SECTOR OF HIGH TECHNOLOGY IN THE BALTIC STATES: COMPARATIVE ANALYSIS

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Abstract. The author of the presented paper aims at bringing forward an overview of the theoretical aspects of the sector of high technology development. International theories of high technology development, such as the Triple Helix Model or the Knowledge System Model, and systematic models of national development programs are analysed here, too. In addition, the author’s overview of a variety of implementation of the suggested models in the Baltic States is performed in the paper. Theoretical framework for the measurement of high technology development in different Baltic countries is also discussed here. The author’s suggestion to investigate processes of high technology development in Lithuania, Latvia and Estonia, based on three main factors: total investment, labor productivity, expenditure on research and development – is raised. As a result, the author foresees some guidelines for comparative analysis of high technology development in the Baltic States.

Keywords: high technology, Triple Helix Model, Knowledge System Model, high technology classification, high technology development.

1. Introduction

The importance of high technology development nowadays is determined by processes of economic globalization, business internationalization and general challenges, which have been faced by the whole world in the last few years due to financial crisis. A majority of foreign and national economists, scientists and researchers, such as Rausch (1998), Snitka (2002), Melnikas (2004), Agmon, Messica (2006), Ghazinoory (2009), and Bielskis (2009), sees the opportunity to transform national economies into competitive knowledge based systems in high technology development, which assures economic and social welfare.

The above mentioned authors agree that the sector of high technology is the long term driver of the economic growth, and economies flourish when societies create conditions in which new sources of wealth and work are created. It is a well known fact that innovative companies of the sector of high technology gain a larger market share, add more value and create more new jobs than other companies. Nowadays the major trends in high technology sector development are the following:

− Rapid scientific change and speedy diffusion of new technologies.
− Increased globalization.
− New customer preferences.
− Emerging information society.

After a long period of Lithianian, Latvian and Estonian economic transition from planned into the market systems, it is extremely important to assure their continuous and sustainable growth. Since the Baltic States became a part of the European Union in 2004, the newly developed situation on economic and political arena has been requiring to design their own national economies regarding European and international requirements.

Lithuania, Latvia and Estonia, being a part of the same regional alliance, still compete in the international market. Therefore, it is very important to analyse and evaluate the achievements and opportunities of high technology sector in every single country.

2. Typology of high technology

Scientific literature provides two main approaches of understanding and classification of high technology sector. One group of authors, such as Gardner, Johnson, Lee, Wilkinson (2000), Sahadev and Jayachandran (2004), ascribes high technology industries according to the extent of funds, allocated for research and development in each sector:

− High technology industries (aerospace, computers, office equipment, electronic communication, pharmaceutical industry).
− Medium/susceptible to high technology industry (scientific instruments, electronic equipment, motor vehicles, chemical industry, non-electrical machinery and equipment).
− Receptive to the knowledge of high technology sectors (post and telecommunications, computers and related activities, research and development).

The other group of scientists, such as Geisler (2002), Heertje (2001), Scheel (2002), Sigurdson and Li-Ping Cheng (2001), relatively divides the sector of high technology into three groups, accord-
ing to their susceptibility to science, which determines the development and production of innovative technological solutions:

- Technology of high scientific susceptibility (aerospace technology, computer technology, medical technology, chemical technology, communication technologies, pharmacology, technology of accurate instruments and machinery industry).
- Technology of medium scientific susceptibility (shipbuilding, ground transportation, industry of polymers, glass, stone, colored metals and alloys).
- Technology of low scientific susceptibility (oil refinery, metallurgical industry, light industry, wood processing, paper industry).

The Organization of Economic Development and Cooperation (OECD) recognizes those high technology industry areas, where research and development are significant in promoting sales of final outputs such as: air industry, the pharmaceutical industry, computers and office equipment, communication tools, and the scientific (medical, precision measurement, optical) measures (Lioshky 2009).

According to the National Science Foundation of the United States of America, there is no single preferred method for identifying high technology industries (National Science Foundation, 2009). Therefore, the National Science Fundation indicates two main criteria necessary for development of high technology sector:

- Skilled labor force which is understood as occupational employment, and the percentage of particular occupations within industries change over time, reflecting upon the changes in employment growth, as well as the business structure.

- Research intensity, where data is derived from studies of publicly traded companies is known as R&D dollars as a percent of total sales.

Due to objects multiplicity, the typology of high technology is multi-faceted, but the key features that distinguish high technology sector are the following: the susceptibility of science, necessity of skilled labor force and research intensity.

3. Overview of the theoretical models of high technology development

The main theoretical models of high technology development were created over the last decade of the previous century. The most popular Triple Helix Model of high technology represents a spiral model of innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization (Etzkowitz 2002). The model consists on three autonomous helices and determines processes related to innovation and high technology development by cooperation between the academic society, public institutions and the business sector. The first dimension of the Triple Helix Model is internal transformation in each of the helices, such as the development of lateral ties among companies through strategic alliances or an assumption of an economic development mission by universities. The second is the influence of one helix upon another. The third dimension is the creation of a new overlay of trilateral networks and organizations from the interaction among the three helices, which supports high-technology development.

![Image of Triple Helix Model](Fig. 1. Triple Helix Model)

Viale and Campodall'Orto (2002), Etzkowitz (2002), Gulbrandsen and Levitt (2000), and Wessner (1999) agree that the Triple Helix Model denotes the university-industry-government relationship as one of the relatively equal, yet independent, institutional spheres which overlap and take the role of the other.

In the last decade scientists started addressing the different aspects of university-industry-government cooperation. Their majority studies the importance of education and qualification of the labor force. This is approved in the working papers of many scientists and researchers, such as Boyer et al. (1999), Etzkowitz (2002), Casas, Gortari and Santos (2000), and Leydesdorff (2005), as well as strategically significant documents of national and international organizations that tend to focus on the importance of educational and training level of high technology development. The main ideas of importance of educational level and qualification of labor force may be explained as the knowledge system within the figure 2.

The Knowledge System Model shows the relationship between the main actors of knowledge-based economy, i.e. enterprises, universities, government and other public research institutions, and
the variety of some specific factors such as the industry structure, the education and training system, the human resources and the labor market, the financial system, etc. Using the model, it is possible to identify the main building blocks of a “knowledge system”. In this system, science, technology or innovations and industry are central but not sufficient to ensure economic growth, competitiveness and job creation. Therefore, the education and training system, human resources and the labor market, and the financial system all have a substantial impact on the performance of the chain ‘Science-Technology-Industry’.

![Knowledge System Model](image.png)

From this perspective, the performance of an economy depends not only on how the individual institutions perform, but also on how they interact with each other as elements of a collective system of knowledge creation. Such interactions between various institutions are possible within the well-developed educational and training system, which ensures the inter-connection between all three elements: science, technology and industry.

4. Sector of high technology in the Baltic States

When the Baltic States regained independence in 1991, the sector of high technology needed not simply to be transformed but to be substantially rebuilt. As a direct result of the exclusion from the broader structures of the former Soviet Union, many business sources and ties were lost. Thus, it was necessary to embark on a radical programme of transformation (Nedeva, Georgiou 2002).

The work of reconstruction that had started in the Baltic States in 2000–2001 by public authorities in developing national strategies and creating forecasts for high technology development was assessed in 2004 upon the accession to the European Union. Since 2007 the Seventh Framework programme for research and technological development (FP7) has been the EU’s main instrument for funding research in Europe. The main aims of FP7 have been to increase Europe’s growth, competitiveness and employment (Eurostat yearbook 2008). Research and development lies at the heart of the EU’s strategy to become the most competitive and dynamic knowledge-based economy; for instance, one of the goals was to increase R&D expenditure to at least 3.0 % of GDP by 2010.

The European Innovation Scoreboard based on statistical cluster analysis of scores over five-year period divides European countries into four groups:

- Innovation leaders, showing an average high technology sector at a 1.6 % growth rate (Denmark, Finland, Germany, Sweden, Switzerland and the UK).
- Innovation followers, showing an average 2.0 % growth rate (Austria, Belgium, France, Ireland, Luxembourg and the Netherlands).
- Moderate Innovators, showing an average 3.6 % growth rate (Cyprus, Estonia, Iceland, Slovenia, Czech Republic, Greece, Italy, Norway, Portugal and Spain).
- Catching-up countries, showing an average 4.1 % growth rate over the five-year period (Bulgaria, Croatia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Turkey) (Ambrusevič, Plakys 2009).

Within the four identified country groups the growth performance is very different (European Innovation Scoreboard 2008). Regarding the rate of improvement in innovation performance each segment may be divided into slow growers, moderate growers and growth leaders. In this way, Estonia is a part of moderate growers in segment of moderate innovators, Latvia belongs to moderate growers among catching-up countries and Lithuania is assigned to the slow growers in catching-up countries’ group.

The differences in countries’ assessments can be explained by a more detailed analysis of the high technology reforms and the overview of sector of high technology in the concerned countries.

4.1. Sector of high technology in Lithuania

Priority of high technology development in Lithuania has been recognized in the areas where activities are based on research and companies are able to compete in the global market. Historically, the major initiative to develop the sector of high technology belonged not to the authorities, but to the academics; as a sequence, a proposal “Lithuanian Science and Technology White Paper” was agreed to develop. Despite the limited promotion of the idea, the concept of Triple Helix Model was im-
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implemented in Lithuania – the working group consisted of representatives of academics, industry and authorities (Chlivickas et al. 2009). Finally, the Government approved the High Technology Development program for 2007–2013, which is a sequel of 2003–2006 program.

Lithuanian high technology sector is understood as the following areas listed below: biotechnology and pharmaceuticals; information technology; telecommunications and laser technology; and electronics and mechatronics (Ambrusevič 2008).

Lithuania’s overall achievements in high technology development position the country among the catching-up countries, with a performance that is well below the EU average but increasing towards the EU average over time.

Lithuania over the last decade achieved particularly high performance in creating academic environment by spending half of its expenditure on R&D in sector of high education and having the largest number of researchers in the Baltic states. In contrast, Lithuania recorded comparatively weak results in the sphere of Intellectual property.

4.2. Sector of high technology in Latvia

The sector of high technology in Latvia consists on following elements:
– Tech trailblazers in the pharmaceutical.
– Biotechnology and biomedicine.
– Information technology.
– Electronics.
– Energy.
– Chemistry and other industries (Investment and Development Agency of Latvia 2009).

As the 2007–2013 EU planning period approaches, Latvia focuses on Innovation and high value-added projects. Latvia’s overall achievements in high technology development situates it among the catching-up countries, with a performance that is well below the EU average but increasing towards the EU average over time. The weakest point of high technology development in Latvia is its lowest labor productivity. As a result, Latvia’s export of high technology products as a share of total export is the least significant among Baltic States.

4.3. Sector of high technology in Estonia

The Estonian Strategy for Research and Development “Knowledge-based Estonia” defines the aims, opportunities and principles for promoting research and development and innovations in Estonia (Tiits, Kaarli 2002). Approved by the Estonian Parliament in December 2001 Estonian Strategy for Research and Development spells out the national aspiration of Estonia to become “a knowledge-based society where the sources of economic and labor force competitiveness, and improvement in the quality of life, stem from research directed towards the search for new knowledge, the application of knowledge and skills, and the development of human capital” (Estonian Strategy for Research and Development 2002). Achieving this national aspiration, however, crucially depends on developing an adequate and efficient research development technology and innovation funding system (Nedeva, Georgiou 2002).

Sector of high technology in Estonia includes the following areas:
– Information technologies.
– Non-electrical machinery (gas turbines and parts thereof, nuclear reactors and parts thereof, machines for welding, etc.).
– Chemistry (selenium, tellenium, silicones, calcium, strontium, radio active materials, insecticides, disinfectants, etc.).
– Armament (arms and amunition) (Trade in high-tech goods in Estonia in the years 2004–2008).

Estonia’s performance in high technology development is on track to reach the EU average within 10 years if current trends continue. As for general strategy indicators, total expenditure on research and development is planned to be increased to 1.9 % by 2010, and 3.0 % of GDP by 2014. Thus, Estonia is relatively weak in the Intellectual property.

5. Methodology of high technology development evaluation

Scientific literature provides a number of different methods of high technology sector evaluation: one group of scientists emphasizes importance of macroeconomic indicators (Lioschky 2009), and the others investigate microeconomic impact. Also, some researchers pay attention to additional factors affecting the economic environment (Guerin, Mancocchi 2009). A group of scientists investigating knowledge-based economy pays attention on the importance of research and development (Dhaoui 2008).

It is important to notice that many Lithuanian scientists, such as Tvaronavičienė and Grybaitė (2007), Šečkutė et al. (2007), and Tvaronavičienė et al. (2008), designate foreign direct investment as the main driving force for economic development. It is proved that not only fixed investments, but its structure across economic activities affects economic growth (Tvaronavičius, Tvaronavičienė 2008).
Melnikas and Smaliukienė (2007) analysing pharmaceutical market as part of high technology sector in Baltic countries suggest determining intangible criteria, important for specific activity development.

Gerasymchuk and Sakalosh (2007) declare that knowledge-based economy may be evaluated by various indexes: economic indexes, government and management efficiency indexes, business efficiency indexes, infrastructure indexes. Ginevičius and Korsakienė (2005) suggest that knowledge economy index is a universal tool in high technology sector evaluation.

The primary systematic classification of methods of high technology development evaluation based on the analysed scientific data is given below:

Table 1. Systematic classification of analysed methods

<table>
<thead>
<tr>
<th>Methods</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>- macroeconomic estimation of national economy;</td>
</tr>
<tr>
<td></td>
<td>- foreign trade;</td>
</tr>
<tr>
<td></td>
<td>- foreign investment;</td>
</tr>
<tr>
<td></td>
<td>- employment and prices.</td>
</tr>
<tr>
<td>Government</td>
<td>- state finance;</td>
</tr>
<tr>
<td></td>
<td>- fiscal policy;</td>
</tr>
<tr>
<td></td>
<td>- institutional development;</td>
</tr>
<tr>
<td></td>
<td>- social environment.</td>
</tr>
<tr>
<td>Business</td>
<td>- labor productivity;</td>
</tr>
<tr>
<td></td>
<td>- labor-market development;</td>
</tr>
<tr>
<td></td>
<td>- practice and quality of management;</td>
</tr>
<tr>
<td></td>
<td>- values and job treatment.</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>- basic, technological, science and social infrastructure development;</td>
</tr>
<tr>
<td></td>
<td>- education condition, public health, environment control.</td>
</tr>
</tbody>
</table>

Thus, the index as a created tool for qualitative and quantitative assessment based on many concepts and number of criteria provides background for universal methodology of high technology sector evaluation, which may include and express results of all analysed methods.

5.1. Theoretical and practical application of high technology development in the Baltic States

Eurostat collects all available high technology statistics from the EU under the more formal name "Statistics on high-tech industry and knowledge-intensive services" and defines high technology according to three approaches:

- The sector approach investigating high technology manufacturing sector and high technology knowledge-intensive service (KIS) focusing on employment, earnings and economic indicators.
- The product approach examining trade of high technology products.
- The patent approach looking at high technology patents (Eurostat yearbook 2008).

In order to complete practical application, particular indicators are given different values and express different aspects of high technology sector development regarding to the theoretical methodical matter of analysed models. In order to detect the aspects of the concerned countries with regards to the greatest importance to high technology sector development, indicators used for comparative analysis represent macroeconomic, social situation and level of science and technology of each investigated country. Indicators that may express leading and the most important tendencies of university-industry-business cooperation in sector of high technology are listed below (Table 2).

Table 2. Indicators included into comparative analysis

<table>
<thead>
<tr>
<th>Macroeconomic indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Real GDP growth, percentage</td>
</tr>
<tr>
<td>2. GDP per capita growth in Purchasing Power Standard</td>
</tr>
<tr>
<td>3. Inflation, percentage</td>
</tr>
<tr>
<td>4. Total investment, percentage of GDP</td>
</tr>
<tr>
<td>5. Export, percentage of GDP</td>
</tr>
<tr>
<td>Social indicators</td>
</tr>
<tr>
<td>6. Unemployment rate, percentage</td>
</tr>
<tr>
<td>7. Real unit labour cost growth</td>
</tr>
<tr>
<td>8. Labor productivity pro hour worked</td>
</tr>
<tr>
<td>Indicators of science and technology</td>
</tr>
<tr>
<td>9. Number of researchers</td>
</tr>
<tr>
<td>10. Expenditure on R&amp;D, percentage of GDP</td>
</tr>
</tbody>
</table>

Despite the fact that included indicators provide the view of basic tendencies of high technology sector development of chosen countries, in order to discover more peculiar tendencies correlation analysis has been performed. As unknown variables ten indicators included into comparative analysis have been used. Correlation analysis has been performed in order to establish dependencies on indicators of four basic approaches characterizing sector of high technology. Three of them are suggested by Eurostat and they are the following:

- The patent approach (number of patents).
- The sector approach (number of enterprises working with high technologies).
The product approach (turnover of trade of high technology production). Additionally, a share of high technology products in the countries’ export as the fourth studied element has been investigated.

The period of eight years from 2001 to 2008 was investigated. The data were collected from statistical bureaus of Lithuania, Latvia and Estonia and Eurostat.

The correlation analysis revealed original results:
- Patents of application in Latvia are irrelevant to the chosen indicators. In case of Estonia correlation coefficients seem to be significant for almost all variables, only t-observed of total investment and export are irrelevant and make an exception. Conversely, in Lithuania correlation coefficient of inflation is relevant and creates a strong relation with the number of patents. This explains processes of patents application in the Baltic States: Estonia gradually increased number of patents from 26 in 2001 to 124 in 2008. This process came alongside the other economic and social transformation in the country. In Lithuania the number of patents was quite similar for the period of 2001–2007 (69–92), and only in 2008 it increased significantly along with inflation (123). In Latvia the spectrum of application of patents is unpredictable and varies.
- Investigation of sector approach of the Baltic States shows an unique unity – correlation coefficients of six variables are relevant to all three countries: GDP per capita growth, total investment, unemployment rate, labor productivity, number of researchers and expenditure on R&D. The processes in Latvia, Estonia and Lithuania demonstrate to be similar: all countries have almost the same dynamic change of number of enterprises working in sector of high technology. In all three countries the number of enterprises during the investigated period has doubled.
- Results of product approach in Lithuania seem to be independent from chosen indicators: there is no correlation coefficient significant to the process of high-tech trade. In Estonia only inflation makes negative impact on turnover of high-tech trade. Latvia, having lowest level of trade of high technology products, depends on large number of indicators: there are established relevant correlation coefficients of GDP per capita growth, inflation, total investment and all included social indicators.
- Lithuania and Estonia have biggest share of high technology products in export: 7.34 and 7.81 % respectively. The difference is that Lithuania shows increasing share (2.92 % in 2001), Estonia – decreasing share in export (17.09 % in 2001).

Many significant relations are established in Latvia, and only the export does not provide relevant correlation coefficient. Correlation coefficients of GDP per capita growth, total investment and unemployment rate are relevant in cases of all three countries.

The results of correlation analysis are given in Tables 3–6. Correlation analysis revealed the most important indicator generating the largest number of relations to investigated elements of the Baltic countries: expenditure on R&D as percent of GDP. It makes deeper investigation of certain indicator extremely important. Comparative analysis of the Baltic States shows that in 2008 the highest level of expenditure is observed in Estonia – 1.29 % comparing to 0.80 % in Lithuania and 0.61 % in Latvia.

The lowest rate of changes in spendings to research and development is recorded in Lithuania: in 2001 it made 0.67 % in Lithuania, 0.41 % in Latvia and 0.7 % in Estonia.

Deeper analysis shows that in Estonia the absolute majority of expenditure on R&D goes on government sector (81.75 % in 2008).

Processes of financing of research and development in Lithuania and Latvia are quite similar; and rather contrary to the process in Estonia.
Table 3. The result of correlation analysis between the number of patents (the patent approach) and investigated variables in the Baltic States

<table>
<thead>
<tr>
<th>Country</th>
<th>R₁</th>
<th>R₂</th>
<th>R₃</th>
<th>R₄</th>
<th>R₅</th>
<th>R₆</th>
<th>R₇</th>
<th>R₈</th>
<th>R₉</th>
<th>R₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuania</td>
<td>-0.6366</td>
<td>0.6385</td>
<td>0.7457</td>
<td>0.4104</td>
<td>0.4336</td>
<td>-0.4360</td>
<td>-0.0288</td>
<td>0.6732</td>
<td>0.5906</td>
<td>0.4815</td>
</tr>
<tr>
<td>t-observed</td>
<td>2.0219</td>
<td>2.0320</td>
<td>2.6418</td>
<td>1.1025</td>
<td>1.1785</td>
<td>1.1867</td>
<td>0.0706</td>
<td>2.2297</td>
<td>1.7928</td>
<td>1.3455</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.2399</td>
<td>-0.5544</td>
<td>0.5529</td>
<td>-0.4178</td>
<td>0.1067</td>
<td>0.5040</td>
<td>-0.5013</td>
<td>0.5346</td>
<td>-0.4841</td>
<td>-0.1891</td>
</tr>
<tr>
<td>t-observed</td>
<td>0.6053</td>
<td>1.6317</td>
<td>1.6252</td>
<td>1.1265</td>
<td>0.2629</td>
<td>1.4293</td>
<td>1.4192</td>
<td>1.5496</td>
<td>1.3552</td>
<td>0.4717</td>
</tr>
<tr>
<td>Estonia</td>
<td>-0.7257</td>
<td>0.8381</td>
<td>0.7436</td>
<td>0.3193</td>
<td>-0.5824</td>
<td>-0.8309</td>
<td>0.9424</td>
<td>0.8622</td>
<td>0.9304</td>
<td>0.8793</td>
</tr>
<tr>
<td>t-observed</td>
<td>2.5834</td>
<td>3.7633</td>
<td>2.7244</td>
<td>0.8254</td>
<td>1.7547</td>
<td>3.6585</td>
<td>6.9021</td>
<td>4.1694</td>
<td>6.2162</td>
<td>4.5224</td>
</tr>
<tr>
<td>t-statistics</td>
<td>2.4469</td>
<td></td>
<td></td>
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<td></td>
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</table>

Table 4. The result of correlation analysis between the number of enterprises (the sector approach) and investigated variables in the Baltic States

<table>
<thead>
<tr>
<th>Country</th>
<th>R₁</th>
<th>R₂</th>
<th>R₃</th>
<th>R₄</th>
<th>R₅</th>
<th>R₆</th>
<th>R₇</th>
<th>R₈</th>
<th>R₉</th>
<th>R₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuania</td>
<td>0.5505</td>
<td>0.9248</td>
<td>0.8643</td>
<td>0.9864</td>
<td>0.4860</td>
<td>-0.9123</td>
<td>-0.0890</td>
<td>0.8693</td>
<td>0.9265</td>
<td>0.8847</td>
</tr>
<tr>
<td>t-observed</td>
<td>1.4746</td>
<td>5.4343</td>
<td>3.8416</td>
<td>13.4319</td>
<td>1.2435</td>
<td>4.9818</td>
<td>0.1999</td>
<td>3.9322</td>
<td>5.5037</td>
<td>4.2440</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.8340</td>
<td>0.9918</td>
<td>0.9183</td>
<td>0.9615</td>
<td>0.6827</td>
<td>-0.9952</td>
<td>0.9199</td>
<td>0.9861</td>
<td>0.8306</td>
<td>0.8712</td>
</tr>
<tr>
<td>t-observed</td>
<td>3.3795</td>
<td>17.3435</td>
<td>5.1877</td>
<td>7.8229</td>
<td>2.0890</td>
<td>22.7788</td>
<td>5.2471</td>
<td>13.2691</td>
<td>3.3348</td>
<td>3.9685</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.2987</td>
<td>0.9785</td>
<td>0.4733</td>
<td>0.9070</td>
<td>-0.5471</td>
<td>-0.9989</td>
<td>0.7874</td>
<td>0.9655</td>
<td>0.8619</td>
<td>0.9611</td>
</tr>
<tr>
<td>t-observed</td>
<td>0.6999</td>
<td>10.5974</td>
<td>1.2016</td>
<td>4.8159</td>
<td>1.4614</td>
<td>15.5706</td>
<td>2.8566</td>
<td>8.2928</td>
<td>3.8013</td>
<td>7.7804</td>
</tr>
<tr>
<td>t-statistics</td>
<td>2.5706</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 5. The result of correlation analysis between the turnover of trade of high technology production (the product approach) and investigated variables in the Baltic States

<table>
<thead>
<tr>
<th>Country</th>
<th>R₁</th>
<th>R₂</th>
<th>R₃</th>
<th>R₄</th>
<th>R₅</th>
<th>R₆</th>
<th>R₇</th>
<th>R₈</th>
<th>R₉</th>
<th>R₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuania</td>
<td>0.5805</td>
<td>-0.1794</td>
<td>-0.3322</td>
<td>-0.1362</td>
<td>-0.4503</td>
<td>0.2154</td>
<td>-0.0656</td>
<td>-0.1577</td>
<td>-0.3189</td>
<td>-0.4883</td>
</tr>
<tr>
<td>t-observed</td>
<td>1.5941</td>
<td>0.4078</td>
<td>0.7876</td>
<td>0.3073</td>
<td>1.1277</td>
<td>0.4933</td>
<td>0.1470</td>
<td>0.3570</td>
<td>0.7524</td>
<td>1.2513</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.6091</td>
<td>0.9491</td>
<td>0.8571</td>
<td>0.8259</td>
<td>0.4745</td>
<td>-0.9476</td>
<td>0.8732</td>
<td>0.9389</td>
<td>0.7380</td>
<td>0.6706</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.3045</td>
<td>-0.4065</td>
<td>-0.8729</td>
<td>-0.1668</td>
<td>0.1947</td>
<td>0.4249</td>
<td>-0.6072</td>
<td>-0.4126</td>
<td>-0.5719</td>
<td>-0.4832</td>
</tr>
<tr>
<td>t-observed</td>
<td>0.7147</td>
<td>0.9949</td>
<td>4.0007</td>
<td>0.3783</td>
<td>0.4437</td>
<td>1.0496</td>
<td>1.7088</td>
<td>1.0129</td>
<td>1.5589</td>
<td>1.2342</td>
</tr>
<tr>
<td>t-statistics</td>
<td>2.5706</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 6. The result of correlation analysis between the share of high technology products in the countries’ export (the high technology export approach) and investigated variables in the Baltic States

<table>
<thead>
<tr>
<th>Country</th>
<th>R₁</th>
<th>R₂</th>
<th>R₃</th>
<th>R₄</th>
<th>R₅</th>
<th>R₆</th>
<th>R₇</th>
<th>R₈</th>
<th>R₉</th>
<th>R₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuania</td>
<td>0.5540</td>
<td>0.8003</td>
<td>0.8623</td>
<td>0.9501</td>
<td>0.3476</td>
<td>-0.8017</td>
<td>-0.1960</td>
<td>0.7332</td>
<td>0.8267</td>
<td>0.7715</td>
</tr>
<tr>
<td>t-observed</td>
<td>1.4885</td>
<td>2.9845</td>
<td>3.8068</td>
<td>6.8083</td>
<td>0.8289</td>
<td>2.9896</td>
<td>0.4469</td>
<td>2.4109</td>
<td>3.2858</td>
<td>2.7114</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.7907</td>
<td>0.9768</td>
<td>0.9227</td>
<td>0.9448</td>
<td>0.5555</td>
<td>-0.9746</td>
<td>0.8574</td>
<td>0.9662</td>
<td>0.8836</td>
<td>0.8231</td>
</tr>
<tr>
<td>Estonia</td>
<td>-0.2587</td>
<td>-0.7588</td>
<td>0.1861</td>
<td>-0.9003</td>
<td>0.6576</td>
<td>0.7793</td>
<td>-0.6526</td>
<td>-0.7488</td>
<td>-0.7451</td>
<td>-0.6572</td>
</tr>
<tr>
<td>t-observed</td>
<td>0.5989</td>
<td>2.6053</td>
<td>0.4235</td>
<td>4.6243</td>
<td>1.9520</td>
<td>2.7809</td>
<td>1.9259</td>
<td>2.5264</td>
<td>2.4977</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Latvia upon considering the needs of sector of business enterprises in research and development over the years 2002–2006, in 2007 chose the Lithuanian model of expenditure on R&D: 47.44 % of spending goes to higher education sector, 27.54 % goes to sector of government and 25.03 % – to the sector of business enterprises.

The comparative analysis of expenditure on research and development in the Baltic States allows declare that the most balanced Model of Triple Helix was implemented in Latvia, which has been changed in the last year. In Lithuania relatively dominated role in high tech development belongs to the sector of higher education. Estonia shows the absolute dominance of government sector in development of high technology.

To summarise and express visually all made statements regarding particularities of high technology sector development in the Baltic States,
the most important indices of Lithuania, Latvia and Estonia, suggested by World Bank, United Nations and Eurostat to evaluate high technology sector, were compared:

– Knowledge economy index, constructed as the simple average of 4 sub-indices, which represent the following 4 pillars of the knowledge economy: economic incentive and institutional regime (EIR), education and training, innovation and technological adoption, information and communications technologies (ICT) infrastructure (Knowledge economy index ranking 2008).

– Index of economic freedom, consisting on ten freedoms: business freedom, trade freedom, fiscal freedom, government size, monetary freedom, investment freedom, financial freedom, property rights, freedom from corruption, labor freedom (Index of economic freedom 2008).

– National innovative capacity index, consisting on proportion of scientists and engineers, innovation policy, cluster innovation environment and linkages sub-indices (National Innovative Capacity 2008).

– Index of globalization, representing political, economic and social globalization (KOF index of globalization 2008).

– World knowledge competitiveness index.

Comparison of the indices of the Baltic States shows that Estonia is taking the leading position in all analysed indicators. Moreover, the country is leading not only in rankings of regular indices, important for high-tech sector evaluation, but the biggest gap between countries may be seen in the rankings of additional indices, such as the index of globalization (28th place with 72.18 points), economic freedom index (12th place with 77.8 points), and world knowledge competitiveness index (139th place and 43.9 points). Lithuania and Latvia show similar results and compete between each other: in the ranking of indexes of globalization Lithuania gets 45th with 63.90 points, Latvia is the 47th with 63.24 points, whereas in the ranking of indices of economic freedom, Lithuania is 28th with 70.80 points, Latvia is 38th with 68.30 points, in the ranking of indices of world knowledge competitiveness Lithuania is 139th with 27.50 points, Latvia is 141st with 20.80 points.

In the rest of the indices the countries show similar results, but the tendency is analogous: Estonia is leading if compared its index of national innovative capacity (27th with 21.2, whereas Lithuania is 37th with 19.2 and Latvia is 41st with 18.5) and knowledge economy index (21st with 7.68, whereas Lithuania is 30th ranking 7.68 and Latvia is 32nd with 7.64).

6. Conclusions

Analysis of the major factors that can affect high technology development shows specific development tendencies in the Baltic countries.

It was proven that all Baltic countries develop sector of high technology regarding the theoretical assumption of the Triple Helix Model based on the university-science-business cooperation. Estonia has chosen a risky way of cardinal reforms based on increasing spendings on research and development regarding requirements of EU FP7 program. Lithuania creates strong academic environment for high technology development. Similarly, Latvia after a long period of supporting industrial sector has decided to increase expenditures on R&D in the sector of higher education.

Correlation analysis revealed that export expressed with percents of GDP is only one indicator, which has no relevant correlation coefficient by investigating performances in high technology development of the Baltic countries.

Comparison of the indices of the Baltic States shows that not only specific indices that directly express high technology development are important, but also additional indices may be helpful in
predicting and forecasting performances in high technology development.

The analysed theoretical and practical data on the Baltic States require improved efficiency of innovation governance, more intense use of evaluation and benchmarking practices in policy making and learning, reinforcement of innovative activities at regional level, and highly determined policy responses to identified challenges. While many actions have already been taken there, future policies could be orientated towards the intelectual property protection, development of innovation poles and networks, and deeper university-industry partnerships in R&D.

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