

SHAPING A HOLISTIC NATIONAL INNOVATION SYSTEM¹

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Abstract

For the sustainable economic development of a state the functioning national innovation system (NIS) is needed. NIS covers different government policies (for instance, education policy, R&D policy innovation support to business sector, intellectual property protection, public procurement policy, etc.). All these policies have to be integrated in a holistic system through innovation policy enabling the functioning different policies in mutual relationships smoothly and effectively for sustainable economic development. The goal of this article is to highlight the role of innovation policy in shaping a holistic NIS. The first part of the article deals with the need for public sector intervention in innovation processes and problems resulting from it. In the second part a holistic NIS model that reflects the role of innovation policy is developed and presented. The third part deals with the structure of innovation policy based on a holistic NIS model.

Keywords: market and system failures, innovation processes, innovation policy, national innovation system, main functions of innovation policy

JEL-classification: O32, O38

¹ This article is written with the support of the Estonian Ministry of Education and Research foundation project No SF0180037s08 “The path dependent model of the innovation system: development and implementation in the case of a small country.” This publication has been supported by European Social Foundation through the Research and Innovation Policy Monitoring Programme.

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INTRODUCTION

High risks related to research and development (R&D) activities inhibit innovation efforts of economic agents (enterprises and organisations) and thus their sustainable development. The success of national development depends largely on how the innovation related risks can be lessened to an acceptable level while preserving enough of the perceived responsibility of economic agents for the efficiency of innovation investments. Innovation is assessed as a most important factor of economic development (Edquist H 2011; European Commission 2014).

Thus, ensuring the innovative development of a country represents an optimisation problem for a multidimensional objective system. Solving it requires balancing the system of measures aimed at achieving the objectives of innovative development of a country. The balancing and integrating different government intervention measures has to play innovation policy. With the support from national regulations (laws, standards and normative) and public sector institutions, the task of innovation policy is to develop a national innovation system (NIS) which helps to cover costs of creating and developing an environment (education, science, supply and mediation of information, intellectual property protection, social networks, etc.) that promotes innovation and which guides economic agents to the search and implementation of innovations through various political support activities (public procurement, tax breaks, subsidies, etc.).

In the modern world the activity and effectiveness of economic units in their innovation processes is largely dependent on the smooth and effective functioning of the innovation system, including the effectiveness and coordination of innovation policy measures characterised through large number and qualitatively different influence on development processes. States need to adopt a broad and holistic development approach to create the supportive macroeconomic environment (Bailey, Lenihan 2015).

The goal of this article is to highlight the role of innovation policy in shaping and ensuring the functioning of a holistic NIS. The following research tasks have been set:

- explain reasons for public sector intervention in innovation processes and problems resulting from it;
- emphasise the nature of a NIS and develop a new holistic VIS model that reflects the role of innovation policy for integrating the government intervention measures in innovation processes;
- analyse the nature and structure of innovation policy areas based on studies of different authors.

The first part of the article deals with the need for public sector intervention in innovation processes and problems resulting from it. In the second part a new holistic NIS model that reflects the role of innovation policy is developed. The third part deals with the structure of innovation policy based on a holistic approach to NIS.

1. Reasons for public sector intervention in innovation processes and problems resulting from it

This section first deals with the reasons for public sector intervention in innovation processes from an economic theory point of view. Then problems related to government intervention generally and some problems related to specific innovation policy instruments are highlighted.

It is generally recognised that the public sector has an important role in promoting innovation – its task is to support the development, diffusion and implementation of innovations (Edquist 2006:182). Government intervention in the economy is usually justified by the need to overcome market failures. The development of innovation policy can also to some extent be explained by market failures occurring within innovation processes. In many cases market forces cannot ensure long-term investments in innovation processes due to the uncertainty, indivisibility and non-excludability of those processes (Nelson 1981:106-107). Market failures hamper the creation and implementation of the new knowledge. Market forces take into account only private benefits but not the positive externalities of innovations to the development of society as a whole, i.e. the social utility. The role of the public sector is to promote the creation of inventions and scientific discoveries by reducing risks with subsidies and by protecting intellectual property. (Edquist et al. 2004:438) Theoretically, the value of public sector support measures should equal the social benefits created by economic agents in their innovation activities.

Innovation policy that is aimed at reducing costs and lowering the risks of innovation activities for economic agents meets the “linear process” of innovation: new knowledge is created in research institutions, then adjusted to practical needs and introduced in companies (organisations) providing products (services). At the same time, only a small part of innovations are developed in a linear process. Thus, market failures are probably not the main hinderer of innovation.

The role of the public sector in innovation processes is better explained with the help of the theory of system failures, which explains that failures in collaboration

between different parties of the innovation system are the main reason for low innovation performance (Soete et al. 2009; Dolfsma 2011; Edquist C. 2011; Bleda, Del Rio 2013; Haapanen et al. 2014). Without preventing or overcoming these failures the innovation activities of economic agents are hindered and innovation performance remains weak.

System failures are innovation hindering incompatibilities (including contradictions) between organisations and institutions in the innovation system, as well as between various policies. Therefore, the role of the public sector lies not so much in supporting the individual innovation actions of economic agents, but in ensuring the emergence and development of a well-functioning innovation system. To overcome system failures adequate policy instruments must be directed towards the creation of missing components in the innovation system, the development of cooperative relationship and the correction of errors made in the development. (Metcalf 2005:68)

According to the OECD (1997a:41), system failures become evident in the insufficient cooperation between parties in the innovation process, in the incompatibility between fundamental research done by the public sector and applied research done by the private sector, in the inefficient operation of technology transfer institutions and in the deficiencies of distributing information. Edquist identifies three major system failures (2002:235): organisations needed for the functioning of the innovation system are missing or are inappropriate; institutions needed for the functioning of the innovation system are missing or are inappropriate; cooperation between the innovation system components (institutions and organisations) is absent or insufficient. This approach is supported by the view (Arnold 2004:7) that the public sector cannot be confined only to the funding of fundamental research, but must ensure the functioning of the whole innovation system and thus help to overcome emerging failures. According to Arnold's approach, system failures can be divided into four types (Ibid.:7):

- capability failures – the inability of companies or organisations to act in their own best interest (because of poor management, lack of technological competence, poor learning ability, or inability to take advantage of offered technologies);

- failures in institutions – the inflexibility of companies and other organisations (universities, research institutes, patent offices, etc.) and the resulting failure to adapt to changes in the environment;

- network failures – problems in relationships between the parties of the innovation system (lack of relations or insufficient quality of relationships; transition failures, where there is a failure to implement new technological opportunities; lock-in failures, where morally obsolete technologies remain in use for too long; problems in the market structure);

framework failures – weaknesses in legal institutions, intellectual property protection, health and safety conditions and other background conditions (cultural and social values).

According to Tsipouri et al. (2008:15), weaknesses in the governance system (policy formulation, evaluation, etc.) should also be added as a fifth policy failure to the previous four system failures.

To relieve system failures in innovation processes, the public sector has to create policy consulting programmes, consultation forums and cooperation networks in order to promote coordinated development, distribution and implementation of innovation policy measures.

Public sector intervention in innovation processes has also earned criticism, because it may damage the normal course of economic processes. Edquist et al. (2004:430) state that two conditions have to be fulfilled for public sector intervention: there has to be a problem (a market or a system failure), i.e. companies need to fail in achieving the objectives of innovation; and public sector institutions have to be able to solve or relieve problems in market economic processes, i.e. effectively implement innovation policy instruments. Potential failures in the public sector (e.g. bureaucracy, incompetence of officials, corruption) have to be also looked at when analysing the purpose of public sector intervention.

Public sector subsidies usually increase the total social costs of introducing new products and technology, slow down the transfer of knowledge from research institutions to enterprises and increase the risk of failure. Public sector intervention in innovation processes may also cause other threats:

- as a result of R&D subsidies, new products are brought to the market too quickly and product life cycles may shorten unreasonably (Grupp 1998:387);

- disparities in regional development levels may increase – disparities in the EU have increased lately (see Reiljan 2010), which is favoured by the concentration of innovation grants to more advanced regions (Fagerberg 2002:56).

There are numerous innovation policy instruments and their effects are different in different circumstances. Each country has to develop and implement a suitable system of innovation policy instruments for itself, taking into account the purpose of public sector intervention. In order to be successful, the development of the innovation policy has to take into account the path dependency of the country's development, but also specific external factors affecting the development of the country. The

Estonian innovation system development requires giving special attention to these innovation policy instruments that are suitable for a small country (see Friedrich et al. 2011).

2. The nature and structure of a national innovation system

The following section discusses problems related to defining and structuring a national innovation system. Christopher Freeman introduced the term national innovation system and defined it as follows (1987:1): a network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies. Nelson (1992:365) defines a NIS as an associated network of institutions and organisations whose interactions determine the innovative performance of companies. Metcalfe (1994:940) defines a NIS as a system of institutions and organisations which promotes the development and diffusion of technologies. He treats the innovation system as a general framework through which innovation policy is implemented.

The OECD report (1997a:9) states that the NIS approach is based on the assumption that innovation and technological progress is the result of complex relations between subjects creating, diffusing and implementing new knowledge. A country's innovation performance depends largely on how these subjects relate to each other in creating and using the collective knowledge and what technologies they use. Edquist (2006:182) defines an innovation system as a set of all important economic, social, political, organisational, institutional and other factors that influence the development, diffusion and implementation of innovations. According to Lundvall's (2010: 2) definition the NIS consists of elements located within the borders of a nation state and relationships between these elements which in conjunction influence the production, diffusion and use of new and economically useful knowledge. According to this concept, innovation as an implementation of novel knowledge takes place in the enterprise's or organisation's innovation system, which is motivated, guided and supported by the national innovation system through innovation policy instruments. Resele (2015) emphasized in NIS definition the cooperation between public and private sector.

In conclusion, contrary to previous standpoints where innovation was treated as the end result of a linear chain beginning from fundamental research, the innovation system treats organisations, enterprises and institutions that promote innovation as an intertwined network.

In the literature, the NIS is defined both in a broad and narrow sense. The narrow national innovation system approach concentrates on organisations, institutions and policies that are directly aimed at the development and implementation of scientific

and technological innovations. The broader approach also takes into account the social, cultural and political environment. (Feinson 2003:25) The innovation system approach emphasises that companies do not carry out innovations in isolation but in collaboration with other organisations and in a framework of specific institutional rules (Edquist 2002:226). Organisations and institutions are referred to as the components of the innovation system. The most important organisations are companies (suppliers, customers and competitors), universities, schools, research institutions, financial institutions and state agencies.

According to the OECD, organisations in the NIS can be divided into five types (1999:32):

governmental organisations (local, regional, national and international) that develop general directions for innovation policy;

bridging organisations, such as research councils and research associations, which are intermediates between government and researchers;

private companies and research institutions that are funded by private companies;

universities and other related agencies that create knowledge and skills;

other public and private organisations that have a special role in the national innovation system (public laboratories, technology transfer agencies, joint scientific and research institutes, patent offices, educational institutions, etc.).

The actions of organisations are influenced by the institutional environment. Institutions are defined as sets of common habits, norms, routines, established practices, rules or laws that regulate the relations and interactions between individuals, groups and organisations and that encourage or hinder innovation (Edquist and Johnson 2000:170). Edquist and Johnson (2000:174) classify institutions in different ways:

formal (e.g. laws, national regulations) and informal (e.g. customs, traditions, cooperation customs) institutions;

- basic institutions (basic rules in economic processes, e.g. property rights and rules for cooperation) and supporting institutions (specific basic rules, e.g. restrictions on the use of private property in specific situations);
- hard institutions which always have to be considered and soft institutions where compliance is recommended;
- deliberately created institutions (e.g. patent law, technical standards) and institutions emerged spontaneously over time (e.g. social practices, habits, routines).

In summary, organisations take the role of players in the innovation system and institutions act as the rules of the game. Despite similarities in formal definitions, the innovation system components may have different content in different countries.

Essential parts of the institutional environment influencing organisations are the legal system, regulations, standards, routines, practices, etc. Often, however, the institutions are created by organisations and some organisations are established to create institutions: organisations creating standards and public sector bodies shaping and carrying out innovation policy.

The development of a successful innovation system is not only the result of spontaneous activities of businesses and organisations. There has been a growing understanding over the last 15-20 years that the role of the public sector, through coordinated purposeful policy measures, is to contribute to the establishment and functioning of an innovation system aimed at improving the innovation performance of businesses. The innovation system must incorporate all public sector policies, measures and activities aimed at promoting innovation into a coherent whole, in order to identify and implement, together with private sector, innovations that bring economic success.

Therefore, the term innovation system expresses the fact that innovation is a product of social cooperation that arises from interactive relationships between businesses and their clients, suppliers, competitors and private and public education, research and similar organisations. This approach also indicates that the innovation system is the base of innovative economic development. A distinction between state, regional and sectoral innovation systems is made, although this article focuses on the national innovation system.

In order to improve the innovation performance of a country as a whole, the public sector contribution to R&D alone is not enough. A basis for successful R&D development and implementation of the results in companies is provided by the education system which prepares the innovation minded and innovation capable workforce. In order to diffuse experience gained from innovations and their implementation, public information systems and networks accessible for those interested have to be developed. Systematic policy measures must be developed to encourage innovative activities and to reduce the associated risks. All policies, measures and actions must be coordinately directed towards achieving the best end result in innovation, i.e. the best innovation performance. In order to prevent systemic failures and overcome the encountered failures, the public sector has to play the central role as a coordinator, motivator, risk reducer and resource allocator. However, it is important to emphasise that innovation policy can affect the spontaneous activities of economic agents towards innovation only to a limited extent (Edquist 2006:191).

Up to now, the place and role of innovation policy in the national innovation system has remained unclear. Reid (2009:1) defines innovation policy as a set of activities

designed to increase the intensity and efficiency of innovation activities. Innovation policy implements various measures aimed at the development, spread and effective use of new products, services and processes in the markets or in the private and public organisations (Lundvall and Borrás 1997:37). The effectiveness of an innovation policy depends on its coherence with other policies (Reid 2009:1). Thus, innovation policy can be treated not so much as a policy besides others, but as a comprehensive and coherent system of innovation promoting components from all policies. Essentially, all public regulations and activities should be designed towards an innovating promoting direction to create an effective national innovation system. Also, the design of an innovation policy should not only focus on economic innovation factors but also on social and political factors.

Various authors have used visual models to characterise the national innovation system. Models developed by the OECD (1999:23), Fischer (2001:208), Kuhlmann and Arnold (2001:2) and Feinson (2003:29) reveal that there is no common understanding of the structure of the national innovation system. Authors of this study have synthesised a new holistic NIS (see figure 1) based on different previous model versions and used it as theoretical base for holistic macro-quantitative modelling and analyses of shaping the influence of innovation policy in EU member states and countries close to EU on business sector R&D activities and innovation performance (see Reiljan, Paltser 2015). The new model emphasises more clearly the role of innovation policy in designing the innovation related relationships between institutions and organisations.

Organisations that create, diffuse and use new and economically useful knowledge are at the centre of the national innovation system. These organisations include businesses, educational and research institutions, government agencies and others. Organisations are affected by formal and spontaneously developing informal institutions. Informal customs, norms of cooperation and value judgments express in particular the path dependency of the development of the society. Formal institutions (consciously and intentionally created rules and relationships) try to organise and develop relationships needed for the development of different areas. The main task of innovation policy is to coordinate and integrate all the policies into the national system that promotes innovation performance. The national innovation system cannot be imagined without the coordinating and integrating roll of innovation policy. The role of innovation policy is to evoke and strengthen the positive impact created by informal and formal institutions on the innovation performance of the country (businesses and organisations).

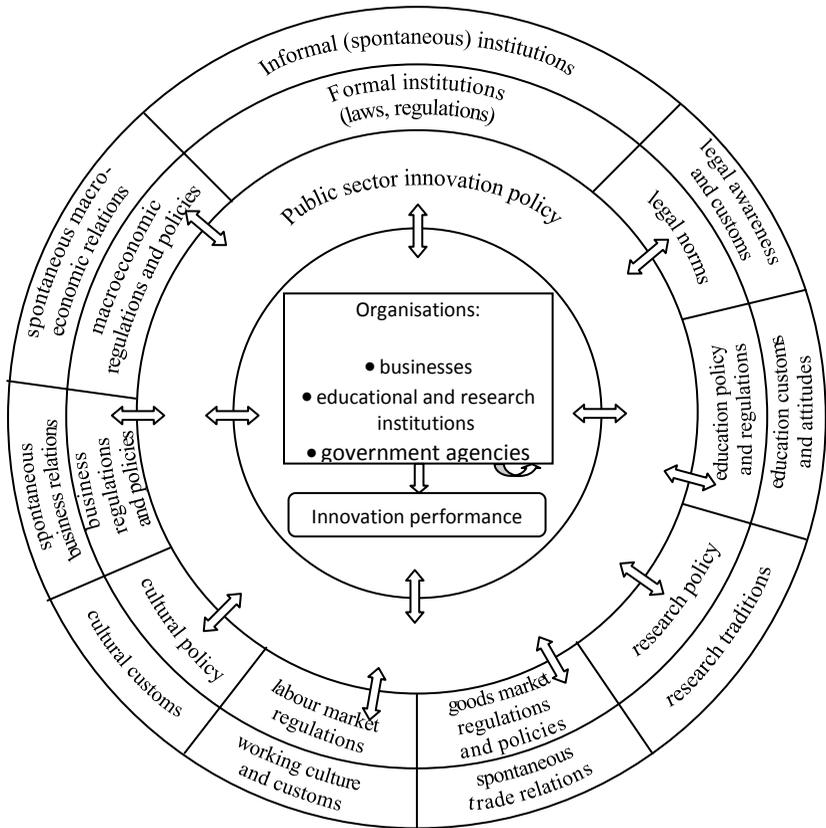


Figure 1. A holistic national innovation system model integrated by innovation policy (compiled by authors).

National innovation system approaches are mainly criticised because of their vagueness – the national innovation system seems to cover almost everything. This deficiency has tried to be reduced by distinguishing between the broad and narrow approach to national innovation systems (Lundvall 2007:102). However, this cannot be assessed as a systematic approach. Studies of innovation, including innovation system approaches, are vague because of the fact that there is a little understanding of the causes of innovation and innovation promoting factors. In particular, little

research on theoretical innovation systems approaches has been done on the role of the public sector, although public sector agencies are important both in the creation and diffusion of new knowledge (Edquist 2001:3). The new holistic NIS model presented in this study allows defining public sector organisations that have been created to promote innovation but also the role of the public sector in shaping the institutional environment and comprehensive system of innovation.

3. The main functions of innovation policy

The following section highlights the main functions of innovation policy by various areas of innovation promotion. On the basis of various approaches of the national innovation system, policy measures aimed at promoting innovation have been structured very differently in different studies. The Oslo Manual identifies four areas of innovation policy (OECD 1997b:19-23). The European Commission (Cunningham et al. 2008:44-45) also distinguishes four areas of innovation policy, which are significantly different from the structure used by the OECD. Arundel and Hollanders (2005:10-15) provide a more detailed division – eight areas of innovation policy. Manjón (2010:16-17) distinguishes seven areas of innovation policy.

The innovation policy framework (see Table 1) used in this study has been synthesised based on the previous approaches and the comprehensive model of the national innovation system developed in the previous section.

Table 1. Innovation policy areas and measures belonging under them

1. Developing public sector R&D
Financing R&D and innovation in the public sector
Directing public sector research and science to economically significant activities
Subsidies to public sector research institutions to purchase modern technology
Programs for supporting business activities of public sector research institutions and their employees
Stimulating public sector R&D staff to continuous learning and mobility
Designing competitive salaries and career management for public sector R&D employees
2. Supporting innovation and R&D in the business sector
Macroeconomic policy (fiscal policy) in support of innovation
National labour market policy in support of innovation (minimum wages, immigration rules)
Offering continuing education in innovation and R&D

Financial support for private sector R&D projects
Targeted support for research and science in strategic areas
Subsidies for companies to purchase advanced technology
3. Supporting innovation cooperation
Supporting collaboration between businesses and public research sector
Supporting inter-enterprise collaboration
Promoting international cooperation in R&D and innovation
4. Developing human resources needed for innovation
Creating an educational base: providing primary and secondary education to ensure basic skills, funding higher education (including vocational training for scientists and engineers)
Raising young people's interest in science, technology and innovation
Adult continuing education programs (lifelong learning)
Preparation of research and scientific personnel and supporting their mobility
Competitive wage and career arrangements for education employees in the public sector
5. Developing legal and business environments that promote innovation (including demand side factors)
Creating a legal environment that promotes innovation (innovation oriented environmental protection, labour and product safety standards)
Innovative product and service procurement by the public sector
Intellectual property protection (including policies supporting patent application, patent information diffusion programs)
Public sector services for innovative companies and start-ups
Improving access to finances for new companies (including venture capital market development)
Supporting the development of an R&D and innovation infrastructure (such as information and communication technologies)

Source: compiled by the authors (see also Arundel and Hollanders 2005:10-15, Cunningham et al. 2008:44-45, and Manjón 2010:16-17).

Three first areas in table 1 form the most important part of the innovation policy – R&D policy having specific influence on business sector R&D activities and innovation performance (Reiljan, Paltser 2015b). As seen in the table, when designing innovation policy it is first necessary to integrate the formal regulations of various socioeconomic policy areas into complete main functions (areas) and then

coordinate the main functions into a comprehensive innovation policy. Based on existing studies, this study discusses only these issues that are related to the main functions of innovation policy.

Developing public sector R&D

Previous studies have shown that countries that create more new knowledge develop faster economically. It has also been found that countries which increase R&D funding gain a competitive advantage over other countries because of an increase in innovations. R&D is the systematic creative work of creating new knowledge for potential users (Grupp 1998:11). R&D is particularly important for the creation of product and process innovations that need new technologies. Public sector R&D is mainly undertaken in universities and research institutions, rarely in larger private companies. Public sector R&D will result in knowledge that is accessible to everyone interested (Edquist 2006:192). R&D done in research institutions is more applicable technical development compared to universities (OECD 1998:83).

The overall goal of funding public sector R&D is to support innovation in the private sector. Fundamental research done in universities or research institutions presumably leads to discoveries which practical value is recognised by private companies and used to carry out innovation projects (Pavitt 2006:93). It is generally thought that research undertaken by universities and research institutions is more useful to large companies because small companies lack the ability to find partners among universities and the possibility to get direct benefits from cooperation (Forsman 2009:225). However, there is also the opposite argument: smaller companies get benefits from university research and discoveries more often because small businesses have better internal opportunities for independent R&D work than large companies (Audretsch 2003:18).

R&D activities by universities and public research organisations are financed from a number of instruments: contracts, regular or irregular project-based grants, but also loans. In many countries regular funding has decreased and financing certain projects has become more important. (OECD 1998:81-83)

Analyses of the relationship between public sector R&D and innovativeness of the business sector have produced mixed results. When analysing the data of 21 OECD member states, Falk (2004:23) found that R&D expenditures in the higher education sector are positively related to business sector R&D expenditures, but statistically significant relationships between R&D expenditures in other public sector agencies and private sector R&D expenditures were not found. At the same time, Guellec and van Pottelsberghe (2003:237) analysing the data of 17 OECD member states found that public sector R&D expenditures encourage business sector R&D expenditures if

public sector research is outsourced to businesses. However, if the research is carried out by public research organisations or laboratories the relationship is negative, i.e. a partial crowding out of business sector R&D expenditures by the public sector can be assumed. Guellec and van Pottelsberghe did not find any significant relationships between R&D expenditures in the higher education sector and R&D expenditures in the business sector.

One must consider the possibility that research undertaken by universities and research institutions might not provide the impulse for economic development desired in innovation policy if the local companies are not able to or not interested in the implementation of research results and thus there is no innovation. New knowledge may move to other countries and its implementation will benefit those economies instead. (Smart Innovation 2006:25) Thus, public sector science and research must be focused on activities important to national economic development.

Supporting innovation and R&D in the business sector

R&D performed by business is primarily development-oriented: the goal is to find profit increasing implementation possibilities for the new knowledge (Edquist 2006:194). The public sector can support private sector R&D through direct and indirect instruments. Direct instruments are targeted grants to companies and subsidised or guaranteed loans. When distributing direct support it is important to verify that it is given to projects worthy of it. (OECD 2007:20) The disadvantage of direct support for private sector R&D is the fact that sometimes public sector agencies can fund research in the wrong areas (OECD 2001:64). Usually, the public sector supports R&D in the private sector less than R&D in the public sector agencies. The main part of private sector R&D funding comes from companies themselves.

Empirical studies point out a clear positive relationship between public sector funding to business sector R&D and innovativeness of the business sector. Guellec and van Pottelsberghe (2003:237) and Falk (2004:23) have found that direct government subsidies to business sector R&D increase business sector R&D expenditures. The same conclusion was reached by Wolff and Reinthaler (2008:1410) who analysed data from 15 OECD member states. Aerts and Czarnitzki (2004:16), by analysing data from Belgian companies, found that public sector funding for business R&D boosts business' own R&D investments. Many companies (especially small ones) would not conduct R&D in the absence of subsidies from the public sector (González and Pazó 2008:385). At the same time, by analysing panel data from 13 US states Wu (2005:799) found no statistically significant effect of R&D subsidies on private R&D expenditures. Czarnitzki et al. (2007:1364) found, by analysing data of German and Finnish companies, that public sector funding increases patenting activity in the private sector.

In addition to direct support, business sector R&D can also be encouraged indirectly through tax incentives. Guellec and van Pottelsberghe (2003:237) and Falk (2004:23) found that tax incentives (measured using the B-index⁴) encourage the business sector to increase R&D spending. Falk pointed out (2004:23) that a one per cent reduction in the price of R&D spending (i.e. increase in the R&D tax credit) will result in a long-term increase of R&D expenditures in companies by 0.9 per cent. Confirmation of the positive effect of tax credits was also found in an analysis based on data from US states (Wu 2005:799). Tax incentives for private sector R&D are a stronger incentive for innovation than direct subsidies from the public sector. The reason lies in the fact that direct subsidies are often directed at specific national objectives and are not intended to encourage private sector overall R&D. (OECD 2007:9) However, the problem with tax benefits is that they do not stimulate companies which are not engaged in R&D to begin investing in R&D and they have no effect on the overall corporate R&D strategy (OECD 2001:64). Therefore, tax credits do not drive businesses to start new R&D projects but only aid existing ones.

When supporting business sector R&D, it is important that the support is targeted at areas that are in accordance with the goals of the national innovation policy. The business sector has to be guided through support measures towards strategic areas in science and research, such as information and communications technology and biotechnology (Arundel and Hollanders 2005:15).

SMEs also contribute to innovation in the private sector, however their R&D expenditures from their own resources are inevitably limited. Public sector funding for R&D is therefore very important for SMEs. SMEs may be important sources for new ideas and growth for the country (Hyytinen and Toivanen 2005:1388). Although large companies that are better equipped with skills and resources are in general more innovative, SMEs have the advantage of better adaptability (Forsman 2009:225). The strength of SMEs also lies in their simple management structure which speeds up decision making (Audretsch 2004:177).

Supporting innovation cooperation

Innovation cooperation between companies and organisations has an important role in the national innovation system. Edquist emphasises (2006:197) that mutual learning between organisations is crucial in the innovation process. By cooperating it is possible to share common problems in R&D, get support from the public sector

⁴ The B-index is an indicator which can be used to compare tax incentives on R&D in different countries. The B-index is calculated as the present value of pre-tax income, which is necessary to cover the initial cost of R&D investment and to pay corporate income tax so that the research would be useful (Warda 2005:5).

more easily, and synergy often occurs when cooperating and businesses can rely on professional partners (Manjón 2008:48). Gain from the cooperation comes from various sources: new knowledge is obtained, it is easier to enter new markets, manufacturing and R&D costs are lower and it is possible to share risks (Glaister and Buckley 1996:304-305).

The importance of cooperation is confirmed by the business innovation survey CIS2008 (The Community Innovation Survey 2008) carried out in the EU. In the EU nearly every fourth (23.6%) innovative company did some kind of innovation related cooperation (Eurostat 2011). Kaiser (2002:767) found, by analysing German business data, that cooperating companies spend 18.3% more on R&D than non-cooperating companies. Cooperation has a positive effect on businesses R&D expenditures and on the number of patents (Czarnitzki et al. 2007:1364). By analysing Dutch business data, Belderbos et al. (2004:1488) came to the conclusion that cooperation with universities and research institutions is positively related to bringing new or significantly improved goods or services to the market. In addition, formal and informal cooperation between companies and between companies and public sector agencies is larger in countries with more innovative companies (OECD 2001:56).

Given the above, one of the main tasks of the public sector is to support the formation of cooperation networks. If companies feel that it is risky to cooperate then they will try to avoid relationships (Liu and White 2001:1109). In this case, the task of the public sector is to ensure that cooperation is protected against opportunism. This can be done by implementing cooperation programs by the public sector which would create a neutral environment where it is safe to cooperate (OECD 2005:21).

The public sector can also create suitable channels and intermediaries of communication so that universities and public research organisations would be aware of the development needs of businesses, and businesses could get information about research offered by universities and public research organisations (Chang and Shih 2004:534).

It is also important to develop cooperation between the companies. This can be encouraged when cooperation projects have priority in public sector funding (OECD 2005:18). Czarnitzki and Fier (2003:25) found that companies belonging to public sector funded networks are more likely to apply for patents than companies belonging to networks financed from their own resources.

Universities and public research organisations could provide SMEs with access to the experience, technology and resources (Tilley and Tonge 2003:7-8). However,

often cooperation between SMEs and universities is hindered by SMEs' attitude that university research is not directly applicable to their specific problems (Woolgar et al. 1997:1).

Developing human resources needed for innovation

An important part of the national innovation system is human capital – skilled labour which is the main input to the innovation process. Thus, in the country it is important to prepare competent workers who are the source and implementers of innovation. Sørensen (1999:429) points out that R&D becomes profitable only when human capital reaches a certain level of development. Manjón (2010:20) argues that the more innovative the economy the higher the individual skills necessary to create new products and services. The creation of new innovative enterprises depends heavily on the skills of the entrepreneur (Manjón 2008:54).

An educated workforce is also essential in the implementation of new technologies. Bartel and Lichtenberg (1987:8) found that the implementation of new technologies is positively related to the demand for highly educated labour force. Rappaport (1999:33-34) found empirically that public sector spending on education is positively related to a country's development.

Investments in education and schooling are important for several reasons. First, educated people are important for the diffusion of new knowledge and turning it into innovations which increase economic growth and wellbeing. Second, the education system must prepare researchers who are needed to create new knowledge. (European Commission 2003b:210) It has been found empirically that the quality of the education has a positive effect on the development of innovation. By analysing data from 29 countries, Varsakelis (2006:1088) found that the higher the investments in education the greater the number of patents in the country. Studies have confirmed that public sector investments in higher education increase business R&D expenditures (Wu 2005:799).

In order to improve innovation performance, it is important to raise young people's interest in science and technology. Learning and schooling should not end after graduating from university. In the time of rapidly changing technologies the acquisition of knowledge should be continuous and adaptation to change is essential to personal professional development and success (European Commission 2003b:203). From the view point of national innovation systems it is important to develop lifelong learning into a smoothly working system.

The education system must ensure a sufficient number of R&D staff in the country. In terms of knowledge diffusion it is essential to increasing the mobility of scientists

and engineers. The public sector should ensure that academic staff is able to work with private companies (to advise private companies, to spend part of their time in companies or even be one of the owners). This would increase the flow of new knowledge from universities and research institutions to the private sector. (OECD 2001:76)

Developing legal and business environments that promote innovation (including demand side factors)

In order to promote innovation, the public sector can apply, in addition to supply side instruments, demand side instruments: different laws, regulations and standards that guide companies to generate and implement new ideas. For example, safety and environmental standards for the production of electricity prohibit the use of outdated technologies and very large investments must be made to develop new technologies. Many OECD member countries are investing heavily in R&D in energetics. (OECD 2007:25) Laws dealing with clean air and environmental pollution related to it have an important and cumulative impact on chemicals and materials manufacturing, mining and transportation related sectors in terms of both products and processes (Tidd et al. 2006:51). Thus, the responsibility of the public sector is to develop the system of regulations promoting innovative activities and to assess the suitability of existing laws, regulations, standards, etc.

Creating and changing laws are considered to be even more important innovation policy tools than subsidies and other financial instruments (Edquist 2002:229). Demand side instruments also include public technology procurements: public sector agencies as clients order a novel product or service. Such order can trigger a chain of innovation implementations, create new markets and solve long-term socioeconomic problems. (Ibid.:229-230)

For innovative activities it is also very important that intellectual property in the country is protected by the law, including an existing patent law. Intellectual property protection promotes investments into R&D and ensures that the diffusion of R&D results is in line with the rights of the creator (Manjón 2010:19). The protection of intellectual property rights is essential in order to promote overall competitiveness of companies and the county (Manjón 2008:56). Effective protection of intellectual property rights motivates the private sector to engage in innovation (Liu and White 2001:1109).

Empirical analyses have confirmed that investments into R&D are larger in countries with stronger intellectual property protection (Varsakelis 2001:1067, Bebczuk 2002:116, Kanwar and Evenson 2003:258, Lederman and Maloney

2003:21). In addition, Falk (2004:23) found that the patent rights index⁵ is positively correlated with business sector R&D spending.

An obstacle to applying for a patent is often the cost of the process. The high cost of patent application is a particularly serious problem for SMEs (Manjón 2008:57). Patents, however, could also have a negative impact on economic development – they prevent the diffusion of innovations and distort competition if a patent holding company achieves monopoly status in the market (OECD 2004:9).

The public sector can support the creation and development of innovative companies by making the environment more favourable to new businesses with administrative, financial and legal measures (European Commission 2003a:6). In order to do this, there must exist public sector agencies in the country that provide business advice: legal assistance, advice on patenting, marketing, management, recruitment and funding (Ibid.: 22). Essential facilities for starting companies are business incubators, innovation centres and technology parks. A business incubator is a supporting instrument for new businesses, which provides resources and services necessary for starting companies until they leave the program financially viable and independent. (Manjón 2008:59)

Since funding is a major obstacle to the creation of new businesses and for the expansion of existing, businesses should be ensured access to the capital market (Manjón 2008:54). For technology-based and innovative companies, the most important funding is access to venture capital because for them it is the main alternative financing form besides self-financing (Manjón 2010:19). Alternative financing is very important especially for SMEs.

SUMMARY

The public sector intervenes in innovative processes in order to eliminate market and system failures that hinder innovation. At the same time, public sector intervention requires careful analytical reasoning, because this intervention could distort market processes and guide innovation processes towards economically harmful directions.

Innovative activities of companies depend largely on the operational efficiency of the NIS. So far, innovation system approaches have been vague and have not been

⁵ The study used the Ginarte-Park intellectual property rights index as the patent rights index. This index consists of five categories: (1) the extent of coverage, (2) membership in international patent agreements, (3) provisions for loss protection, (4) enforcement mechanisms, and (5) duration of protection. Each category is estimated between zero and one and the sum of the five categories equals the index value of the respective country. Thus, the index value is between zero and five, where a higher number indicates a stronger level of protection. (Park and Ginarte 1997:52)

able to adequately characterise the role of the innovation policy in the system. In this article, a new holistic NIS model was synthesised, based on previous studies. In the centre of a national innovation system are various organisations, which together generate, diffuse and use new and economically useful knowledge. Innovative activities of organisations evolve directly under the influence of national innovation policy that integrates and mediates relationships of organisations with the formal and spontaneous institutions.

The public sector promotes business sector R&D activities and innovation performance by implementing different innovation policy instruments. The choice of suitable instruments has to be based on the path dependence of development, economic policy goals and general factors affecting the implementation of national innovation policy. This article discusses public sector innovation policies in five main functions (areas) that are based on numerous international studies: developing public sector R&D, supporting innovation and R&D in the business sector, supporting innovation cooperation, developing human resources needed for innovation, developing a legal and business environment that promotes innovation (including demand side factors).

Therefore, this article has created a comprehensive methodological basis for international comparative analysis and holistic macro-quantitative modelling of innovation policy influence on business sector R&D activities and innovation performance. This holistic approach is productively used in the studies of the authors of this article.

REFERENCES

1. Aerts, K. and Czarnitzki, D. (2004) "Using Innovation Survey Data to Evaluate R&D Policy: The Case of Belgium." Zentrum für Europäische Wirtschaftsforschung / Center for European Economic Research, Discussion Paper No. 04-55.
2. Arnold, E. (2004) "Evaluating research and innovation policy: a systems world needs systems evaluations." *Research Evaluation* 13, 1, 3-17.
3. Arundel, A. and Hollanders, H. (2005) *Policy, Indicators and Targets: Measuring the Impacts of Innovation Policies*. European Trend Chart on Innovation, MERIT, December 19th.
4. Audretsch, D. B. (2003) "Globalization, Innovation and the Strategic Management of Places." In *Innovation Clusters and Interregional Competition*. J. Bröcker, D. Dohse, R. Soltwedel, eds. 11-27, Berlin: Springer.
5. Audretsch, D. B. (2004) "Sustaining Innovation and Growth: Public Policy Support for Entrepreneurship." *Industry and Innovation* 11, 3, 167-191.
6. Bartel, A. P. and Lichtenberg, F. R. (1987) "The Comparative Advantage of Educated Workers in Implementing New Technology." *The Review of Economics and Statistics* 69, 1, 1-11.

7. Bailey, D. and Lenihan, H. (2015) A Critical Reflection on Irish Industrial Policy: A Strategic Choice Approach. -- *International Journal of the Economics of Business*, 22:1, pp. 47 - **78**.
8. Bebczuk, R. N. (2002) "R&D expenditures and the role of government around the world." *Estudios de Economía* 29, 1, 109-121.
9. Belderbos, R., Carree, M. and Lokshin, B. (2004) "Cooperative R&D and firm performance." *Research Policy* 33, 1477-1492.
10. Bleda, M. and Del Rio, P. (2013) The market failure and the systemic failure rationales in technological innovation systems. -- *Research Policy*, 42(2), pp. 1039-1052.
11. Chang, P. L. and Shih, H. Y. (2004) "The Innovation Systems of Taiwan and China: a Comparative Analysis." *Technovation* 24, 7, 529-539.
12. Cunningham, P., Robson, D. and Neves, E. (2008) Mapping of Innovation Support Measures. Pro Inno Europe, Inno Learning Platform.
13. Czarnitzki, D., Ebersberger, B. and Fier, A. (2007) "The relationship between R&D collaboration, subsidies and R&D performance: Empirical evidence from Finland and Germany." *Journal of Applied Econometrics* 22, 1347-1366.
14. Czarnitzki, D. and Fier, A. (2003) "Publicly Funded R&D Collaborations and Patent Outcome in Germany." ZEW Discussion Paper No. 03-24.
15. Dolfsma, W. 2011. Government Failure – Four Types. -- *Journal of Economic Issues* 45 (3):593–604. doi:[10.2753/JEI0021-3624450304](https://doi.org/10.2753/JEI0021-3624450304).
16. Edquist, C. (2011) Design of innovation policy through diagnostic analysis: identification of systemic problems (or failures). -- *Industrial and Corporate Change*, Volume 20, Number 6, pp. 1725–1753 doi:[10.1093/icc/dtr060](https://doi.org/10.1093/icc/dtr060)
17. Edquist, C. (2002) "Innovation Policy – A Systemic Approach." In *The Globalizing Learning Economy*. D. Archibugi, B.-Å. Lundvall, eds. 219-238, Oxford: Oxford University Press.
18. Edquist, C. (2006) "System of Innovation. Perspectives and Challenges." In *The Oxford Handbook of Innovation*. J. Fagerberg, D. C. Mowery, R. R. Nelson, eds. 181-208, Oxford: Oxford University Press.
19. Edquist, C. (2001) "The Systems of Innovation Approach and Innovation Policy: An account of the state of the art." Paper presented at the DRUID 2001 Nelson and Winter conference, Aalborg, Denmark, June 12-15, 24 p.
20. Edquist, C. and Johnson, B. "Institutions and Organisations in Systems of Innovation." In *Systems of Innovation: Growth, Competitiveness And Employment*. Volume II. C. Edquist, M. McKelvey, eds. 165-187, Cheltenham, Northampton: Edward Elgar Publishing.
21. Edquist, C., Malerba, F., Metcalfe, J. S., Montobbio, F. and Steinmueller, W. E. (2004) "Sectoral systems: implication for European innovation policy." In *Sectoral Systems of Innovation: Concepts, Issues and Analyses of Six Major Sectors in Europe*. F. Malerba, ed. 427-461, Cambridge: Cambridge University Press.
22. Edquist, H. 2011. Can Investment in Intangibles Explain the Swedish Productivity

- Boom in the 1990s? -- The Review of Income and Wealth 57 (4):658–682. doi:[10.1111/j.1475-4991.2010](https://doi.org/10.1111/j.1475-4991.2010).
23. European Commission. (2014) State of the Innovation Union. Taking stock 2010-2014. – Luxembourg. -- 101 p.
 24. European Commission (2003a) PAXIS – Results and policy recommendations. Luxembourg: Office for Official Publications of the European Communities.
 25. European Commission (2003b) Third European Report on Science & Technology Indicators. Towards a Knowledge-based Economy. Luxembourg: Office for Official Publications of the European Communities.
 26. Eurostat (2011) European Commission.
 27. Fagerberg, J. (2002) “Europe at the Crossroads: The Challenge from Innovation-Based Growth.” In *The Globalizing Learning Economy*. D. Archibugi, B. Å. Lundvall, eds. 46-60, Oxford: Oxford University Press.
 28. Falk, M. (2004) “What Drives Business R&D Intensity Across OECD Countries?” WIFO Working Papers, No. 236.
 29. Feinson, S. (2003) “National innovation systems. Overview and country cases.” *Knowledge Flows and Knowledge Collectives: Understanding the Role of Science and Technology Policies in Development. Volume 1: Knowledge Flows, Innovation, and Learning in Developing Countries. A Project for the Global Inclusion Program of the Rockefeller Foundation*, 13-38.
 30. Fischer, M. M. (2001) “Innovation, Knowledge Creation and Systems of Innovation.” *The Annals of Regional Science* 35, 199-216.
 31. Forsman, H. (2009) “Improving Innovation Capabilities of Small Enterprises: Cluster Strategy as a Tool.” *International Journal of Innovation Management* 13, 2, 221-243.
 32. Freeman, C. (1987) *Technology Policy and Economic Performance: Lessons from Japan*. London: Pinter.
 33. Friedrich, P., Reiljan, J. and Paltser, I. (2011) “Policy Suggestions for Integrated Public Innovation Policies in a Small Country.” In *Innovation Systems in Small Catching-Up Economies. New Perspectives on Practice and Policy*. E. G. Carayannis, U. Varblane, T. Roolaht, eds. 343-370, New York, Dordrech, Heidelberg, London: Springer.
 34. Glaister, K. W. and Buckley, P. J. (1996) “Strategic motives for international alliance formation.” *Journal of Management Studies* 33, 3, 301-332.
 35. González, X. and Pažo, C. (2008) “Do public subsidies stimulate private R&D spending?” *Research Policy* 37, 371-389.
 36. Grupp, H. (1998) *Foundations of the Economics of Innovation: Theory, Measurement and Practice*.” Northampton: Edward Elgar.
 37. Guellec, D. and van Pottelsberghe, B. (2003) “The impact of public R&D expenditure on business R&D.” *Economics of Innovation and New Technology* 12, 3, 225-243.
 38. Haapanen, M., Lenihan, H. and Mariani, M. (2014) ‘Government Policy Failure in

- Public Support for Research and Development. -- *Policy Studies*, 35(6), pp. 557-575.
39. Hyytinen, A. and Toivanen, O. (2005) "Do financial constraints hold back innovation and growth? Evidence on the role of public policy." *Research Policy* 34, 1385-1403.
 40. Kaiser, U. (2002) "An empirical test of models explaining research expenditures and research cooperation: evidence for the German service sector." *International Journal of Industrial Organization* 20, 747-774.
 41. Kanwar, S. and Evenson, R. (2003) "Does intellectual property protection spur technological change?" *Oxford Economic Papers* 55, 235-264.
 42. Kuhlmann, S., Arnold, E. (2001) "RCN in the Norwegian Research and Innovation System." Background Report No 12 in the Evaluation of the Research Council of Norway.
 43. Lederman, D. and Maloney, W. F. "R&D and Development." The World Bank, Policy Research Working Paper No. 3024.
 44. Liu, X. and White, S. (2001) "Comparing innovation systems: a framework and application to China's transitional context." *Research Policy* 30, 7, 1091-1114.
 45. Lundvall, B.-Å. (2007) "National Innovation Systems – Analytical Concept and Development Tool." *Industry and Innovation* 14, 1, 95-119.
 46. Lundvall, B.-Å. (2010) "Introduction." In *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*. B.-Å. Lundvall, ed. 1-19, London, New York: Anthem Press.
 47. Lundvall, B.-A. and Borrás, S. (1997) *The Globalising Learning Economy: Implications for Innovation Policy*. Commission of the European Union.
 48. Manjón, J. V. G. (2010) "A Proposal of Indicators and Policy Framework for Innovation Benchmark in Europe." *Journal of Technology Management & Innovation* 5, 2, 13-23.
 49. Manjón, J. V. G. (2008) "Establishing a set of indicators for measuring the impact of R&D policies." *BEFORE: Benchmarking and Foresight for Regions of Europe*, September.
 50. Metcalfe, J. S. (1994) "Evolutionary Economics and Technology Policy." *The Economic Journal* 104, 425, 931-944.
 51. Metcalfe, J. S. (2005) "Systems failure and the case for innovation policy." In *Innovation Policy in a Knowledge Based Economy*. P. Llerena, M. Matt, eds. 47-74, Berlin: Springer.
 52. Nelson, R. R. (1981) "Assessing Private Enterprise: An Exegesis of Tangled Doctrine." *The Bell Journal of Economics* 12, 1, 93-111.
 53. Nelson, R. R. (1992) "National Innovation Systems: A Retrospective on a Study." *Industrial and Corporate Change* 1, 2, 347-374.
 54. OECD (1997a) *National Innovation Systems*. Paris: OECD Publications.
 55. OECD (1997b) *Oslo Manual. The Measurement of Scientific and Technological Activities. Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*. 2nd ed. Paris: OECD Publications.

56. OECD (1998) *Technology, Productivity and Job Creation: Best Policy Practices. The OECD Jobs Strategy*. Paris: OECD Publications.
57. OECD (1999) *Managing National Systems of Innovation*. Paris: OECD Publications.
58. OECD (2001) *Science, Technology and Industry Outlook. Drivers of Growth: Information Technology, Innovation and Entrepreneurship*. Paris: OECD Publications.
59. OECD (2004) *Patents and Innovation: Trends and Policy Challenges*. Paris: OECD Publications, 2004.
60. OECD (2005) *Innovation Policy and Performance. A Cross-Country Comparison*. Paris: OECD Publications.
61. OECD (2007) *Innovation and Growth: Rationale for an Innovation Strategy*. Paris: OECD Publications.
62. Park, W. G. and Ginarte, J. C. (1997) "Intellectual Property Rights and Economic Growth." *Contemporary Economic Policy* 15, 51-61.
63. Pavitt, K. (2006) "Innovation Processes." In *The Oxford Handbook of Innovation*. J. Fagerberg, D. C. Mowery, R. R. Nelson, eds. 86-114, Oxford: Oxford University Press.
64. Rappaport, J. (1999) "Local Growth Empirics." Harvard University, Center for International Development, Working Paper 23.
65. Reid, A. (2009) "Systems failures and innovation policy: do national policies reflect differentiated challenges in the EU27? Observations from a decade of the European TrendChart on Innovation." Paper presented at the 6 Countries Programme workshop on New economic ground for innovation policy, Bilbao, Spain, September 14.
66. Reiljan, J., Paltser, I. (2015b) Influence of Research and Development Policy: Estonian Case in the EU. – *European Journal of Innovation Management*, Volume 18, Iss 3, pp 307-329.
67. Reiljan, J., Paltser, I. (2015) The Role of Innovation Policy in National Innovation System: the Case of Estonia. – *TRAMES*, 19(69/64), No 3, pp 249-273.
68. Reiljan, J. (2010) "Possibilities of Discussing Convergence of Regional Economic Development in the EU." *Proceedings of the Institute for European Studies*, Tallinn University of Technology, 8, 33-60.
69. Resele, L. (2015) Impact of national innovation system on innovation. – *Journal of Business Management*, 2015, No 9, pp. 97 – 106.
70. Smart Innovation (2006) *A Practical Guide to Evaluating innovation programmes. A Study for DG Enterprise and Industry*.
71. Soete, L., Verspagen, B. and ter Weel, B. (2009) "Systems of Innovation." UNU-MERIT Working Paper No. 2009-062, 36.
72. Sørensen, A. (1999) "R&D, learning and phases of economic growth." *Journal of Economic Growth* 4, 4, 429-445.
73. Tidd, J., Bessant, J. and Pavitt, K. (2006) *Innovatsiooni juhtimine. Tehnoloogiliste*,

- organisatsiooniliste ja turu muudatuste integreerimine. Tallinn: Pegasus.
74. Tilley, F. and Tonge, J. "Introduction." In *Competitive advantage in SMEs: Organising for Innovation and Change*. O. Jones, F. Tilley, eds. 1-13, Chichester: Wiley.
 75. Tsiouri, L., Reid, A. and Miedzinski, M. (2008) "European Innovation Progress Report 2008." Brussels: Directorate-General for Enterprise Policy, European Commission.
 76. Warda, J. (2005) "Measuring the Value of R&D Tax Provisions. A Primer on the B-index Model for Analysis and Comparisons." Paper prepared for The OMC Working Group on "Design and evaluation of fiscal measures to promote business research, development and innovation".
 77. Varsakelis, N. C. (2001) "The impact of patent protection, economy openness and national culture on R&D investment: a cross-country empirical investigation." *Research Policy* 30, 1059-1068.
 78. Varsakelis, N. C. (2006) "Education, political institutions and innovative activity: A cross-country empirical investigation." *Research Policy* 35, 1083-1090.
 79. Wolff, G. B. and Reinthaler, V. (2008) "The effectiveness of subsidies revisited: Accounting for wage and employment effects in business R&D." *Research Policy* 37, 1403-1412.
 80. Woolgar, S., Gomes, P., Vaux, J., Ezingard, J.-N. and Grieve, R. (1997) "Abilities and competencies required, particularly by small firms, to identify and acquire new technology." Paper presented at the IEE Colloquium on Technology Management Initiative, London, United Kingdom, December 9.
 81. Wu, Y. (2005) "The Effects of State R&D Tax Credits in Stimulating Private R&D Expenditure: A Cross-state Empirical Analysis." *Journal of Policy Analysis and Management*, 24, 4, 785-802.

RIIGI TERVIKLIKU INNOVATSIOONISÜSTEEMI KUJUNDAMINE¹

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Kaasajal on innovatsioon üldtunnustatult majandusarengu peamine tõukejõud. Teadus- ja arendustegevusega (T&A) seotud suured riskid pärsivad majandusagentide (ettevõtete ja organisatsioonide) innovaatilist tegevust ja sellega nende arengu jätkusuutlikkust. Seega sõltub riigi majanduslik edu innovatsiooniriskide alandamisest majandusagentide seisukohalt aktsepteeritavale tasemele, säilitades samal ajal majandusagentide piisava vastutuse innovatsiooniuotsuste tulemuste eest.

Riigi innovaatilise arengu tagamiseks tuleb majanduspoliitiliselt tasakaalustada multidimensionaalse eesmärksüsteemi komponendid. Innovatsioonile suunatud valitsussektori meetmete tasakaalustamine ja ühtseks tervikuks integreerimine on innovatsioonipoliitika ülesandeks. Innovatsioonipoliitika ülesandeks on kujundada regulatsioonide (õigusaktid, standardid, normatiivid) ja institutsioonide abil terviklik ja ühtne riigi innovatsioonisüsteem (RIS), mis katab vajaliku osa innovaatilise keskkonna (haridus, teadus, info pakkumine ja vahendamine, intellektuaalse omandi kaitse, võrgustike loomine jms) loomisse kuludest ning pakub majandusagentide innovaatilisele tegevusele ka otseseid toetusi (subsiidiumid, riiklikud tellimused jms). Kaasajal sõltub majandusagentide innovaatilise tegevuse aktiivsus ja tõhusus olulisel määral RIS tõrgeteta ja tõhusast toimimisest.

Käesoleva artikli eesmärgiks on tuua välja innovatsioonipoliitika roll tervikliku ja ühtse RIS kujundamisel. Eesmärgi saavutamiseks püstitati järgmised uurimisülesanded:

- Selgitada valitsussektori innovatsiooniprotsesside sekkumise põhjusi ja sellega seotud probleeme;
- Analüüsida RIS olemust ja töötada välja RIS terviklik mudel, mis tooks välja innovatsioonipoliitika koha ja rolli valitsussektori interventsioonimeetmete ühtseks tervikuks integreerimisel;
- Analüüsida teadusallikate põhjal innovatsioonipoliitika struktuuri ja selle erinevate valdkondade olemust.

Valitsussektori sekkumist majandusse õigustatakse üldjuhul turutõrgete ületamise vajadusega, see on aluseks ka innovatsioonipoliitika rakendamisel (innovatsiooniprotsessidesse investeerimise tasuvuse liiga pikk aeg ja ebakindlus, majandusagentid ei arvesta innovatsiooni positiivseid välismõjusid). Innovatsioonipoliitika meetmete rakendamise eesmärgiks on majandusagentide innovaatiliste investeeringute riskide maandamine ja erakasulikkuse võrdsustamine ühiskondliku kasulikkusega. Selline lähenemine vastab „lineaarse“ innovatsiooniprotsessi olemusele: uus teadmus luuakse teadusasutustes, seejärel kohandatakse see praktiliste vajadustega innovaatilisi tooteid (teenuseid) loovates ettevõtetes. Kuna „lineaarprotsessis“ luuakse ainult väike osa

¹ Artikkel “Shaping a holistic national innovation system” asub ajakirja CD-I.

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innovatsioonist, siis ei ole turutõrked ilmselt peamised valitsussektori sekkumise põhjused. Paremini selgitab valitsussektori sekkumist innovatsiooniprotsessides süsteemitõrgete teooria, mille kohaselt tõrked innovatsiooniprotsesside erinevate osaliste koostöös on innovaatilise tegevuse nõrkade tulemuste peamiseks põhjustajaks. Süsteemitõrked kujutavad endast nii innovatsiooniprotsessides osalejate tegevuse, aga ka rakendatud poliitikate kooskõlastamatust või koguni vastandlikkust. Seega ei ole valitsussektori ülesandeks niivõrd majandusagentide individuaalse innovatsioonitegevuse toetamine, kuivõrd tõhusalt toimiva RIS loomine: süsteemi puuduvate komponentide loomine ja komponentidevahelise koöperatsiooni arendamine.

Innovatsiooni pärssivate süsteemivigadena tuuakse välja: majandusagentide nõrk innovatsioonialane võimekus; ettevõtete ja organisatsioonide vähene paindlikkus keskonnamuutustega kohanemisel; innovatsiooniprotsesside osapoolte koostöö (võrgusuhete) nõrkus uue teadmuse ja praktilise kogemuse levitamisel; innovatsiooni õigusliku, aga ka kultuurilise ja sotsiaalse keskkonna puudulikkus; puudused valitsussektori poliitikate formuleerimisel, elluviimisel ja tulemuste hindamisel. Valitsussektor peaks innovatsiooni edendamiseks põhitähelepanu pöörama süsteemitõrgete ületamisele.

Valitsussektori sekkumist innovatsiooniprotsessidesse on aga põhjust ka kritiseerida, kuna see moonutab majandusarengu normaalset kulgu. Valitsussektori sekkumiseks peab olema täidetud kaks tingimust: esiteks peab olema täpselt identifitseeritud lahendamist vajav probleem (turu- või süsteemitõrge); teiseks peab aga olema selge, et valitsussektoril on probleemi lahendamiseks kasutada adekvaatsed vahendid turumajanduse toetamise suunas. Seejuures tuleb arvestada valitsusasutuste töö ebatäiuslikkust (bürokratiat, ametnike ebakompetentsust, korrupsiooni), mille tõttu võib põhimõtteliselt võimalik lahendus saavutamata jääda. Valitsussektori subsidiumid suurendavad innovatsiooni ühiskondlikku kogukulu, aeglustavad teadmuse ülekandumist teadusasutustest ettevõtetes, uued tooted ja teenused tuuakse turule liiga kiiresti (vanade elutsükkel ei ole veel lõpule jõudnud), arengu regionaalsed erinevused suurenevad (toetused suunatakse eelkõige edukamatele), st suureneb väärarengute risk. Erinevatel poliitmeetmetel on erinevates tingimustes erinevad tulemused, mida on väga raske ette näha.

Innovatsioonipoliitika tasakaalustatud ja tulemusliku rakendamise peab tagama RIS – valitsus- ja erasektori institutsioonide võrgustik, mille tegevuse ja koostöö tulemusena initsieeritakse, imporditakse, kohandatakse ja rakendatakse uued tehnoloogiad (protsessid), tooted ja teenused. Lineaarprotsessi asemel teostub innovatsioon majandusagentide ja institutsioonide võrgustikus.

RIS kujutab endast võrgustikku, mis moodustub viiest erinevat tüüpi organisatsioonidest: valitsusasutused kohalikest kuni rahvusvahelisteni; ülikoolid ja teised uut teadmuse loovad asutused; valitsus- ja teadusasutusi ühendavad nõukogud ja assotsiatsioonid; eraettevõtted ja uurimislaborid; spetsiifiliste ülesannetega muud avaliku ja erasektori organisatsioonid. Organisatsioonide tegevust mõjutab (kujundab) institutsionaalne keskkond. Institutsioonid jagunevad formaalseteks (õigusaktid) ja mitteformaalseteks (traditsioonid, harjumused).

Viimaste aastakümnete jooksul on kasvanud arusaam, et innovatsiooni arengus on järjest kasvav roll innovatsioonipoliitikal, mis peab tagama kõigi valitsussektori poliitmeetmete integreerimise ühtseks terviklikuks RIS, mis soodustab ja suunab

ettevõtete innovaatilist tegevust. RIS baseerub teadmisel, et innovatsioon on ühiskondliku koostöö produkt, mis tekib ettevõtete ja nende klientide, varustajate ning konkurentide koostöös haridus- ja teadusasutustega. RIS on innovaatilise majandusarengu baasiks. Valitsussektori ülesandeks on RIS raames innovatsiooni pärssivate tõrgete avastamiseks ja ületamiseks täitma innovatsioonipoliitika abil initsieerija, koordinaatori, riskide maandaja ja ressursidega varustaja rolli.

RIS olemuse iseloomustamiseks on erinevad teadlased välja töötanud rea RIS visuaalseid mudeleid. Ühist arusaama RIS struktuurist senini tekkinud ei ole. Käesoleva artikli autorid sünteesisid seni väljatöötatud mudeliversioonide baasil uue tervikliku RIS mudeli, mis on aluseks makrokvantitatiivse lähenemisviisi kasutamiseks innovatsioonipoliitika mõju matemaatilis-statistiliseks modelleerimiseks ja analüüsimiseks innovatsioonipoliitikat ja innovatsiooni arengut iseloomustavate andmete alusel võrreldavate riikide kogumis. Uus mudel rõhutab senistest selgemalt innovatsioonipoliitika rolli institutsioonide ja organisatsioonide seoste kujundamisel innovatsioonitegevuses. RIS keskmes on innovatsioone loovad, levitavad ja kasutavad organisatsioonid (ettevõtted, haridus- ja teadusasutused jt). Organisatsioonide tegevus kujuneb formaalsete ja mitteformaalsete institutsioonide innovatsioonipoliitika poolt vahendatud mõju keskkonnas.

RIS lähenemisviisi kritiseeritakse peamiselt selle ebamäärasuse tõttu – RIS näib hõlmavad peaaegu kõike. Põhjuseks on asjaolu, et arusaam innovatsiooni esilekutsuvatest ja seda mõjutavatest teguritest on ebamäärane. Põhjuseks on valitsussektori ja innovatsioonipoliitika rolli alahindamine. Käesolevas töös esitatud RIS mudel võimaldab paremini mõista valitsussektori rolli nii innovatsiooni toetavate organisatsioonide kui ka innovatsiooni kujundava institutsionaalse keskkonna arendajana.

Järgnevalt käsitletakse innovatsioonipoliitika funktsioone erinevates innovatsiooni toetamise valdkondades. Neid valdkondi struktureeritakse erinevates uuringutes erinevalt. Käesoleva töö autorid sünteesisid RIS uuele mudelile toetudes varasematest uuringutest innovatsioonipoliitika raamistiku (vt tabel 1).

Tabel 1. Innovatsioonipoliitika valdkonnad ja nende alla kuuluvad meetmed

1. Avaliku sektori T&A arendamine
Avaliku sektori R&A ja innovatsiooni rahastamine
Avaliku sektori R&A ja innovatsiooni suunamine majanduse jaoks olulistesse valdkondadesse
Subsiidiumid avaliku sektori teadusasutustele kaasaegse tehnoloogia ostmiseks
Programmid avaliku sektori teadusasutuste ja nende töötajate ettevõtluse toetamiseks
Avaliku sektori R&A töötajate jätkukoolituse ja mobiilsuse stimuleerimine
Avaliku sektori R&A töötajatele konkurentsivõimelise palga ja karjäärijuhtimise süsteemi kujundamine
2. Innovatsiooni ja T&A toetamine ettevõtlussektoris
Innovatsiooni fiskaalpoliitiline toetamine
Innovatsiooni toetamine tööturupoliitikaga (miinimumpalga määr, immigratsioonireeglid)
Innovatsiooni- ja T&A-alase jätkukoolituse pakkumine
Erasektori T&A projektide rahaline toetamine
Teaduse ja T&A sihttoetused strateegilistes valdkondades
Subsiidiumid ettevõtetele kaasaegase tehnoloogia ostmiseks
3. Innovatsioonialase koostöö toetamine
Ettevõtete ja avaliku sektori teadusasutuste koostöö toetamine
Ettevõtetevahelise koostöö toetamine
Innovatsiooni- ja T&A-alase rahvusvahelise koostöö soodustamine
4. Innovatsiooniks vajaliku tööjõuressursi arendamine
Haridusliku baasi loomine: baasteadmisi andva põhi- ja keskhariduse arendamine, kõrghariduse rahastamine inseneride ja teadlaste ettevalmistamiseks
Noorte huvi suurendamine teaduse, tehnoloogia ja innovatsiooni suhtes
Jätkuhariduse programmid täiskasvanutele (elukestev õpe)
Teadus- ja T&A töötajate ettevalmistamine ja nende mobiilsuse toetamine
Avaliku sektori haridusasutuste töötajatele konkurentsivõimelise palga ja karjäärisüsteemi tagamine
5. Innovatsiooni soodustava õigusliku ja ettevõtluskeskkonna arendamine (kaasaarvatud nõudluspoole meetmete rakendamine)
Innovatsiooni soodustava õigusliku keskkonna loomine (innovatsioonile orienteeritud keskkonnakaitse, töö- ja tooteohutuse standardid)
Innovaatiliste toodete ja teenuste tellimine avaliku sektori poolt
Intellektuaalse omandi kaitse (ka patentide taotlemist ja patendiinfo levikut toetava poliitika rakendamine)
Avaliku sektori teenused innovaatilistele ettevõtetele ja idufirmadele
Uute ettevõtete finantsressurssidele juurdepääsu parandamine (ka riskikapitali turu arendamine)
T&A tegevust ja innovatsiooni infrastruktuuri arengu toetamine (nt informatsiooni- ja kommunikatsioonitehnoloogiatega)

Tabelist nähtub, et innovatsioonipoliitika kujundamisel on kõigepealt vaja erinevate sotsiaalmajanduspoliitika valdkondade arengupoliitikad integreerida ühtseks ladusalt koostöömivaks tervikuks. Käesolevas töös käsitletakse lõpuks innovatsioonipoliitika peamisi funktsioone puudutava viie suure valdkonna (vt tabel 1) arenguprobleeme.