CONTRIBUTION OF THE PUBLIC SECTOR TO THE DEVELOPMENT OF INNOVATION: POSITION OF ESTONIA

Janno Reiljan, Peter Friedrich, Ingra Paltser[1]
University of Tartu

Abstract

Under conditions of regional competition the authors discuss the role of the public sector in developing innovation activities and the ways to encourage innovation in the private and the public sector. Innovation policy gets linked to modern stage theories of development that focus on innovation. Estonia has reached the investment driven stage. With respect to several innovation indexes and measures of innovation policy a statistical comparison between Estonia and European Union member countries shows whether Estonia belongs to the group of leaders, renegades from leader role, losers or to that of aspirers. The indexes and indicators applied refer to the Community Innovation Survey, Summary Innovation Index, and Global Competitive Index. Although public higher education and R&D expenditures and co-operation of firms are above EU levels the analysis demonstrates that total R&D expenses are below European average. Co-operation between Universities and private firms is low and the number of patents as well. The knowledge creation and the ability to apply innovations enabled Estonia to reach an "aspirer position" whereas with respect to global competition Estonia possesses a "looser" position partly due to the lack of scientists, engineers, etc. Estonian public sector should develop and promote actively the necessary and promising fields of innovation analysed.

Keywords: innovation policy, economic development, public sector innovation, private sector innovation, European comparison, Estonia's innovation situation

Introduction

The globalization of competition has raised new tasks for the public sector – to support innovation in the socio-economic development of a country. Therefore, in recent decades economics has been increasingly concerned with the role of the public sector in ensuring the effectiveness of public policy in innovation processes. In this article the problems of Estonia as a small member state of the EU will be explored in this field.

Traditionally, the role of public policy is seen as supporting private entrepreneurs as innovators oriented towards the production of goods for existing markets. The active role of the public sector in demand creation for innovative products/technologies has to be developed. For firms it is advantageous to avoid the costs involved in research and development (R&D) as long as the framework conditions do not change much.

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However, these conditions may change if: the needs and desires in a country become satisfied, production costs in other countries become cheaper or if the protection of shipping costs decreases, if production factors become scarce (e.g. labour, energy) and if new needs develop. These changes may hamper economic development if innovation is the task of private firms alone (Hauff, Scharpf 1975). Therefore, a co-ordinated public sector innovation policy is necessary, and it also seems necessary to determine which stages of the innovation chain should be financed or operated by public institutions.

The objective of the current article is to find out which Estonian innovation policy measures are competitive from the international perspective and which need to be improved. In order to achieve the objective the following research tasks have been set:

- describe the public sector's role in developing innovation activities and systematize public innovation support measures;
- analyze innovation policy implementation in Estonia;
- compare Estonian innovation policy measures with other European Union members and assess the position of the Estonian public sector in regard to support for innovation.

The source of data used for the empirical analysis is the *Eurostat* database. Some data originates from the European Innovation Scoreboard and Global Competitiveness Reports.

1. Main fields of public sector intervention for developing innovation

Estonian economic development until now has been mainly based on the production and export of traditional labour and resource intensive products, whereas innovation has played a less important role. Under the conditions of a sharpening deficit of labour resources, rising prices for all inputs and unbalanced regional development, the formulation of appropriate innovation policies are of essential importance. The misalignment of public policy in these fields has become one of the limiting factors of economic development in Estonia (Varblane *et al.* 2007; Ukrainski, Varblane 2006; Ukrainski 2006a).

The fashionable term *innovation* is understood and interpreted differently (J. A. Schumpeteri 1989: 62; Michael E. Porter 1990: 45; Oslo Manual 2005: 46; Fagerberg 2006: 8; Tidd *et al.* 2006: 5; V. A. Thompson 1969: 5; Grupp 1998: 13; Kurik *et al.* 2002: 19; Marxt, Hacklin 2005: 414; Francisa, Bessant 2005: 172; Smart Innovation 2006: 13). The fact that the term *innovation* is not understood clearly in Estonian society, is supported by the PRAXIS Center for Policy Studies 2005 study "Innovation and Estonian opinion leaders" (Kalvet *et al.* 2005).

The central aspect concerning innovation is implementation – are renewals put into practice. At the same time the innovation process should be viewed widely within the organisational and social context. Giovanni Dosi (1988: 222) describes the

following innovation stages: the search for new products, production processes or organisational structures, testing, development, imitation and acknowledgement. Peter Drucker (2004: ix) emphasises that innovative action must be systematic. Marinova, Phillimore (2003: 47-48) and Edquist (2006: 182) highlight the importance of cooperation in promoting innovation process.

According to Porter's development model, three stages can be distinguished in economic development (Porter 1990: 545-556): the factor-driven stage common to low level of income, the investment-driven stage common to medium income levels, the innovation-driven stage common to higher income levels. This theory of stages is strongly related to the actual theories of developmental stages. "A developing country, in the context of an open economy, industrialises and goes through industrial upgrading, step by step, by capitalising on the learning opportunities made available through its external relationship with the more advanced world" (UNCTAD 1995: 259). In combination with two kinds of markets (i.e. domestic and export markets) and five types of industries (i.e. R&D-intensive and easily imitable high-tech industries, as well as capital-, labour- and natural resource-intensive industries), the stages of economic and industrial development can generally be divided into three phases, through which countries progress (Akamatsu 1961; Kojima 2000; Nam 2006):

- stage 1: natural resource and labour driven;
- stage 2: capital and imported technology driven;
- stage 3: R&D and innovation driven.

In the third R&D and innovation driven stage, firms are challenged by the increased levels of world competition to innovate new products derived from high levels of technology and know-how. Apart from the well-known impacts of the modern R&D infrastructure and high-quality human capital in generating and implementing new technologies in the development of new products (Ranis 2004), the networks that innovative industrial firms (institutionalised and therefore long-lasting) have with research institutions and high-tech business service firms as well as other industrial companies in the context of a national innovation system become crucial for the country's continued economic and industrial growth in the third stage.

This concept can be applied to regions that are to be found on the continuum within and between these stages. Within this approach decline leads to less innovation, less learning activities, weaker competitive strength, over specialization, etc. and the countries fall back along the continuum (Friedrich, Nam 2009).

In general, countries at the first stage are less developed. There, a whole range of measures to overcome such underdevelopment could be applied. Countries that have reached stage two or fallen back to the second stage have to foster measures to provide capital (also venture capital) and to enforce technological development and import technological knowledge. Countries falling back in position within the third stage should push technological development, co-operate with industrial partners in other developed countries, develop modern service industries and concentrate more on technological strategic branches that fit into their overall economic structure. The

objective of every country should be to reach the innovation-driven stage. Such development demands direct state intervention – the implementation of innovation-directed policies (Lundvall, Borrás 1997: 37).

Innovation has long been understood as a linear process in which the public sector's objective is to support R&D activities and direct knowledge transfer from one innovation process stage to another. In the mid 1990s, the creation of an operating innovation system was emphasised: starting from a functioning education system and science through to a suitable tax system, patent laws etc. All policies (i.e. regional, education, competition etc.) should be innovation-friendly (Rutten, Boekema 2006). The role of the public sector is to work beside the development of R&D and innovation systems and to support innovation cooperation (Innovation … 2002: 10-11; Cooke *et al.* 2007; Karlsson 2008; Capello, Nijkamp 2009). The objective of the public sector is also to produce, diffuse and use innovations (Edquist 2006: 190; Windrum, Koch 2008).

Table 1 presents a summary classification of innovation-oriented policy measures based on Edquist's approach.

Table 1. The classification of public sector policy measures oriented to innovation

1. Provision of knowledge inputs for the innovation process
Financing R&D
Raising the competence of the workforce: financing vocational, technical engineering and academic higher education
Develop inventions and innovations in public sector research institutions, military and civilian public offices, large public firms such as hospitals, public utilities, agriculture, forestry, public industrial companies, shipyards, space and aircraft industries, etc.
3. Provision of markets – demand-side factors
Innovation oriented laws, regulations and standards (i.e. safety and environment standards)
Public technology procurement, investment in future energetics
4. Provision of constituents for the innovation system
Support of SME innovation activities, for instance loan guarantees, start-up and risk capital support
Supporting innovation cooperation, for instance inter-firm cooperation programs, exchange of information, financing of cooperation projects
Creating legislative environment for innovation, for instance patent law
5 Support services for innovation firms
Creating favourable conditions for innovation, for instance tax system, access to risk capital market
Support of innovative firms, for instance consulting, financial support, guaranteeing loans
Investment in information and communication technology

Source: Composed by authors and based on Edquist (2006).

Investments in infrastructure development are in general recognized as one of the major tasks of the public sector for promoting innovation in socio-economic development (Feng, Popescu 2007; Baldwin *et al.* 2003; Subramanian *et al.* 2001; Piet, Shefer 1999). Empirical research conducted in Western countries points to a positive correlation between the development of public infrastructure and investments of private capital (Aschauer 1989a; Aschauer 1989b; Aschauer 2000; Seitz 1994).

The systems of education and research are important instruments of public infrastructure that enable a country to increase sustainability and enhance innovative activities. It is important to raise people's awareness of science and technology (Innovation … 2007: 18). Inputs and outputs of the education system are mainly assessed using a comparative analysis of financing and effectiveness of educational institutions (Spraul 2007; Unnever *et al.* 2000; Bates 1997), but also more broadly as the knowledge base in innovation systems (Lundvall 1992; Leydesdorff, Etzkowitz 1996; Breschi, Malerba 1997). These problems are highly relevant in Estonia as well (Reiljan, Reiljan 2005; Ukrainski 2006b).

Invention and innovation also take place in large public research institutes that operate in the fields of basic and applied research. Examples include institutes in the natural and technical sciences, in agriculture, in meat research, in bioscience, forestry, space science, materials development, atomic research, arms development, defence, health equipment, etc. (Niopek 1986). These institutes sometimes operate closely with related private firms. Sometimes these firms are also spin offs of state universities using the forms of private or public law. Public enterprises are also important units in encouraging innovations. Examples include the public railway systems in France, Germany, Japan, China etc. and former state owned air line carriers, public shipyards, shipping lines, municipal transportation companies, public utilities, public water providers, public forestry firms and wineries, public enterprises in agriculture, mining; however, also in banking, insurance, exchanges, fair companies, public chemical industries, public industrial enterprises, postal services as a major technical developer in Germany after the second world war, etc. In some countries like Estonia the public universities act as public enterprises as well. Sometimes public offices do research themselves, especially if this research and development of inventions and innovations have to take place under secrecy. There exist public offices dedicated to technical knowledge and development like the European and national patent offices, safety monitoring institutions, water control authorities. This public research may lead to common projects with private firms within the framework of PPP, or in research and development co-operation. Some times they are embedded in official programs to encourage materials, biotech, energy, nano-research etc. Apart from these technical and commercially oriented activities public bodies also encourage cultural development and innovation through educational and cultural administrations, such as vocational training (vocational schools, colleges) and higher education institutions (universities) and public firms like museums, operas and theatres.

This support of innovation takes place at the EU level, the national, sub state and municipal level. The intensity of public sector research, development and innovation support also depends on the competitive situation in the society and economy in question. In times of harsh competition, cold wars and games of survival, the need for public sector activities is felt more than in times of peaceful market economy development or if a leading nation is indirectly governing other nations via free trade, market economy concepts, etc.

The objective of a state innovation system is to raise the innovative potential of society, which means promoting science and education, and setting them as the foundations of societal development (Köörna 2005: 55). It is up to the state to decide what proportion of the state budget is meant for education. Rappaport empirically found (1999: 33-34), that state expenditure on education is positively connected to local development. Still, a quick result from education and science expenditure growth cannot be expected. Sørensen emphasises (1999: 429) that R&D is non-profit in the context of a low level of human capital, and it only becomes profitable when human capital reaches a certain level.

The threats of public intervention in innovation processes must also be taken into account. Liberal market economy supporters think that regulation restrains innovation and ties them down with bureaucracy, which in turn results in growth in the cost of new products and technology, a slowing of innovation transfer and increased risks. Incompetent economic policy can hinder innovation (Köörna 2005: 19-20). Support for new product development can shorten the life cycle of existing products often for no good reason (Grupp 1998: 387). In addition, it has been found that public sector support for innovation raises the risk of a regional imbalance of development: innovations, which are vital for European growth and competitiveness in general, might further aggravate regional disparities (Fagerberg 2002: 56). Every country must find suitable innovation policy instruments.

The instruments of public policies have to be applied differently, taking into consideration the economic situation of the country. According to current knowledge, to form an innovation-oriented public sector in Estonia, it is important to take into account the impact of the following factors:

- The phase of transformation as one of the main complexes of historical path-dependency indicators and embeddings in a Political and Economic Union that constitutes the most important change in the international environment of Estonian socio-economic development;
- The size of the country limiting the extent of the tasks and instruments of public policy, but also determining the position of the country in broader regional competition (Batey, Friedrich 2000; Feng, Friedrich 2002);
- The structure and efficiency of the public sector as the main complex of political path-dependency indicators, actual and future political needs for the formation of an innovation-oriented public sector;

- The inequalities in attainable public services as part of the consumption basket, which can expand the gap in welfare internationally and between communities as well;
- The structure of industries and the size distribution of firms in industries as objects of public innovation policy.

2. Analysis methodology

The values of volume, share and relationship of competitiveness indicators for a certain economic sector provide an overview of the situation achieved through historical development, which is in turn the basis for future development. The competitive position can be calculated through comparing the economic sector's indicators with some standard (for instance with the same indicator values for the most successful or average competitor). Using partial comparisons based on all indicators, the total assessment of path dependency for an economic sector can be brought out using competitive position.

The indicators chosen depend greatly on the characteristics of regional competition (Buhr, Friedrich 1978; Batey, Friedrich 2000; Feng Friedrich 2002). It may occur as macroeconomic competition where representative bodies in sectors and regions act using macroeconomic instruments like aggregate demand, tax receipts, taxation and subsidization to enforce the application of innovations, expenditure for education, research and so on, or as microeconomic competition dealing with microeconomic parameters of action such as zoning, real estate, projects, special fees, etc. Competition can be development competition concentrating on planning and educational or research infrastructure, or project competition such as attracting high-tech firms, skilled workers, an educated population and public offices. The outcome of regional innovation oriented competition also depends on the market forms of competition. In such competition one normally finds more suppliers than demanding firms. This competition occurs worldwide, for example, in Europe, USA, India, China, Brazil and Russia. Within the European Union 27 member states compete and about 100 sub-states and provinces are engaged in innovation-oriented competition and thousands of municipalities support innovation activities. They are engaged in development and project-oriented competition. At least with project oriented competition there are few demanding firms and public offices. Regional competition within the framework of supporting and attracting innovation also depends on the goals of the competitors. Their goals may be quite different, such as the re-election of politicians and parties, the greater centrality of cities, higher income, higher employment, a high-tech sector structure to name just a few. Also, if the competitors try to achieve the same goals, their operational goal, for example in terms of income and employment, may be different as the goal might be acted upon at the national or only the municipal level. Many times the main goals for competitors refer to income maximization. Any success in innovation competition is then reflected in an increase in regional income.

In the following empirical part of our investigation we refer to nations within the EU as competitors who want to achieve high income and income growth. We do not use these directly as success indicators. We apply indicators that reflect the positive conditions for achieving these aims and that describe innovation competition as a kind of regional competition. The macroeconomic parameters of action we chose as relevant in macroeconomic competition to launch and intensify innovations are shown in figure 6 with indicators 1 to 10 (excluding indicator number 2). Other indicators show favourable innovation competition conditions and parameters of action that have evolved in the Community Innovation Survey (CIS), the Summary Innovation Index (SII) and the Global Competitiveness Index (GCI). They also help to identify the country's position in terms of innovation competition.

The growth rates of competitiveness indicators help us to assess the direction and speed of change of different aspects of competitiveness. The growth rate of competitiveness indicators must also be compared with a standard. Those comparisons make up the total assessment of the competitiveness dynamics.

When comparing the competitive position and its dynamics indicators, a standard could be:

- the values of the competitive position and the dynamics of the most successful competitors (*benchmarking*), in order to assess the lag of the economic sector under observation from the top level of the world economy;
- the average value of the competitive position and the dynamics of the set of competitors, in order to assess the managing capabilities of the economic sector in comparison with average competitors in the world economy;
- the values of the competitive position and the dynamics of the weakest competitors, in order to assess the possibility of the displacement of that economic sector from the world economy.

The scales for the competitive position and the dynamics form a competitiveness field for each aspect of competitiveness according to the definition given in figure 1. On the figure's X-axis we can see the scale of the position measure and on the Y-axis, the scale of the dynamics measure. For the cut-off point for those axes it is analytically reasonable to choose the average value of both scales (see figure 1).

ΔY_i I quadrant **"aspirers"**	II quadrant **"leaders"**
IV quadrant **"losers"**	Y_i III quadrant **"renegades from leader role"**

Figure 1. Economic competitiveness assessment field with the help of figure Y_i level scale and dynamics scale ΔY_i.

Countries in the first quadrant are “aspirers” with a less than average competitive position, but with a higher than average growth rate. In the second quadrant there are countries with a higher than average competitive position and growth rate known as “leaders”. In the third quadrant there are countries with a higher than average competitive position, but a lower than average growth rate and are termed “renegades from leader role”. The countries in the fourth quadrant have a lower than average competitive position and growth rate and are referred to as “losers”.

When implementing the competitive field method, the analysis of the competitiveness of the economic sector can be conducted from the aspect of the competitive position and its dynamics:

1. **Indicator analysis**. The analysis of the indicators of economic competitive position and its dynamics is carried out separately for each indicator Y_i. By placing the most successful and unsuccessful competitors on the field formed by the level of the indicator and its dynamics, we get a complex assessment of the state’s competitiveness as assessed through indicator Y_i. The nature of the analyzed indicator broadly reflects the necessary work categories and public sector measures needed in order to raise economic competitiveness.
2. **Pattern analysis**. We obtain an overview of the economic competitiveness pattern by putting assessments of competitive position and dynamics calculated with the help of all indicators in one competitiveness analysis field. When standardizing position assessments, and if necessary the variation of dynamics indices calculated using partial indicators of competitiveness in a set of comparable competitors (the measurement unit here is the deviation from the average in the meaning of standard deviation), we create similar scales of different partial level and dynamics indicators. This in turn makes competitive position and dynamics indicators comparable in respect to all partial indicators of competitiveness. Using different partial indicators of competitiveness, a different assessment of the sector’s competitive position and dynamics is calculated. In some aspects of competitiveness, a sector can be a “leader”, in other aspects an “aspirer”, “renegade from the leader role” or a “loser”. Complex analysis of different competitiveness aspects helps to create a complete description of the economic competitiveness pattern, which helps us to describe single critical points for competitiveness formation as well as synthesize public sector policies for increasing competitiveness.
3. **Dynamic analysis**. To analyse competitiveness dynamics, competitive position and dynamics values for different periods are put in the competitiveness assessment field. In order to forecast competitiveness, it is important to see the development path in the competitiveness field for the last 5-10 years in comparison with the position or path of the competitors. Changes in the development path describe the results of previous public policy measures and changes in the market environment.

When using the competitiveness assessment field method, the main objective is to bring out and connect different aspects of the sector’s competitiveness exposure, in order to create a basis for understanding competitiveness development mechanisms and determine directions for research to find factors for raising competitiveness.

3. The position of Estonia in terms of public sector innovation activities

According to Porter's development model and modern stage theories, Estonia is at the moment in the investment-driven stage. The production of firms is not sufficiently competitive to succeed in foreign markets; they are lacking investments in technology and development activities. With the current low cost levels and lack of production development, subcontracting is the main option for selling on foreign markets (Eesti … 2002: 28-29). That is why Estonia has not reached the innovation-based development phase.

In order to bring Estonia into the innovation-driven development stage more attention has been paid to creating and developing national innovation system. Estonian R&D guiding document is at the moment Estonian research, development and innovation strategy 2007-2013 "Knowledge-based Estonia" (2007).

As an overall indicator of strategy implementation it has been projected that the cost of R&D shall reach 1.5% of GDP by 2008, 1.9% by 2010 and 3.0% by 2014. Public sector R&D investments have been projected at 0.8% of GDP by 2008, 1.0% by 2010 and 1.4% by 2014 (*Ibid.*: 36).

Funds in the state budget intended for research is given to the Eesti Teadusfond (*Estonian Science Foundation*). Eesti Teadusfond distributes scientific grants to individuals and research groups through competition. The objective of the Eesti Teadusfond is to support high quality scientific research, new ideas and search as well as degree studies (Estonian … 2009).

The agent implementing state innovation policy support measures is the Ettevõtluse Arendamise Sihtasutus (EAS – *Enterprise Estonia*). During 2005-2007, 150 different innovation audit programs were implemented with the help of EAS, which was aiming to raise the awareness of innovation among managers and motivate them to initiate, promote and carry out innovative activities in their firms (Eesti ... 2007: 14). At present the innovation awareness program "Hea Eesti Idee!" (*Good Estonian Idea!*) is being implemented. Through EAS cooperation is also supported more precisely through the technology development centre program and the COMPERA program.

Providing loan and lease guarantees to innovative firms is also the task of the Krediidi ja Ekspordi Garanteerimise Sihtasutus KredEx (*Credit and Export Guarantee Foundation KredEx*) operating under the administration of the Ministry of Economic Affairs and Communication, which among other objectives offers guarantees for small and medium sized enterprises (KredEx 2009).

Next we will explore how Estonia manages certain innovation policy measures compared to other European Union countries. In terms of providing knowledge inputs for the innovation process, we will analyse public sector expenditure on R&D and education. We will also look into how Estonia provides the various elements for the system of innovation, by analysing cooperation in innovative projects between

firms and institutions, but also innovative small and medium sized enterprises (SME). We will analyse public sector support services and measures for innovative firms, and finally, we will look at Estonia's position on the European Innovation Scoreboard and the innovation chapter of the Global Competitiveness Report.

In terms of creating innovation knowledge it is extremely important that the state supports the arrangement of R&D. The position of Estonia and other European countries according to public sector (state and higher education sector) R&D expenditure in 2005 (in relation to GDP) and related dynamics for 1999-2005 can be seen on the competition field diagram (see figure 2). Figure 2 demonstrates that Estonia was situated in the 1st quadrant during all the years viewed; that means it was an "aspirer". Estonia is characterized by a R&D cost level lower than the EU average, but at the same time has a higher growth rate. That is why Estonia is slowly but confidently approaching the average EU level.

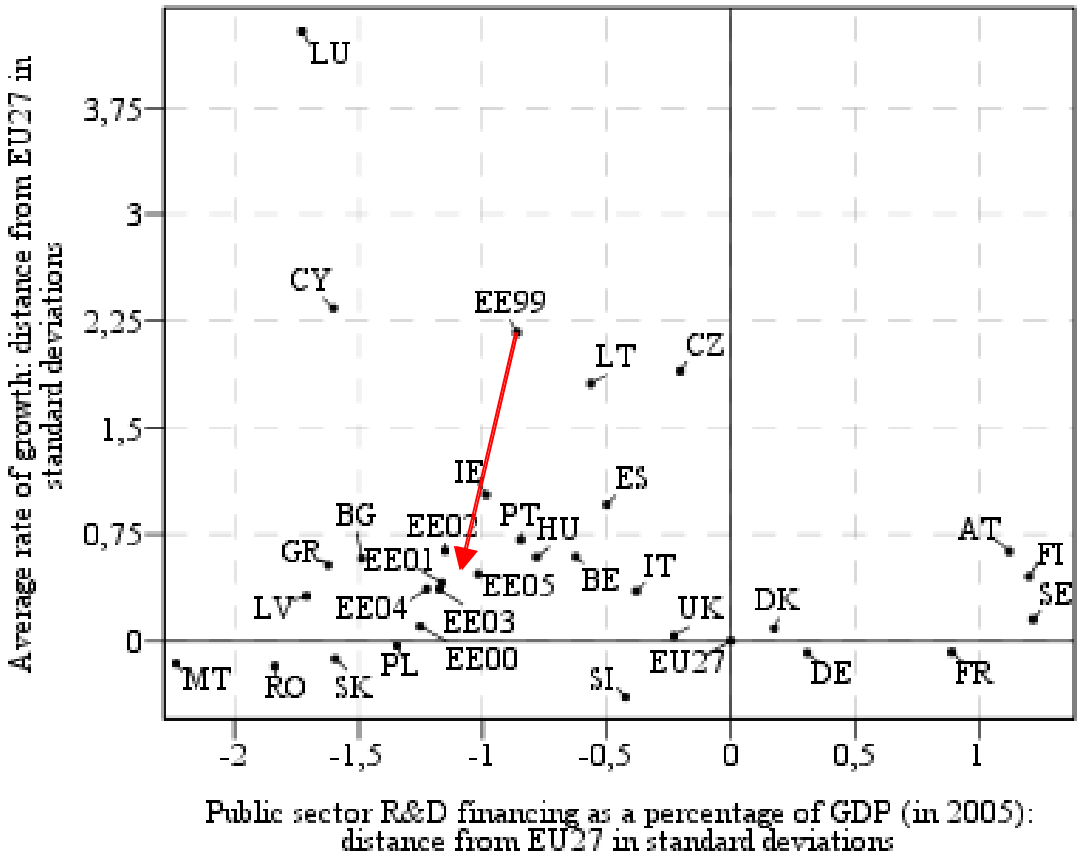


Figure 2. Estonia's position in EU according to public sector R&D financing (relationship to GDP) and dynamics. (Eurostat; calculation by the authors)

Estonia has a public sector R&D expenditure level about a third less than the EU average: respectively 0.42% and 0.64% of GDP. The highest R&D cost share of GDP is in Finland and Sweden (0.9%).

When viewing Estonia's R&D expenditure change over time, it can be seen that public sector R&D as a percentage of GDP for 1998-2005 has risen. The highest

increase was in 1999 compared to 1998, when the share of R&D expenditure from GDP grew 18.4%.

Most of the new knowledge created by the state is created at universities and public sector institutions. The higher education sector enjoys the majority of public sector expenditure and that share has been relatively even in Estonia: 64-73% of public sector R&D expenditure.

Besides creating innovation knowledge, the preparing a competent workforce is very important. Next, we will analyse public sector education cost level and dynamics in comparison to other EU members (see figure 3). The development path of Estonian education costs can be viewed for 1999-2005. The background of other EU members has been created using 2005 data. From figure 3 it can be seen that Estonia was in quadrant II, which means it was a "leader", but for 2000-2003, Estonia dropped into quadrant III, which means it became a "renegade from leader role" and was moving towards quadrant IV. During the years 2004-2005, Estonia was already among the "losers" when taking into account the education cost level, lagging behind the EU average in respect to the public sector education cost level as well as the growth rate. That is why Estonia's competitive position viewed from that aspect has become worse among EU countries.

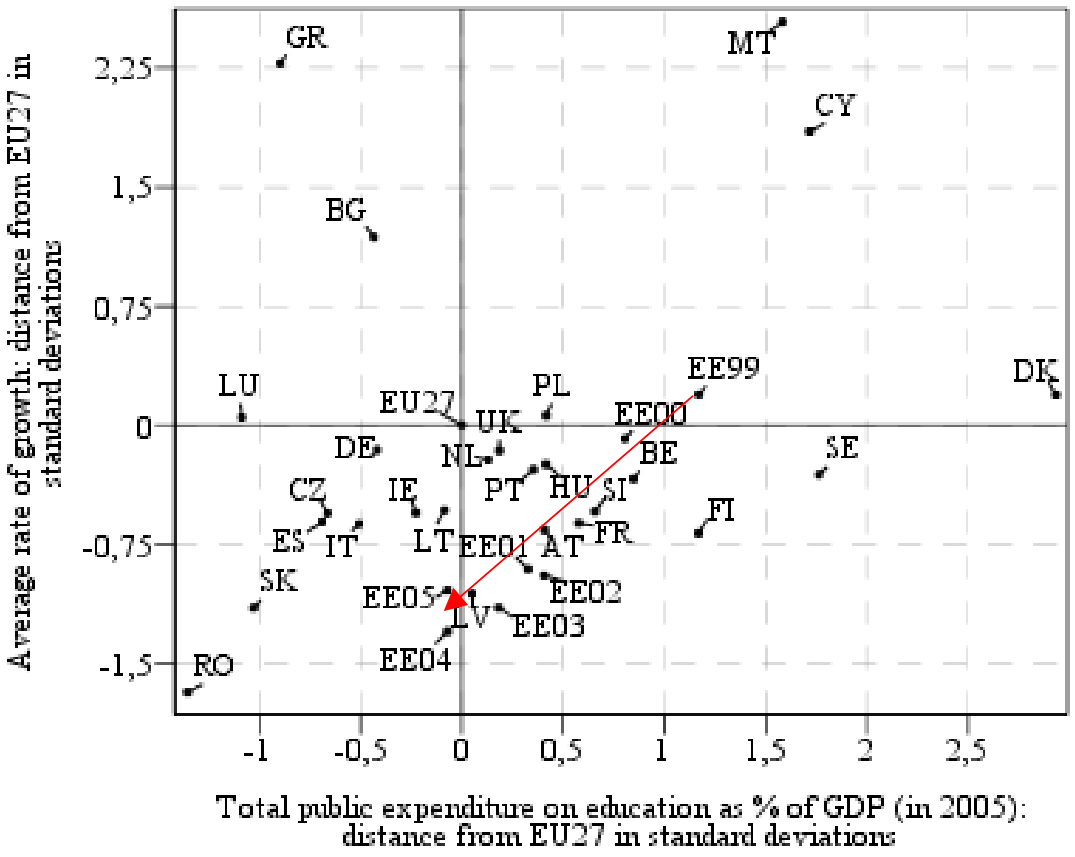


Figure 3. Estonia's position in EU when taking into account public sector education cost level (relationship to GDP) and dynamics. (Eurostat; calculations by the authors)

The education cost level as a percentage of GDP was 4.92% in Estonia in 2005, and the EU average was 5.00%. Compared to countries with the highest public education sector costs level (Denmark 8.3% and Sweden 7.0%), Estonia's level is respectively 40% and 30% lower.

As the number of students differs among different countries, then public sector education costs per student should be compared. Therefore, we will only view those education costs per student that go directly to educational institutions. In figure 4, a competition field diagram has been presented, where Estonia's and EU countries' public sector education costs level (per student) and dynamics has been presented. Estonia's development path can be viewed for 2000-2005 and the background for other EU members has been given on the basis of 2005 data. In the period 2000-2002, Estonia was in quadrant IV and so among the "losers", but starting from 2003, the average growth rate of that indicator has been above the EU average. That means that for 2003-2005, the level of public sector education costs (per student) was less than average in Estonia, but higher than the EU average growth rate and this put Estonia in quadrant I among the "aspirers".

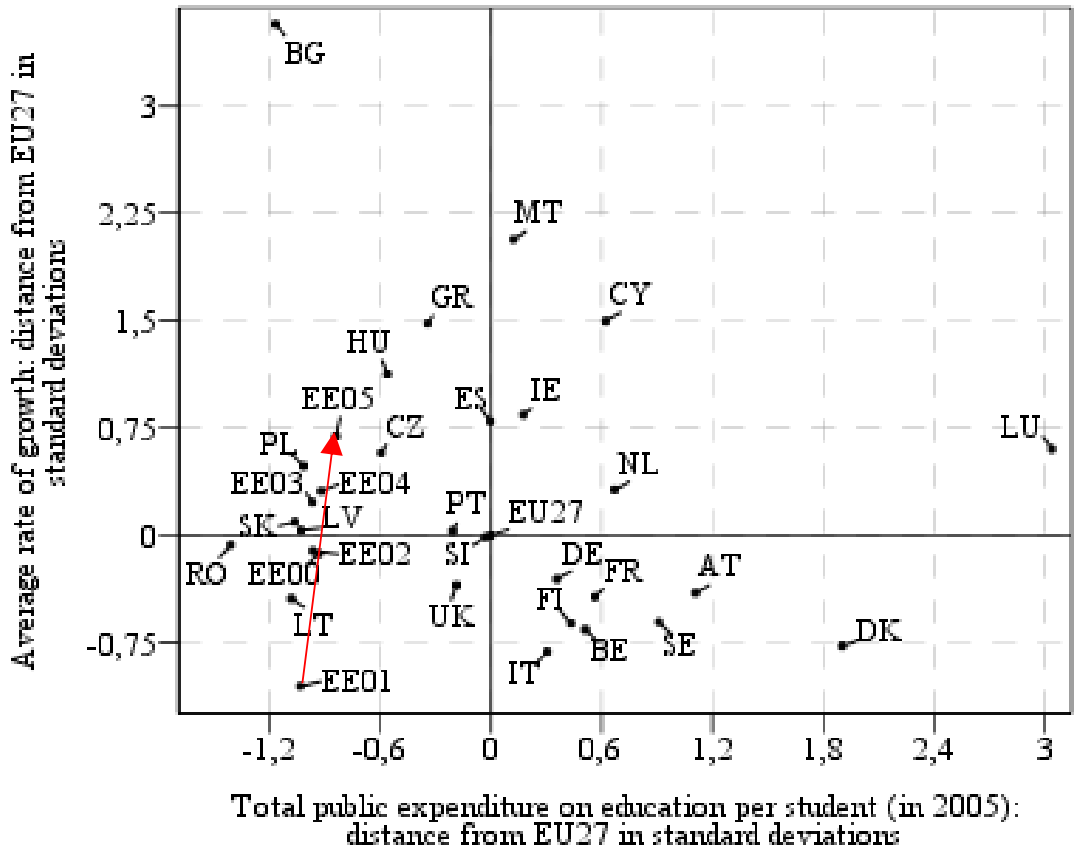


Figure 4. Estonia's position in EU in respect to the level and dynamics of public sector education costs per student. (Eurostat; calculations of authors)

In 2005, total public expenditure on education per student was 3 204 EUR (PPS). The average in the EU was 4 527 EUR (PPS) per student; that means about 1.5 times higher than in Estonia.

Next, (see figure 5) the Estonian innovation competitiveness pattern is presented in respect to the levels and dynamics of all previously viewed components plus two other innovation indicators are added: business sector and higher education sector R&D expenditures (in relation to GDP).

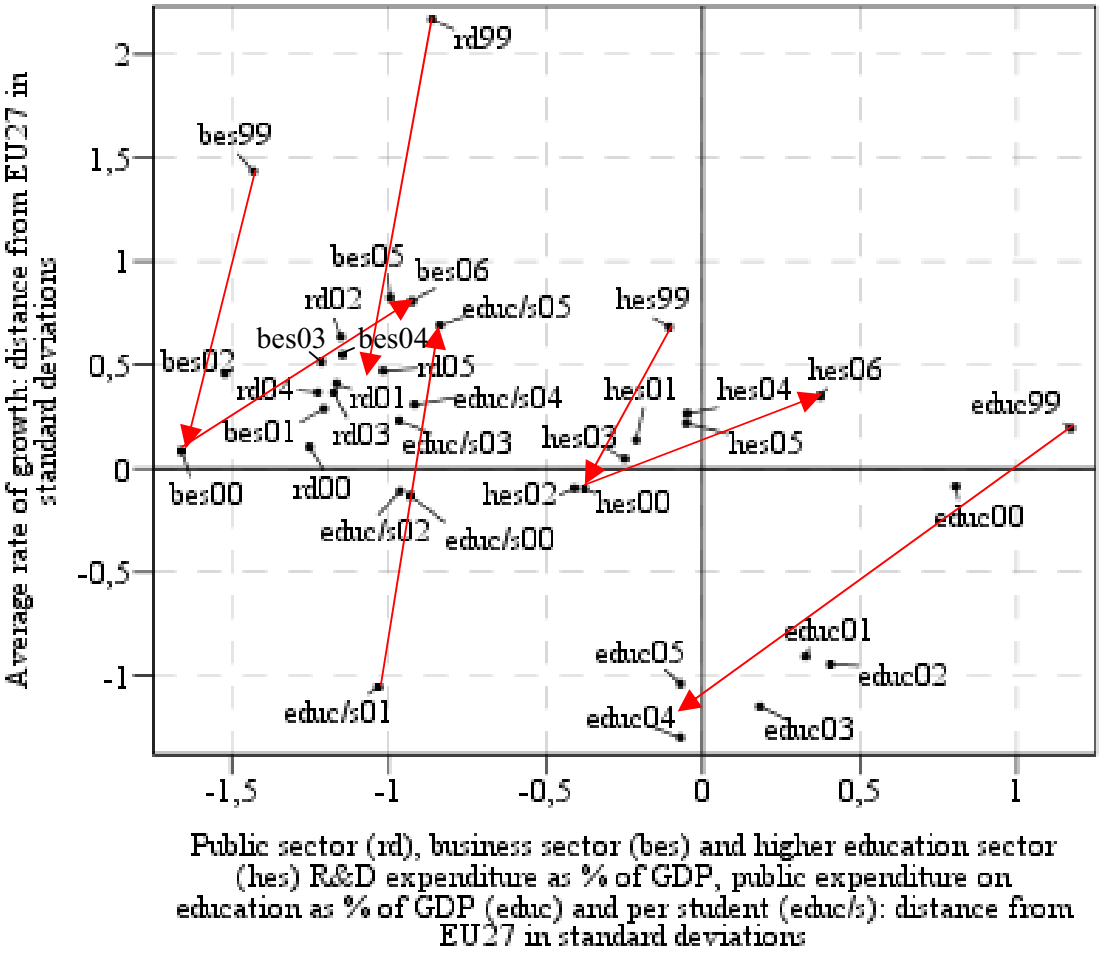
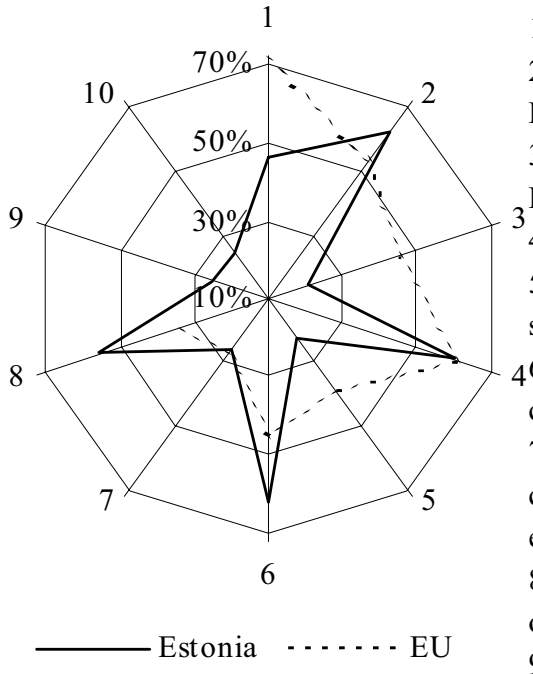


Figure 5. Estonia's innovation competitiveness pattern in the EU in respect to set levels and dynamics of components of innovation. (Eurostat; calculations by the authors)

When looking at the business and higher education sector R&D expenditure, Estonia's development path can be viewed for 1999-2006. According to business sector R&D expenditure, Estonia is in quadrant I, which means among the "aspirers" – business sector R&D costs were lower than the EU average, but the growth rate was higher. According to higher education sector R&D expenditure, Estonia has moved between different quadrants in the years under observation, but in 2006, Estonia was in quadrant II, which means among the "leaders" – higher education sector R&D costs and average growth rate were higher than the EU average.

In conclusion, the following chart is drawn (see figure 6), which relies on the relationship of the Estonian and EU average innovation indicators to the set's highest value. As there was no EU average for some indicators, then for those only the Estonian share of the highest value has been presented. Figure 6 provides a good

overview of which indicators are higher in Estonia compared to the EU average and how the Estonian values compare to the highest value for each indicator in the entire sample.



1. Total public expenditure on R&D
2. Higher education sector expenditure on R&D
3. Business enterprise sector expenditure on R&D
4. Total public expenditure on education
5. Total public expenditure on education per student
6. Enterprise engaged in innovation co-operation
7. Enterprise engaged in innovation co-operation with universities or other higher education institutions
8. Enterprise engaged in innovation co-operation with other enterprises or suppliers
9. Enterprise that received any public funding
10. SMEs that received any public funding

Figure 6. The level of Estonian innovation indicators in comparison to the EU average. (Eurostat; composed by the authors)

In Estonia, the values for indicators 2, 6, and 8 are higher than the EU average. That is why the costs in Estonia higher education sector R&D are relatively high and innovation cooperation is carried out by a relatively large share of innovative firms. Cooperation with other firms and suppliers is remarkably higher in Estonia compared to the EU average. At the same time, all three indicators make up below 65% of the highest value.

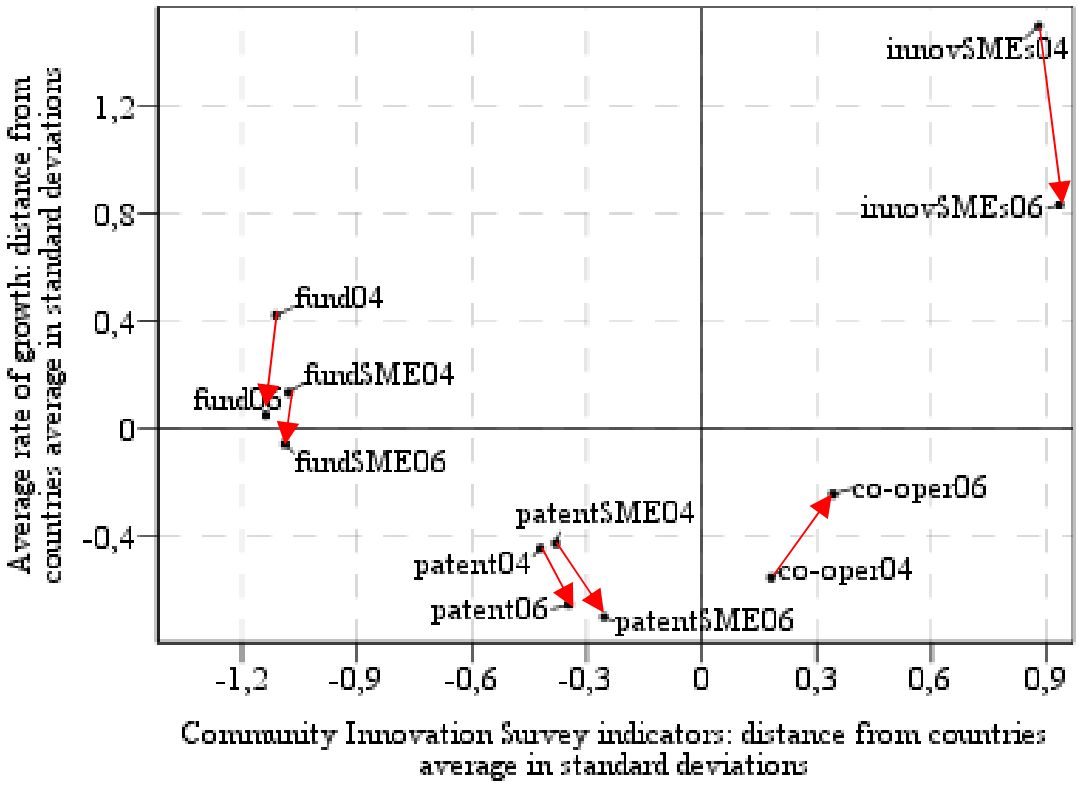
The values for indicators 4 and 7 are roughly on the EU average level. That is why public expenditure on education (from GDP) and the share of innovative firms that cooperate with universities and other higher education institutions in Estonia is on about the same level as the EU average. The average Estonian level is respectively 60% and 25% of the highest values. The Estonian public sector must provide more support for cooperation between firms, universities and public sector research institutions.

The values for indicators 1, 3 and 5 are lower than the EU average in Estonia. That is why public sector R&D costs, public expenditure on education per student and business sector R&D costs are low in Estonia. From this the Estonian public sector should increase public sector R&D expenditure and education costs. Attention should be drawn to encouraging the private sector, so that firms can also increase R&D costs.

There is no comparison with the EU average for figures 9 and 10, but only in one member state are values lower than in Estonia. That is why SME innovation activities have been left without attention and financial support to innovative firms is very low in Estonia.

4. Assessing Estonia's innovative position using indicators from the Community Innovation Survey and innovation charts

In figure 7, the pattern of Estonian innovation competitiveness is presented using the level and dynamics from certain indicators in the Community Innovation Survey (CIS). These indicators are the share of innovative firms involved in innovation cooperation, the share of firms that have made patent applications, the share of innovative SME and the share of innovative firms that received any public funding. The Estonian development path can be viewed with the help of CIS4 and CIS2006.



Share of innovative firms making innovation cooperation (co-oper) and that received any public funding (fund), share of firms/SME that have made patent applications (patent/patentSME), share of innovative SME (innovSME), share of innovative firms/SME that received any public funding (fund/fundSME).

Figure 7. Estonia's innovation competitiveness pattern using the values and dynamics for CIS indicators (Eurostat; calculations by the authors).

Using the innovation cooperation indicator, Estonia is situated in quadrant III, which means it is among "renegades from leader role". So Estonia is characterised by a greater share of firms that have made innovation cooperation than the EU average, but a less than average growth rate.

In the period 2002-2004, at least some innovation cooperation was carried out by 34.82% of innovative firms; the EU average was 25.50% of innovative firms. To some extent, more innovative firms were involved in innovation cooperation (39.47%) in the period 2004-2006. Table 2 summarizes the share of firms that have been involved in innovation cooperation from the total number of innovative firms and this has been observed using different cooperation partners.

Table 2. Share of firms that have been involved in innovation cooperation from the total number of innovative firms in 2002-2004 and 2004-2006 (%)

	Estonia	EU	Highest	Latvia	Lithuania
In period 2002-2004 (CIS4)					
All types of innovation co-operation	34.82	25.50	Lithuania 56.11	38.83	56.11
Innovation cooperation with universities or other higher education institutions	8.57	8.84	Finland 33.1	13.86	12.03
Innovation cooperation with government or public research institutes	6.07	5.67	Finland 26.35	12.10	9.60
Innovation cooperation with other enterprises of the same sector	18.49	8.34	Finland 34.22	25.08	25.44
Innovation cooperation with consultants, commercial labs, or private R&D institutes	9.98	8.89	Finland 32.67	18.26	24.94
Innovation cooperation with suppliers	23.32	16.52	Lithuania 45.45	32.56	45.45
In period 2004-2006 (CIS2006)					
All types of innovation co-operation	39.47	-	Cyprus 68.8	39.11	51.16
Innovation cooperation with universities or other higher education institutions	9.34	-	Finland 35.99	16.86	18.81
Innovation cooperation with government or public research institutes	4.95	-	Finland 27.86	14.05	8.69
Innovation cooperation with other enterprises of the same sector	16.05	-	Finland 35.59	20.73	18.33
Innovation cooperation with consultants, commercial labs, or private R&D institutes	10.73	-	Cyprus 44.76	18.15	22.78
Innovation cooperation with suppliers	22.76	-	Cyprus 62.42	32.79	40.42

Source: Eurostat; calculations by the authors.

From table 2 we see that according to the CIS4 questionnaire in Estonia, innovation cooperation was conducted at a higher level than the EU average with other enterprises of the same sector, suppliers, consultants, commercial labs or private R&D institutes. To some extent less cooperation was conducted with universities or other higher education institutions than the EU average. The cooperation figures were highest for 2002-2004 in Finland and in Lithuania. Attention should be drawn to the fact that among all cooperation partners more innovation cooperation was conducted in Latvia and Lithuania than in Estonia.

In the period 2004-2006 (CIS2006), more innovation cooperation was conducted in Estonia with universities and other higher education institutions, consultants, commercial labs or private R&D institutes than for 2002-2004 (CIS4). Among other cooperation partners, the share of innovative firms that have cooperated has fallen. Most cooperation in the period 2004-2006 was conducted in Finland or in Cyprus, and still all the shares of firms that have cooperated is higher in Latvia and Lithuania than in Estonia.

Derived from this, it can be concluded that compared to the other EU member states, Estonian firms cooperate relatively more with other firms (from the same economic sector as well as with suppliers). At the same time, the cooperation of firms with universities and public research institutes is relatively low in Estonia. That is why Estonia should support cooperation between firms, universities and public sector research institutions. For instance, the state could initiate a communication channel, so that universities and research institutions could be informed about which innovations firms need, and so that firms could be informed about what research universities and research institutions could offer.

When looking at patent application indicators, it can be seen that Estonia is in quadrant IV, which means among the “losers” (see figure 7). In Estonia the share of firms that have applied for patents and their growth rate is lower than the EU average. That is why Estonia’s competitive position among EU countries is low when viewed in this area.

Of the Estonian firms questioned in CIS4, only 3.22% had applied for a patent in 2002-2004. In the CIS2006 survey, the figure dropped even more – in the period 2004-2006 only 2.29% of firms applied for patents. The share of SMEs that applied for patent in 2002-2004 and 2004-2006 was also very low in Estonia – respectively 2.85% and 2.15%. Private sector innovation is strongly supported by SMEs and the public sector should help them.

We will now look at the European SMEs that answered the CIS4 and CIS2006 questionnaires. When taking into account the innovative SME figure, then Estonia is in quadrant II, which means among the “leaders” (see figure 7). In other words, Estonia is characterised by a greater share of SMEs and a greater growth in the number of SMEs than the EU average.

Of Estonian SMEs questioned in CIS4, 47.79% were engaged in innovative activities and the EU average was 38.22%. In CIS2006 the share of innovative SMEs in Estonia was somewhat smaller (47.11%). The highest share of SMEs was in Germany – 63.5% (CIS4) and 61.0% (CIS2006).

According to public sector financial support figures, Estonia is in quadrant I, which means among the "aspirers" (see figure 7) – the share of innovative firms that received any public funding was lower than the EU average, but the growth rate was higher. At the same time Estonia is moving towards quadrant IV. The share of innovative SMEs that received any public funding in Estonia has reached quadrant IV, which means among the "losers", having lower than EU average growth rate.

The share of innovative firms that received public sector financial support in 2002-2004 and 2004-2006 was low in Estonia compared to other EU countries – respectively 9.71% and 9.49%. Only in Bulgaria was the figure lower – respectively 4.9% and 8.1%. The share of innovative SMEs that received any public funding in 2002-2004 and 2004-2006 was also low in Estonia – in both cases 9.32%. These figures were only lower in Bulgaria – respectively 4.1% and 7.7%.

A relatively large number of SMEs are engaged in innovative activities in Estonia. At the same time, only a small proportion of Estonian innovative SMEs received public sector financial support. Governments in Estonia should pay more attention to supporting innovative activities among SMEs. The share of large firms that received public sector financial support was two times higher in Estonia than the share of SMEs. One reason for this could be that SMEs do not have the competence to apply for support. That is why measures should be taken to raise the awareness of public sector financial support applications among SMEs.

The European Innovation Scoreboard, created at the initiative of the European Commission, lists EU member states according to innovation capability. The innovativeness of countries is measured using the Summary Innovation Index (SII). To calculate the SII index, 25 innovation indicators are used, which have been divided into five categories: innovation drivers, knowledge creation, innovation and entrepreneurship, applications and intellectual property (European ... 2008: 8). The first three categories involve innovation input indicators and the other two, output indicators.

Figure 8 presents the Estonian innovation competitiveness pattern using the European Innovation Scoreboard indicators and their dynamics. The Estonian development path can be seen for 2004-2007.

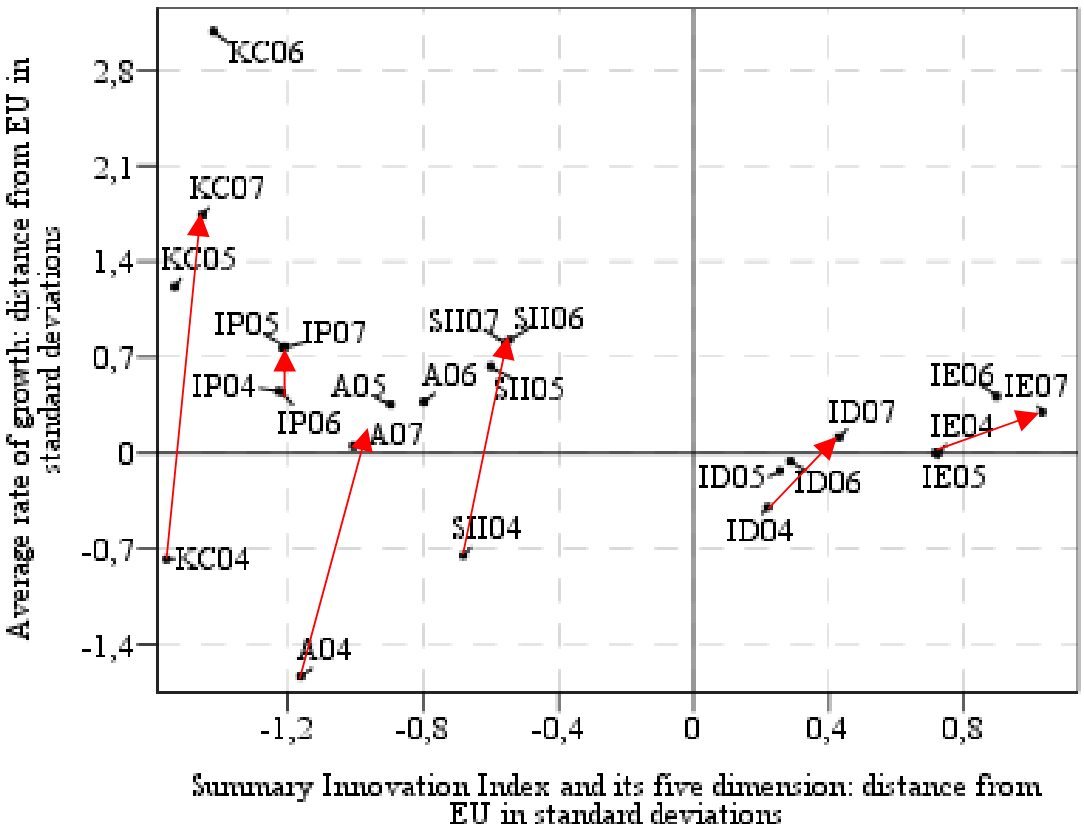


Figure 8. Estonian innovation competitiveness pattern using European Innovation Scoreboard indicators and their dynamics. (European Innovation Scoreboard; calculations by the authors)

According to SII, Estonia was in quadrant IV in 2004, which means among the "losers", but starting from 2005 Estonia had a lower value in SII than the EU average, but at the same time a higher growth rate. So Estonia is now situated in quadrant I, which means among the "aspirers". In Estonia, the SII value was 0.37 in 2007, which is to some extent lower than the EU average – 0.45. In Sweden the SII value was the highest (0.73).

In terms of innovation drivers, we see that Estonia was in quadrant III in 2004-2006, which means among the "renegades from leader role", moving towards quadrant II. In 2007, Estonia arrived among the "leaders", having more than EU average value in the innovation driver category and to some extent a higher growth rate. So the structural changes needed for innovation in Estonia are better than average. The best structural conditions had been created in Denmark, Finland, Sweden and UK in 2007.

In terms of knowledge creation, Estonia was in quadrant IV in 2004, which means among the "losers", but from 2005, Estonia is described as having low knowledge creation value, but a higher growth rate than the EU average. So Estonia is now in

quadrant I, which means among the “aspirers”. In terms of knowledge creation, Estonia is among the stragglers in the EU. Only in four countries were R&D investments on a lower level than in Estonia in 2007 – Latvia, Malta, Slovakia and Romania. The EU average for this indicator was three times higher than in Estonia. The highest R&D investments were in Sweden, Finland and Germany.

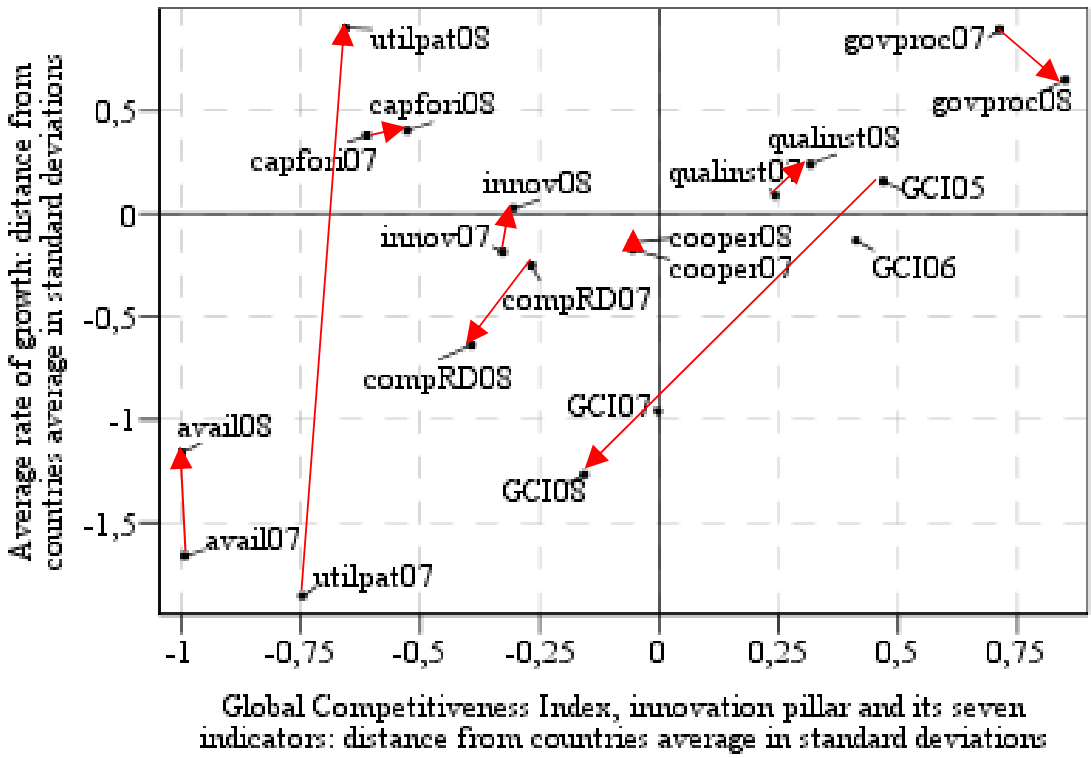
In terms of innovation and entrepreneurship, Estonia has been in quadrant II, which means among the “leaders” during all years under observation, having more than the EU average indicator value and growth rate. In terms of innovative entrepreneurial activity, Estonia was in fourth place in the EU in 2007. Only in Sweden, UK and Cyprus were innovation activities higher than in Estonia.

In respect to the application of innovation, Estonia was in quadrant IV, which means among the “losers” in 2004, but since 2005 Estonia has had a lower than average innovation implementation value, but at the same time higher than average growth rate. So Estonia is now situated in quadrant I, which means an “aspirer”. In respect to innovation implementation Estonia was in 20th place in the EU in 2007. On the same level with Estonia were Poland and Bulgaria. The effectiveness of innovative sectors was the highest in Malta and Germany.

With respect to intellectual property, Estonia was in quadrant I in 2004-2007, which means among the “aspirers”. Estonia is characterized with relatively low intellectual property category value, but higher than EU average growth rate. From intellectual property aspect Estonia was lower than EU average in 2007. In respect of knowledge growth best results were achieved in Germany, Luxemburg and Sweden.

The Global Competitiveness Report from the World Economic Forum lists world countries on the basis of competitiveness. Competitiveness is measured using the Global Competitiveness Index (GCI). The GCI shows 12 different pillars, of which the last is dedicated to innovation. Within this framework, the ability of an economy to produce new technologies is assessed using seven indicators: capacity for innovation, quality of scientific research institutions, company spending on R&D, university-industry research collaboration, government procurement of advanced tech products, availability of scientists and engineers and utility patents (The Global ... 2008).

Next (see figure 9), Estonia’s position in comparison to other EU members will be viewed in respect to the GCI, innovation pillar and its sub-indicators. Using the GCI we can monitor the Estonian development path for 2005-2008, but the innovation pillar and its indicators only for 2007 and 2008.



innov - innovation pillar; capfori - capacity for innovation; qualinst - quality of scientific research institutions; compRD - company spending on R&D; cooper - university-industry research collaboration; govproc - government procurement of advanced tech products; avail - availability of scientists and engineers; utilpat - utility patents

Figure 9. Estonian innovation competitiveness pattern using the GCI, innovation pillar and its indicators values and dynamics. (Global Competitiveness Report; calculations by the authors)

According to the GCI, Estonia was in quadrant II, which means among the "leaders" in 2005, but moving through quadrant III reached quadrant IV, which means among the "losers" in 2007, where it also stayed in 2008. So Estonia's competitiveness and its growth rate are lower than the EU average. In Estonia the GCI value in 2008 was 4.67, which was somewhat lower than the EU average – 4.75. The GCI value was highest in Denmark (5.58).

In terms of the innovation pillar, Estonia was in quadrant IV, which means among the "losers" in 2007, but in 2008 it reached quadrant I, which means among the "aspirers". So Estonia can be said to have an innovation indicator lower than the EU average, but a higher than average growth rate. Estonia was in the middle of EU ranking – 13th place, according to 2008 innovation assessment. Finland, Germany, Sweden and Denmark had the highest rankings.

Estonia's strengths in the field of innovation are government procurements of advanced tech products, the quality of scientific research institutions, capacity for innovation and utility patents. Estonia's problems are a lack of scientists and

engineers, university-industry research collaboration and low company spending on R&D. So the public sector should pay attention to creating new knowledge and raising the qualifications of workers, but also encouraging firms to increase their R&D expenditure.

Conclusions

During the last decade Estonian economic development was mainly based on the production and export of traditional labour and resource intensive products, whereas innovation has played a less important role. Although innovation has been defined in various ways, and it takes place within private and public economic units, some authors stress that innovation activity should provide competitive advantage and economic profit.

The modern stage theory of development focuses on innovation. Three developmental stages are considered. In stage 1 development is natural resource and labour driven, whereas in stage 2 capital and imported technology are the main developmental factors. Stage 3 development is dominated by R&D and innovation. Therefore, innovation policy is a central instrument of development policy. Estonia has reached the investment driven stage 2. It has to apply instruments of innovation policy to develop from a technology importing country to an innovation-based country.

Therefore, innovation policy is one of the main tasks of Estonian economic policies. The public sector has to provide knowledge and other inputs for the innovation process. Moreover, it should provide and develop innovations in its research institutes and public offices – universities, vocational colleges and public enterprises. The public sector is responsible for an innovation friendly legal environment and should control and encourage innovations via procurement and investment policy. Much financial assistance should be offered to start ups, to developing innovative firms and as far as it possesses large firms that have to apply innovative technologies. Co-operation among them should be backed and investment in information and communication technology needs to be a priority.

For Estonia as a small transformation country the potential of the public innovation policy is rather limited. Moreover, this policy is embedded in macroeconomic and microeconomic regional competition, which takes place as development competition and in the form of project oriented competition. Rather harsh oligopolistic competition prevails in development competition. Monopsonies and oligopsonies prevail in project oriented regional competition.

To discover the actual competitive situation with respect to competitive innovation policy, a statistical comparison between Estonia and European Union members and the average situation in the European Union was carried out. A successful competitive innovation policy raises the national income and its growth. The conditions for a public innovation policy to contribute positively to these items and the potential of success of innovation policy are expressed through indicators. The value of the indicators mainly used in Estonia and partly chosen by the authors as

well as indicators applied in the Community Innovation Survey (CIS), the Summary Innovation Index (SII) and the Global Competitiveness Index (GCI) were used, determined and calculated by the authors. The position of the member countries of the European Union are calculated and measured along the X-axis of a coordination system and the changes are determined and measured along the Y-axis. In this way members who are "leaders" in the second quadrant, "renegades from the leader role" in the third quadrant, "losers" in the fourth quadrant and aspirers in the first quadrant were identified.

The investigation of the first group of indicators shows the following interesting results. Estonian higher education sector expenditures in R&D and the co-operation of firms concerning innovations are above the average EU level. Total public R&D expenditures and that of businesses are lower than the European average.

Therefore, the Estonian public sector should promote cooperation between firms, universities and public sector research institutions and should spend more on public sector R&D expenditure and education programs to encourage firms to increase R&D. The Community Innovation Survey (CIS) refers to the share of innovative firms involved in innovation cooperation, the share of firms that made patent applications, the share of innovative SMEs and the share of innovative firms receiving public funding. Estonian firms cooperate relatively often with other firms in the same economic sector and with suppliers. However, the cooperation between firms and universities and public research institutes is relatively low. The number of patents is low in Estonia and with respect to support for innovative small firms we obtained the same result as with the first indicator group.

The innovativeness of EU-countries is measured using the Summary Innovation Index (SII), where 25 innovation indicators are assigned to five categories: innovation drivers, knowledge creation, innovation and entrepreneurship, applications and intellectual property. During the last years, Estonia has developed from a "looser" position to that of an "aspirer". Successful structural reforms in innovation policy signal innovation driver indicators here in Estonia to move in the direction of a "leader" position. Entrepreneurial innovativeness category is also among leaders. The positive development of knowledge creation and an innovation application system has resulted in Estonia reaching the "aspirer" position where also protection of intellectual property category stands.

Competitiveness measured using the Global Competitiveness Index (GCI) refers to the role of innovations as well. The respective seven indicators are: capacity of innovation, quality of scientific research institutions, company spending on R&D, university-industry research collaboration, government procurement of advanced tech products, availability of scientists and engineers and utility patents. In total, Estonia's competitiveness and its growth rate are lower than the EU average. Estonia possesses a "loser" position. According to single indicators, Estonia does well in the field of government procurements of advanced tech products, with respect to the quality of scientific research institutions, capacity for innovation and utility patents.

The problems in Estonia are the lack of scientists and engineers, university-industry research collaboration and low company spending on R&D.

The Estonian government sector should promote new knowledge creation, improve workers' skills and encourage firms to increase their R&D expenditure. The public sector has to execute an active innovation policy using the instruments mentioned, and the government can learn about the necessary and promising field of innovation policy from this comparison with European indicators.

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