of that expenditure influence upon the export of high-tech commodities in Lithuania.

The paper is structured as follows: the second section describes the relationship between innovation and economic growth, the roles of knowledge spillovers. The third section provides the structure of R&D spending in Baltic States, the fourth section – the structure of export in Baltic States, the fifth section – the statistical model of innovative production, the sixth section concludes with a discussion and suggestions for practice.

2. Innovation and economic growth

The relationship between innovation and economic growth has been well studied. However, that is not to say that it is well understood. The scholars continue to work with incredibly simplified models of an incredibly complex economy. Consequently, the empirical results are usually carefully annotated with the caveats noting the limitations of all findings and the great uncertainties that remain concerning fundamental assumptions in the field (Stat. Canada, 2002).

A theoretical link between innovation and economic growth has been contemplated since at least as early as Adam Smith. Not only did he articulate the productivity gains from specialization through the division of labour as well as from technological improvements to capital equipment and processes, he even recognized an early version of technology transfer from suppliers to users and the role of a distinct R&D function operating in the economy.

Although the relationship between innovation and growth had been articulated at an intuitive level for some time, the innovation was not introduced into formal economic growth models until 1957 (Solow, 1957). Like scholars before him, R. Solow defined growth as the increase in GDP per hour of labour per unit time. He carefully measured the fraction of this growth that was actually attributable to increases in capital, such as investments in machinery and related equipment, since the theory of the day was that capital accumulation was the primary determinant of growth. However, a capital accumulation accounted for less than a quarter of the measured growth. The Solow's insight was in attributing the remainder of the growth, the majority share, to the "*technical change.*" The magnitude of residual calculated in this empirical study placed the role of innovation in economic growth squarely on centre stage, where it has remained for the past half century. The

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A distinction between the economic growth and economic development should be noticed too. The former designates the increases in population within a specific area, or the increases in quantity or the value of the goods and services, and does not necessarily lead to qualitative improvements in life, the way of development does (Macys, 1999). The technological capability is closely related to capability in R&D. The economic change, including the technological change, is an evolutionary process. Much of technological change is cumulative within the firms, and within the regions and nations. The analysis explains some reasons behind this phenomenon. It then focuses on the internal organization of R&D within the firms. The issues of strategy, organization and external relationships are the means of competing in a setting of rapid technological and political change. The R&D is necessary for competitiveness, but not enough; the conventional strategies are changing to encompass the people - their contacts and skills - as another vital basis for success of firms in new technologies and in alliances and other co-operations.

Since Solow's contributions, the relationship between innovation and economic growth has been modelled in increasingly sophisticated ways. Perhaps, the most notable recent advances came from Lucas (1988) and Romer (1986, 1990), who emphasized the concepts of human capital and knowledge spillovers, respectively. Following the recent idea of distinguishing the human capital, which is developed by investments in education and training, from a physical capital, Lucas modelled the human capital with the constant rather than diminishing the returns, thus offering the useful insights into the critical role of a highly skilled workforce for a long-term growth. Romer androgenised the innovation in the growth model by introducing knowledge spillovers, which resulted in deep implications for how the scholars think about a growth. The firms engage in a R&D because they expect it will be profitable, i.e. the business companies allocate the funds to the R&D as long as the expected payoff (a return on investment) from R&D at the margin is higher than for any other allocation of those resources. These investments in R&D result in the creation of two types of knowledge, that which is appropriable and that which is not. An appropriable knowledge refers to knowledge the firm can utilize itself, exclude others from using, and generate profits from. The knowledge that is not appropriable has the properties of public good; it is not hostile: the use by one firm does not preclude use by another, and non-excludable, because it is difficult to prevent others from using it. More the knowledge is there, the more productive the R&D efforts using the human capital are. So, when the firms conduct a R&D, they apply a human capital to the stock of knowledge for the profit-maximizing purposes. In the process, however, the firm unintentionally contributes back to the increasing stock of knowledge. This unintentional contribution is referred to as a knowledge spillover.

This explains why the concept of knowledge spillovers is central to the thinking about the innovation and growth. If the knowledge spillovers are a public good, why does it matter which country produces them? In fact, might it not be optimal for a particular country to "free ride" on the efforts of other nations? At the same time, the concept of knowledge spillovers as a public good may seem inconsistent with the evidence, given the variety of growth rates across the open economies. Why haven't all countries converged towards equal prosperity if knowledge spillovers are freely available? There may be many path dependency reasons for this, i.e. the differences in initial conditions and the innovative capacities have to build early in the development process in order to possess the learning capacities that will allow to "catch-up" the high-tech world technologies to happen (EU Comm., 2011).

There are two major sets of influences on the innovativeness and competitiveness of places: a) the technical skills and information are the key-factors in the process of technological change and competition; and b) the urban areas contain a complex synergy of factors that the smaller, more remote places cannot attain. The producer services, which are strongly based on knowledge and symbolic analysis, are therefore typically clustered in cities. The small firms and entrepreneurship are examined as a crucial part of a well-functioning regional economy. The close relationship between entrepreneurship and regional or local development is crucial. The innovativeness developed within the local inter-firm networks both supports the existing firms and presents the opportunities for starting the new businesses in order to serve the newly identified markets. The networks of firms complement and sometimes substitute for a firm's own technological capability. The networks of large firms and the globalization of economic activity should be then considered. The ladder network effects begin to play in these knowledge networks (Macys, 2011). On the other side, those knowledge spillovers are taking a practical shape of technological parks or science valleys in Baltic countries. The formers are acting as the accommodations for business start-ups. The science valleys are usually the places where the R&D unities, business entities and support institutions are working in conjunction. These institutions are funded by the EU support programmes and national budget means. Unfortunately, they are sluggish in Lithuania during the last years, and the huge funds of untapped EU support means should be refunded according the information of Lithuanian Government.

The innovations are not alike. The difference between incremental and radical innovations as well as discoveries is brought (Olsson, 2005). The radical innovations comprise entirely the new products, often undertaken by new entrants with a diversified knowledge base, for example. The minor improvements in existing products and processes constitute the incremental innovations, often undertaken by incumbent firms with a specific knowledge base. Furthermore, the concept of technological opportunity which works as an upper limit for further incremental innovations is introduced too. As opposed to models where innovations are homogenous (Jones, 1995), the technological opportunity is here a necessary input to R&D. The new incremental innovations increase the level of total factor productivity, but at the same time depletes technological opportunity. The radical innovations, on the other hand, provide no direct increases to productivity; they serve to renew the technological opportunity. In a sense, thus, a technological opportunity is modelled like a renewable resource here. Indeed, a key driver of this growth has definitely been an innovation. The creation, dissemination and application of knowledge have become a major engine of economic expansion. The corporations have come to rely more and more on this precious tool. It is a practice that has moved from the periphery of many corporate agendas right to the centre of their strategies for growth and leadership. Most sectors and industries are currently experiencing what is called a *"Schumpeterian renaissance"*: an innovation is today a crucial source of effective competition, of economic development and transformation of society (Torun, Cicekci 2007).

The modern economies are built with the ideas, as much as with the capital and labour. It is estimated that nearly half the US' GDP, for example, is based on intellectual property. The EU has set the "*Barcelona target*" of increasing R&D to 3% of GDP by 2010 to become "*the most competitive and dynamic knowledge-based economy in the world*". Look at China: according to OECD estimations, in 2006 for the first time China spent more on R&D than Japan, becoming the world's second largest investor in R&D after the US (EU Comm., 2011).

The globalisation itself is a product of innovation. The application of constantly improved technologies to the massive means of transport and communication has produced an unprecedented level of global connectivity and global awareness. The economies are becoming more interdependent, while the cultures are

becoming more permeable, transparent and stronger through the intensified exchange of goods, services, ideas, values, experts, problems and solutions.

Summing up, an innovation is facing new challenges today. Its own dynamism has produced a world that requires in many ways a rethinking of innovation itself. In the corporate sector, the determinants of innovation performance have changed in a globalised knowledge-based economy, partly as a result of recent developments in information and communication technologies. The strategies like the market capitalisation, mergers and acquisitions and a just-in-time delivery, have to be revised in the light of the Internet, online shopping and digital TV. The companies are hungry for new ideas about new ideas.

3. Innovative activities in Baltic States

The main aggregate index used for international comparisons is a gross domestic expenditure on R&D. This consists of total expenditure (current and capital) on R&D by all resident companies, research institutes, universities and government laboratories, etc. It excludes the R&D expenditures financed by the domestic firms but performed abroad.

The R&D is a key indicator of government and private sector efforts to obtain the competitive advantage in science and technology. In 2004, the R&D amounted to 2.3% of GDP for the OECD as a whole. The R&D comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including the knowledge of man, the culture and society, and the use of this stock of knowledge to devise new applications. The R&D is a term covering three activities: the basic research, applied research, and experimental development.

The basic research is the experimental or theoretical work undertaken primarily to acquire a new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. The applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. The experimental development is a systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to produce new materials, products or devices, to install new processes, systems and services, or to improve substantially those already produced or installed.

A real sustainable economic growth can be achieved only under large promotion of development of innovations in a country, according the Lithuanian national strategies. It has become especially clear during the last crisis 2009, when a drastic decline of internal consumption has been noticed and a rate of national export fell more than 26.6% due to the reduced incomes of population and fast growing unemployment in 2009 (Macys, 2012). The deteriorative expectations consumers have worsened furthermore the internal consumption in Lithuania and the business community has pursued the large structural reforms applying the new technologies and innovations and reducing the costs of production as well. The Government of Lithuania has expanded the gross domestic expenditure on R&D up to 1.9% under efforts to follow-trough the objectives of EU Strategy 2020.

Fig. 1. The gross expenditures on R&D in the Estonia, Latvia, Lithuania, and EU27 as a percentage of national and European GDP, 2004-2011.

The expenditures on R&D were growing the entire period after joining the EU in 2004 at all three Baltic countries though at the different paces. The rate of expenditure has been growing up to 0.08% yearly in

Lithuania and has achieved 0.92% in 2011, although a lag from EU27 corresponding average rate has achieved 2.2 times. The returns on R&D have been mainly assigned to the R&D in Lithuanian universities. On the other side, the rate of expenditures on Lithuanian R&D is behind the Estonian corresponding rate of expenditures too. A corresponding lag has been noticeable growing and the Estonian rate has been 2.59 times higher than a Lithuanian in 2011 (Jonusas, 2012).

Fig. 2. The structure of gross expenditure on R&D in Lithuania, 2004-2011.

The universities and other public R&D institutions are spending almost a half of returns on R&D in Lithuania, and less than a third - from the private sector. On the other side, the business expenditures on R&D have expanded 2.5 times during the 2004-2011 period. The business sector budgeting for R&D is following the economic growth in Lithuania. The increase of that index has achieved 66.3% in 2006 during the time of economic boost - 7.6% of annual GDP growth, and fell more than 14% in 2009 at the beginning of crisis. The present index has begun to rise in 2011 after the crisis (Macys, 2012). The business corporations are as usually preoccupied on competitive position in local and global markets, and invest in R&D during the time of economic upturn. They are usually preoccupied to survive by the contrary at time of crisis, and suspend naturally the R&D budgeting.

On other side, the contributions of universities and business sectors to the R&D development are growing in Lithuania and Latvia but they are still noticeable behind the corresponding EU27 average rate: the EU27 business sector is budgeting 63.3% for R&D, the universities and other tertiary education institutions - 23.5%, the public sector - 13.2% (Eurostat, 2013).

Summing up, the gross domestic expenditures on Lithuanian R&D are still noticeable behind the corresponding level of EU27 expenditures. The Estonian gross domestic expenditures have given a noticeable jump and exceeded the corresponding level of EU27 in 2011. The Lithuanian public sector contributes the biggest part of expenditures on R&D in country. They are not addressed to the common needs of State or Industry but usually are fulfilling the narrow specific exigencies of industries or corporations, i.e. a largest majority of innovations is falling under the incremental innovation label in Lithuania.

4. The structure of export

The low and medium levels of technologies prevail in the structure of Lithuanian exports. The levels range marginally at the rates 35.4% and 34.8% of national export correspondingly. On the other side, the low-tech export is obviously shrinking, and the medium-and high-tech export sectors are gradually rising. The accession into EU and the abolition of all free trade barriers has compelled the industry of Lithuania to search for the new competitive positions in the European Single Market, i.e. to create and implant the high-tech technologies. The epoch-making turning point was reached in Lithuania at the end of 2012 when the volume of national export has exceeded the volume of national import at first time after the Independence Day – the March 11, 1990.

Fig. 3. The structure of Lithuanian national export in 2004-2011.

The high-tech technologies sector of Lithuanian export encompasses usually the products of pharmacy, organic chemistry, optics, medicine, surgical instruments, and it was noticeable grown at 25.6% annually, i.e. 4.2 times more during 2004-2011 period. The low-tech export sector has grown correspondingly only

14.4% annually.
Fig. 4. The structure of Latvian national export in 2004-2011.

It is clear that the low-tech export industry prevails in Latvia though the reduction of sector is noticeable too. The accession of Latvia into EU compelled the industry to change very fast into a modern competitive production. The high-tech national export has grown 9.7% in 2011.

Fig. 5. The structure of Estonian national export in 2004-2011.

By contrary, the high-tech export prevails in Estonian national export, and encompasses the electric appliances, machine components or air appliances. The high value added commodities for international mechanical engineering compose the biggest part of Estonian national export (Circa, 2012). A considerable part of export encompasses the conventional production.

Summing up, a high-tech industry composes the largest 5.2% part of Latvian national export in 2011, comparing with other Baltic countries. The high value added production composes largest 38.7% part of Estonian national export. The highest 25.6% grow of high-tech export was noticed in Lithuania.

5. The statistical model of innovative production

As stated above, the relationship between the gross domestic expenditures on R&D and the export volume does exist and it is interesting to apply a simple econometric model to delineate this relationship.

Fig. 6. An export of high-tech commodities versus the gross domestic expenditures on R&D in Lithuania, 2011.

The linear regression curve remarkably well describes the relationship between the export of high-tech commodities and the gross domestic expenditures on R&D in Lithuania and a goodness-of-fit is noticeably high (R=0.90). The high rank of this correlation is not a new phenomenon. It was also identified by the other researchers (Keiko, Lechevalier 2010, Roberts et al. 2005, Torun, Cicekci 2007).
The linear growth regression describes appropriately the growths of national GDP per person versus export of high-tech commodities (R=0.76). It means that a proportion of high-tech commodities is clearly high in volume of national export and is fast growing after the crisis.

Fig. 7. The annual growth of national GDP per person versus the annual growth of export of high-tech commodities in Lithuania, 2011.

The difference between the innovation-based growth and investment-based growth should be noticed. The investment-based growth, i.e. the growth based on the capital accumulation, catch-up and imitation, is possible under a variety of traditional economic measures. In fact, the ability of some politically weak Governments to coordinate the economic activity and channel the resources to the well-established local firms might even be a temporary advantage for an investment-based growth, as it was seen during the last decade in Lithuania. The investment-based growth has the limits, however, unless a society transitions to the innovation-based growth and starts making the advances in frontier technologies, it will exhaust its own economic potential. It can be seen under a close range at the dynamics of export structure in Lithuania during the past decade.

Yet innovation-based growth, i.e. the growth based on technological change and creative destruction, is all but impossible unless a society allows new talent to replace the old, new firms to uproot established ones and the process of creative destruction run its course. The creative destruction, by its nature, creates the losers as well as winners, and many of these losers are the established firms. This perspective therefore suggests that the investments in traditional industry would ultimately be a serious impediment to economic growth, because they will prevent a transition from investment-based growth to innovation-based growth. Summing up, the presented difference between the investment and innovation based economic growth clarify the persuasively different economic growths in Estonia and Lithuania. The analysis of that difference will be presented in the next paper of series "*The innovations and economic growth*".

6. Conclusions

The innovation can originate anywhere. The increased education and economic growth have improved the capacity of developing countries to offer the new products and services. The modern communications and transportation technologies allow these countries to share the advances with consumer across the globe. As a result, the great ideas - regardless of where they originate - are less likely to be lost in our increasingly interconnected world.

The innovation is greatly important at all stages of development. The creation and diffusion of technologies matter for economic growth across all economies. However, it is also true that different types of innovation play different roles at various stages (OECD, 2012). In earlier stages, incremental innovation is often associated with the adoption of foreign technology, and a social innovation can improve the effectiveness of business or public services. The high-technology R&D based innovation matters greatly at the later stages of development, when there are both factors of competitiveness and of learning that allow for completing the "*catch-up*" processes. The latter innovation type can be denoted in Estonia.

The analysis of Lithuanian export clearly denotes the structure of developing country, since the commodities of low-and medium technologies prevail in national export structure. The gross domestic expenditures on Lithuanian R&D are still noticeable behind the corresponding level of EU27 expenditures and attain the 0.92% of national GDP in 2011. It is still behind even the corresponding level of Estonia at 2.59 times. On the other side, it is not a coincidence that the countries such as USA, Japan or even China are the world's top economies because their allocations of resources into creating innovation are massive. It indicates that innovation is a key driving the growth and prosperity. The economists calculate that approximately the 50% of US annual GDP growth is attributed to increases in innovation. For the past two centuries, the US has been the world-leader in developing innovative products and services.

The public sector contributes the biggest part of expenditures on R&D in Lithuania and averages 63.3% in 2011 though the main source of R&D finances in other EU countries is the private sector. They are not addressed to the common needs of State or Industry sector but usually are fulfilling the narrow specific exigencies of industries or corporations. The same structure can be featured in service export sector in Lithuania where the knowledge based services comprise the 17.7% of service export, the high-tech knowledge based – 3.4%. The high-tech commodities part in total export average reach 40-65% in EU countries and the private budgeting sector prevails in R&D expenditures. The practical implication of these findings is that in order to improve performance, they must avoid narrowly focusing on R&D, but must invest also in capabilities to commercialize technologies resulting from R&D.

An econometric model was applied on the Lithuanian export and R&D finances. A simple linear regressive

curve delineates especially well the high-tech commodities export dependence from the R&D finances in Lithuania (R=0.9).

An answer to the initial question of research can be answered now which was: the innovation - is the engine for the economic growth? The conclusion that the innovation makes a great contribution in the economic growth and development of country economy can be stated on the ground of initial analysis. This right was proved also the by developing some more complicated econometric models applied on Lithuania (see next paper of series).

The following suggestions for practice can be proposed to discuss:

a) To raise more the R&D finances from private sector. It would raise the efficiency of R&D overall and especially the high-tech part of total export.

b) To encourage the cooperation between public and private sectors, i.e. to promote the development of knowledge spillovers. Three science valleys and a number of technological parks are acting now in Lithuania. Despite the large finances from national budget and EU support means, their achievements are still unimpressive. The largest famous Lithuanian pharmaceutical or IT engineering inventions have been still elaborated abroad. On the other side, the next generation of technology-based economic development strategies will need to address a dramatically different world from the one in which research parks and incubators were born and thrived. Unfortunately, the presence of Lithuanian R&D entities in the Global research networks is still in embryonic stage.

c) To elaborate the rigorous national R&D strategies and raise the R&D finances up substantially to 3% of national GDP in Lithuania. Some progress can be noticed now but at a very slow pace. The politically week Governments are changing during this decade though the economic and social situation does not varies in Lithuania. The new strategies and policies for the innovation, entrepreneurship, and the functioning of knowledge economy, and the flexibilities in order to respond to the quickly changing conditions in the world economy, in specific product markets, and in technologies are urgently required in Lithuania.

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Tables

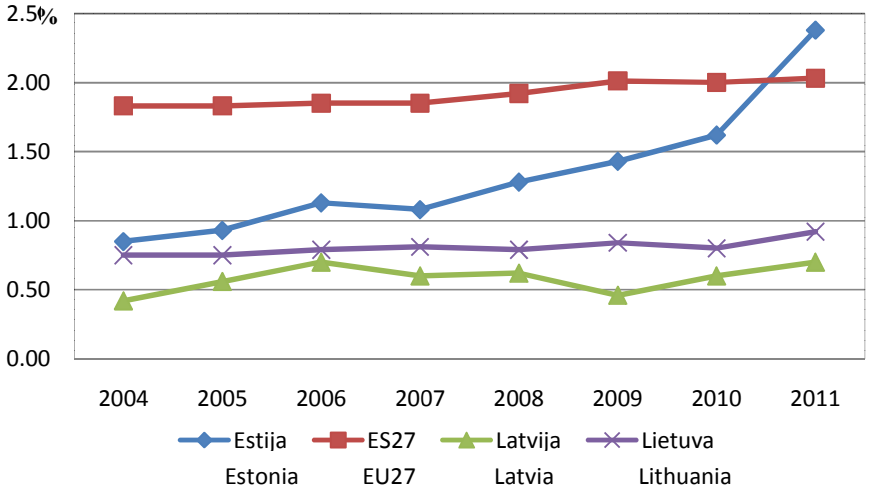

Fig. 1. The gross expenditures on R&D in the Estonia, Latvia, Lithuania, and EU27 as a percentage of national and European GDP, 2004-2011.
Source: Eurostat data.

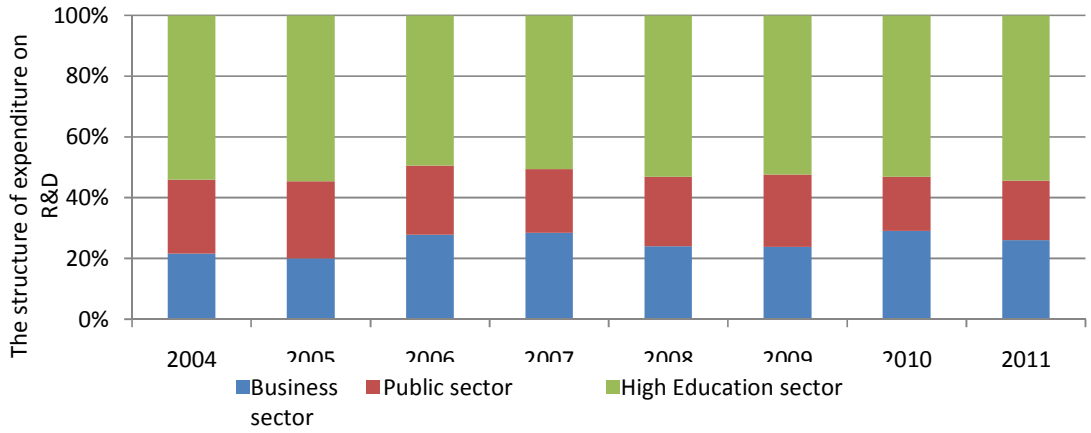

Fig. 2. The structure of gross expenditure on R&D in Lithuania, 2004-2011.
Source: LitNDS data.

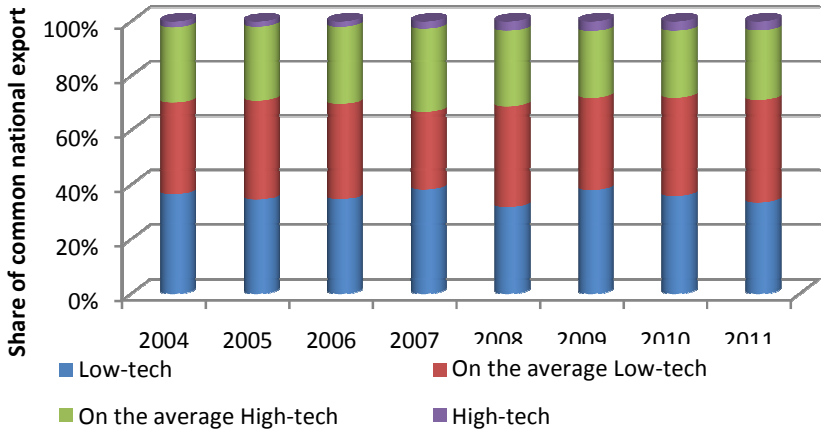

Fig. 3. The structure of Lithuanian national export in 2004-2011.
Source: LitNDS data.

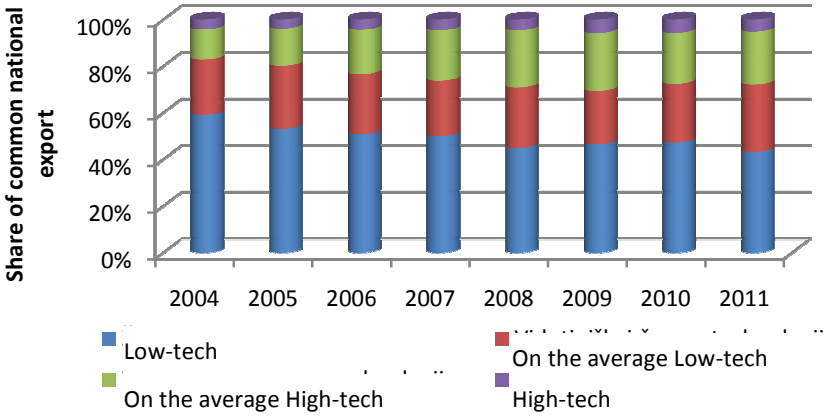

Fig. 4. The structure of Latvian national export in 2004-2011.
Source: LatNDS data.

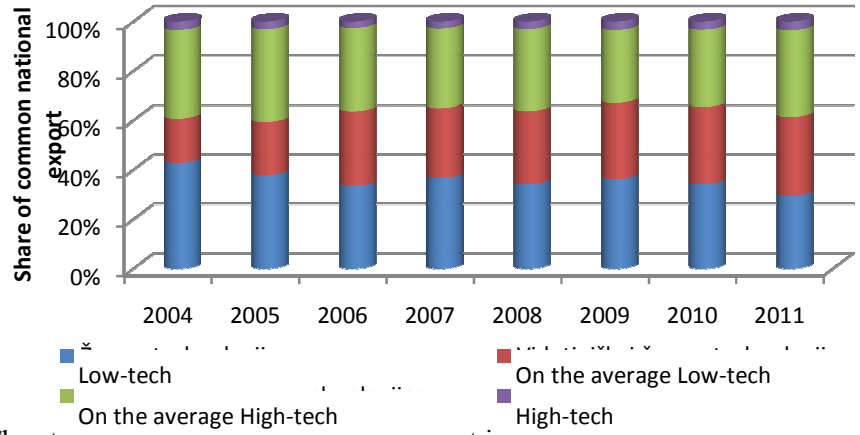

Fig. 5. The structure of Estonian national export in 2004-2011.
Source: EstNDS data.

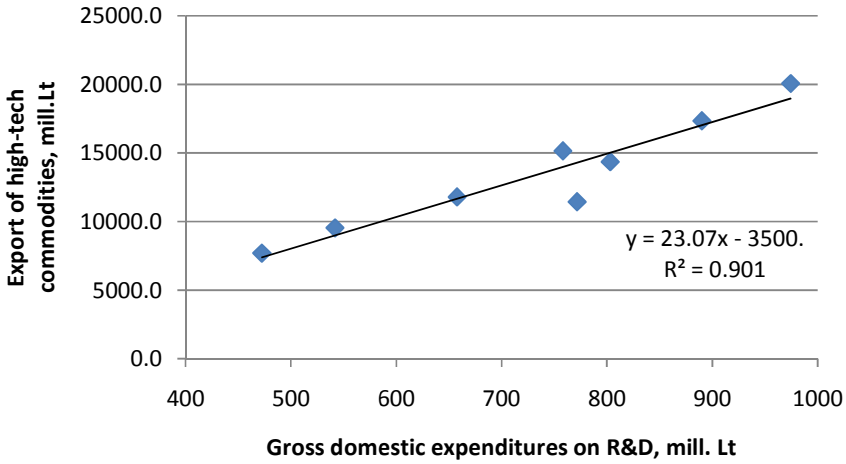

Fig. 6. An export of high-tech commodities versus the gross domestic expenditures on R&D in Lithuania, 2011.
Source. LitNDS.

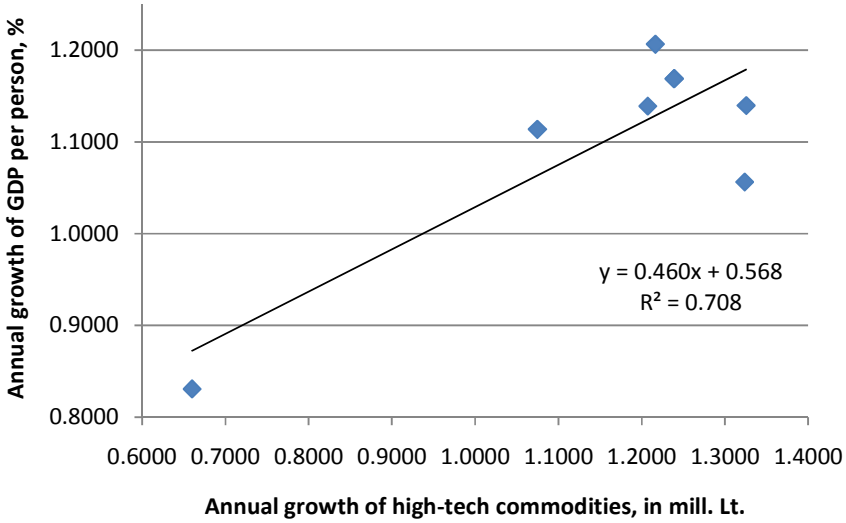

Fig. 7. The annual growth of national GDP per person versus the annual growth of export of high-tech commodities in Lithuania, 2011.
Source. LitNDS.