OPO

Ordnungspolitische Diskurse

Discourses in Social Market Economy

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National Innovation Systems: Can they be copied?

Diskurs 2012 – 2

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Abstract.

This chapter discusses the application of the national system approach in the catching up economies. It criticizes the assumption that there exists an optimal one-size-fits-all national innovation system model. The example is the Estonia-Finland case, in which Finland's national innovation system is being applied to Estonia. We argue that innovation is *path dependent* and that factors such as distance from the current technological frontier (latecomer or frontrunner) and different national knowledge bases must be considered when developing a national innovation system for a specific country. The aim of the chapter is thus two-fold: 1) we are interested in how the concept of innovation is presented and reproduced within the national context and 2) exploring the adverse effects of (re)producing National Innovations Systems in an uncritical and unreflexive manner.

Keywords:

National Innovation System, Copy, Estonia

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National Innovation Systems: Can they be copied?

1. Short introduction into the national innovation system concept

Discussions about national innovation systems as an approach started from the desire to explain the differences between countries on the basis of capabilities, strategies and revealed performance. These differences seemed to be stable over time (Dosi 1999: 35–36). The notion of a national innovation system originates from Friedrich List, who developed the concept of the national system of political economy already in 1841 (Freeman 1997: 24). List tried to explain why there is a change in the countries dominating the world's economy. He explained this emphasizing the role of public-sector policy measures related particularly to learning and education to increase the knowledge of different technologies. He also emphasized the importance of learning from other developed countries.

The necessity to treat the innovation process systematically was again raised in the 1980s based on the understanding that most of the new knowledge needed for innovation did not come directly from universities or research institutions, but from a much wider range of sources: customers, production engineers etc. (see Lundvall *et al.*2002: 215). The need emerged to integrate different producers of new knowledge and their relationships, networks and rules into a holistic approach. This was realised in the form of the concept of the *national innovation system* (NIS), presented in parallel by C. Freeman (1982) and B-A. Lundvall (1985). NIS consists of three components: 1) institutions; 2) actors, networks; 3) knowledge, technologies. Based on those principles, an innovation system was defined as "the elements and relationships which interact in the production, diffusion and use of new, and economically-useful, knowledge". Lundvall (1992:2)

Soon after seminal publications, the national innovation system approach became widespread and studied by several researchers resulting in a high number of definitions of NIS differing from each other in terms of the scope of the study. These definitions can be divided into two groups – narrow and broad definitions. Narrow definitions like R. Nelson's are similar to a *triple helix* approach – including links between research institutions, firms and government in the area of R&D efforts. Broader definitions like B.A.Lundvall's define the national innovation system as also including interactive learning, tacit knowledge, economic and political freedoms, norms, culture and so on, besides formal R&D. (Johnson *et al* 2003: 4, 13).

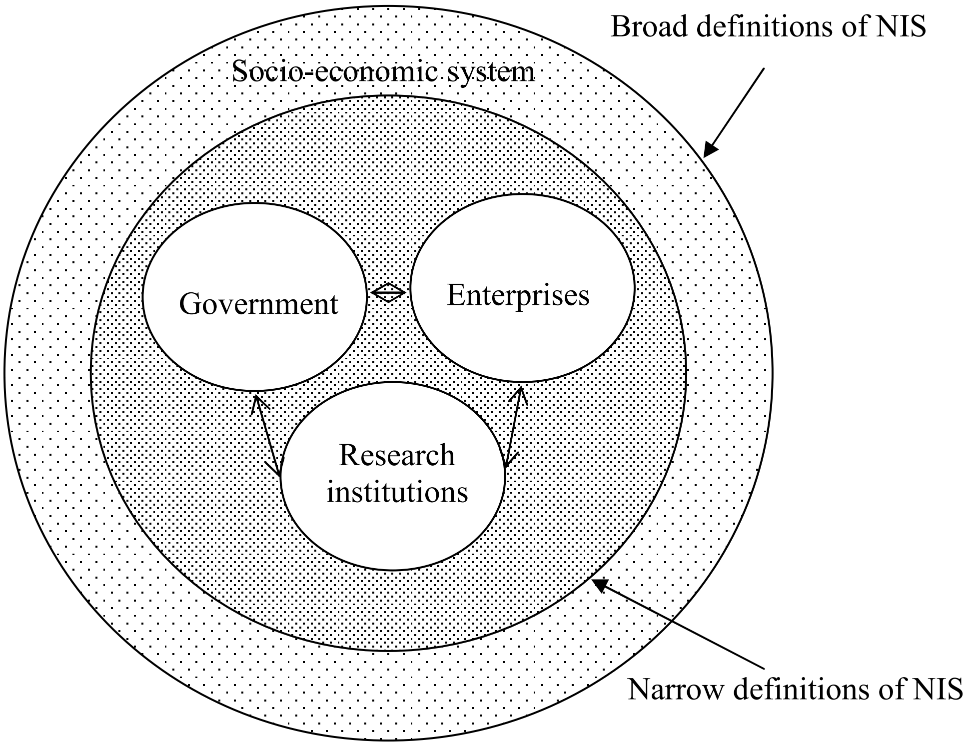

Figure 1. Broad and narrow definitions of the national innovation system (composed by D.Tamm and U.Varblane)

At the same time researchers using a narrow definition usually do not reject the wider institutional environment. They refer to those institutions as the "rules of the game". (Smith 2000: 77) In general the narrow definition takes into account the organizations directly involved in searching, exploring, acquiring and diffusing knowledge, while broader definitions also considers the broader socio-economic system surrounding organizations – all aspects of the external environment influencing learning, searching and exploring activities (Freeman 2002: 194, Smith 2000: 76) (see Figure 1). The socio-economic system includes different sub-systems like politics, religion, science, technology, culture and entrepreneurship. Thus in broader view NIS intersects with other systems and comprises parts of: 1) the economic systems including firms with a wide variety of innovative behaviours; 2) the education- and research systems, and; 3) the political systems, which are responsible for the innovation policy and its institutions and rules. It is important that these sub-systems are in accordance with each other to facilitate the innovation process effectively. (Freeman 2002: 195) At the same time, even broader definitions of IS do not mention explicitly the importance of international links – links with foreign organizations, systems and institutions.

2. Optimality issue of national innovation systems - why copying national innovation system is not a good idea?

The innovation system approach is based on the understanding that innovation processes are evolutionary, which means that they are path dependent over time and it is not clear even to the actors involved—what the end-result is going to be, i.e. which path will be taken (see Edquist, 2001). The system never achieves an equilibrium and in the framework of innovation system is not used the notion of optimality. Due to the complexity of the national innovation systems it is extremely difficult to create a single best instrument or an ideal strategy for the production of innovations.

Among the cornerstones of the national innovation system approach is the understanding that does not exist one optimal system for all countries (Edquist 1997; Metcalfe 1998). Each country has its own technological, cultural, social, political etc. development path, which influences the choice and implementation methods of different policies. Therefore common problem in the building up of national innovation systems could be the path- dependency. Path-dependence processes are characterized as phenomena whose outcomes can only be understood as part of a historical process. But those outcomes are not necessarily optimal, which means that no single ideal national innovation system exists, which would suit nations with different socio-economic, political and cultural development paths. Many researchers believe that a large part of the inefficiencies and ineffectiveness of national innovation systems may be related to the path-dependence and lock-in situations, such as characterized by evolutionary and historical economics (Nelson 1993). Consequently the well functioning innovation system could be also understood as “smart innovation system” as it takes into consideration specificity of the country and considers the system as a whole.

Historically the theory of national innovation systems was created based on the experience of high-income countries with a strong knowledge base, long-lasting continuous market economy experience, well functioning markets, long-developed stable institutional framework and a very good infrastructure to support innovation activities. Primarily due to path dependency innovation systems created in those high income countries cannot be automatically transplanted into medium or low-income countries, where the knowledge base is narrower, the infrastructure is less developed and the institutional framework is different and weaker.

Therefore is proposed that lower- income economies should use *late-comer advantage,* concept first described by the economic historian A.Gerschenkron (1962). He argued that late-comer firms have several advantages against firms from the front running countries. They could acquire and use new knowledge and innovations produced by the frontrunner economies at much lower costs by transfer agreements, inward investment and the recruitment of skilled people and skip certain stages in the trajectories of technological development. In addition the leading firms and countries had already created a growing world market so that the catch-up firms did not have to face all the uncertainties, costs and difficulties of opening up entirely new markets (detailed analyses in Freeman 2002).

But Abramowitz (1994) pointed also to the weaknesses in A. Gerschrenkron’s catch-up theory suggesting that the exploitation of the late-comer advantage is not an automatic process. He proposed that the differences in the countries’ abilities to exploit this potential might be explained with the help of two concepts: technological congruence and social capability. The first concept signified the degree to which the leader and the follower country resemble in areas such as market size, factor supply, etc. The second concept points to the capabilities that the developing countries have to acquire in order to catch up, especially the improvement of education and business infrastructure (UNIDO 2005). Bell and Pavitt (1997) indicated that it is not sufficient for late-comers to simply install large new plants with foreign technology, but they need a capacity to absorb the new technology, which necessitates serious attention to the development of human capital stock. That requires wide implementation of active learning policies. Further C. Freeman (2002) linked the findings of Abramovitz about technological congruence and social capability with the ability to make institutional changes. He expressed it as follows: „The huge divergence in growth rates which is so obvious a feature of long-term economic growth over the past two centuries must be attributed in large measure to the presence or absence of social capability for institutional change, and especially for those types of institutional change which facilitate and stimulate a high rate of technical change, i.e. innovation systems ” (Freeman 2002:191-211).

Hence the latecomers need a properly working innovation system with the wide use of active learning policies. It requires the creation and development of policy capacities. Painter and Pierre (2005:2-4) further unpack policy capacities distinguishing state, policy and administrative capacities. The broadest concept is state capacity, which means achieving appropriate outcomes e.g. sustainable economic development and welfare. Policy capacity refers to the ability to make intelligent policy choices (based on values like coherence, credibility, decisiveness etc.). Administrative capacity refers to effective resource management (based on values like efficiency, responsibility, probity, equity). In short the effective public policy is a combination of three capacities – the administrative capacity helps to manage effectively resources, policy capacity enables to make intelligent choices and state capacity provides with appropriate outcomes.

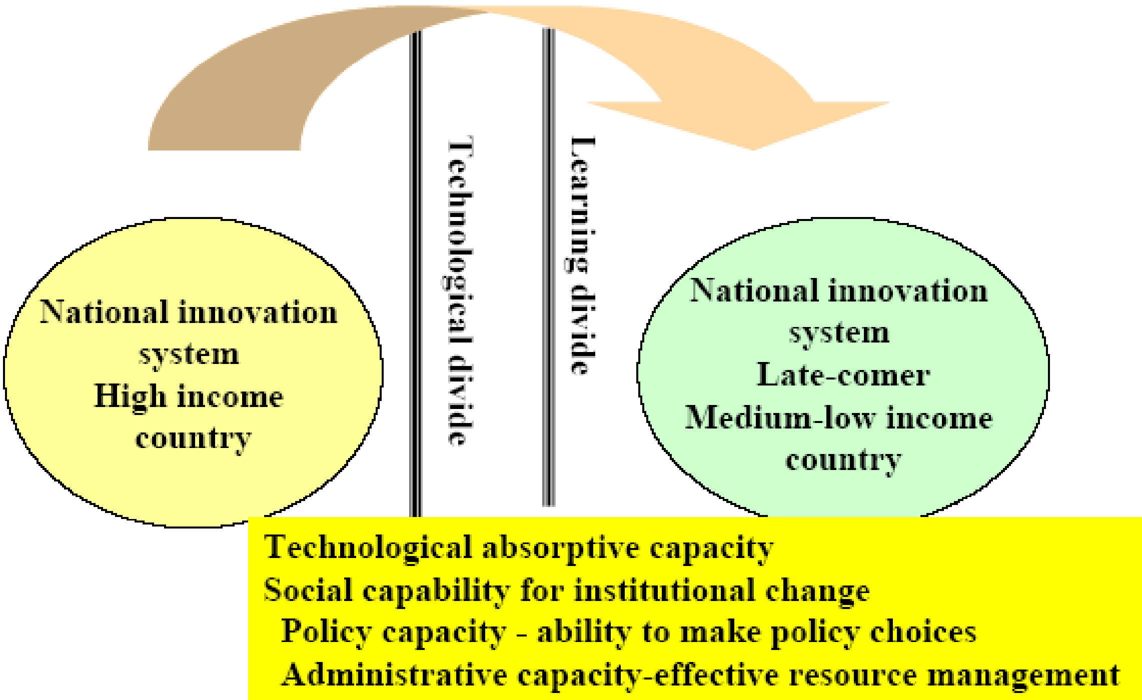

Figure 2. What is needed for late-comer economies in order to learn from national innovation systems of high income countries?

Hence summarising the discussion above late-comer countries should develop wide range of capacities in order to be able to use their late-comer advantage to establish well functioning innovation systems and achieve dynamic development (see Figure 2). Recent developments in East-Asia have clearly indicated what an important role is played by the institutional changes. Those countries have successfully introduced the mechanisms of the necessary institutional change required for bridging the "learning divide" or the "technological divide" (Arocena and Sutz 2003).

3. How to explain the copying phenomena in the building of national innovation systems in Central Eastern Europe?

But reality is rather different. Our analysis of the experience in building national innovation systems in the EU new member states suggests an existing widespread confusion on how to apply a national system approach. Applications of national innovation systems in new EU member states are characterised by strong belief in the linear innovation model; lack of more interactive innovation models; confrontation between high-tech and traditional industries; insufficient and limited use of the foreign direct investments as knowledge transfer mechanism; lack of social capital and network failure, and; weak innovation diffusion system and low motivation to learn in the society (discussion in Varblane et al, 2007).

Oversimplification about the importance of the development of science-intensive industries prevails in NMS. In their strategic documents the major focus has been on the creation of new high-technology industries – biotechnology, materials technology and ICT. The policy makers tend to believe that growing expenditures into those high-technology industries will automatically help to generate competitiveness and wealth. But overlooked remains the question how those expenditures into high-technologies could be translated into the new business ideas, emerging firms and structural change of their economies. Widely spread misunderstanding in the innovation and research policy documents of the EU new members is the conclusion that bio-, nano and information technologies should be supported as independent sectors of economy, which are the major sources of future growth. The understanding that those are only high-technologies, which need to be combined with the traditional industries and services in order to benefit and create knowledge intensive economies are rare. Already the classification of economic sectors in so called low and high technology sectors can have unintended consequences. Once a sector is classified as "high-tech", it will colour the beliefs of decision makers, who may automatically assume that all firms in a high-tech sector are highly innovative and that the innovations will have only beneficial effects, whereas potential negative effects are not even discussed. This may be summarised as the high technology bias, which manifests itself in the form of mismatch between R&D and education policies on the one hand and industry needs on the other.

New member states also have often set overambitious targets – the best example is the 3 % ratio of R&D expenditures from their GDP in near future. Their economic structure simply is not supporting its obtaining and does need different type of investments in encouraging functioning of their national innovation systems. Instead unrealistically high targets of R&D expenditures the critical issue is how to combine innovation, education, competition, FDI and other policies in order to create environment, which produces change in the economic structure. This leads also to the growth of research and development expenditures from their GDP afterwards.

In short new EU member states governments often fall into the trap of policy imitation without analysis**.** Perfectly applicable is warning "*In many countries, policy makers are simply doing similar things to what has been done previously in other countries (or in the same country)*" (Edquist, 2001: 19). Approach used by NMS governments toward the building of their national innovation systems often does not consider specificity of countries (path dependency, existing capacity and network failures). The examples are the many national technology programmes in the fields of information technology, new materials and biotechnology. They are almost identical across countries; the variations in the national characteristics between countries are often not taken into account.

Why this unreflexible copying of recommendations happened among policy makers in Central and Eastern Europe? In the beginning of transition process the governments where faced with serious macroeconomic problems and their major political attention was given to the stabilisation process. The relative importance of systemic development of innovation policies was extremely low. Country specific approach toward solving economic problems was almost unused by governments in CEE. This attitude was even more emphasized with the creation of „Washington consensus" [1] by IMF which gave very simplistic recommendations about policy making. The Washington Consensus assumed that all countries face fundamentally similar problems (be it in Eastern Europe or Latin America) and hence also recommendations to face those issues could be similar. This rather simplistic set of restructuring recommendations contained privatization, liberalisation of trade and inflows of foreign direct investments, deregulation, tax reform and fiscal discipline as its main elements.

Central and Eastern European countries followed those recommendations with remarkable discipline. Their Washington Consensus inspired policies replaced actual capacity building; the market was seen as the producer of priorities. It took away the burden of domestic capacity building and evaluation and replaced it with a set of universal policies. This is the direct opposite of the previous development consensus. (see details in Karo, Kattel, 2010: 175 -176). The outcome was even worse as Wash-

[1] J.Williamson originally developed the phrase in 1990 "to refer to the lowest common denominator of policy advice being addressed by the Washington-based institutions to Latin American countries as of 1989." (Williamson, 2000)

ington Consensus inspired policies were equalised by majority of Central and Eastern European countries with the innovation policy measures. In fact there were no other policy initiatives during the 1990s which could be called as innovation and industrial policies. The whole capacity building of policy making was directed towards macro-economic competencies (at central banks, ministries of finance etc.). In 2001 T.Mickiewicz and S.Radosevic concluded: „In the past 10 years innovation policy was considered as secondary to transition-related concerns. " (Mickiewicz, Radosevic, 2001:10)

As Central and Eastern European countries followed by large no innovation policies also the institution building for the innovation systems virtually did not exist. In NMS a rather simplistic understanding about the role of innovation in the society was widely spread, not only among politicians, but also among government officials responsible for developing the national innovation system. The main logic (or hope) was by delivering economic stability oriented policies which must help to attract foreign direct investments. Those were seen as the major technology and knowledge transfer instruments, which will deliver the real restructuring and replacement old Soviet type industry. Washington Consensus influence revealed in the widely spread understanding that market demand delivers economic restructuring and along with it creates also a need and direction for innovation-system reform (R&D, education systems, labour policy, etc.). (Karo, Kattel, 2010)

By the end of 1990's the CEE countries started to negotiate about future joining with the European Union and this process activated policy making process in those countries. Suddenly policy makers in CEE were told by EU officials that your indicators about innovation, first of all research and development expenditures, are very low. It created temptation of CEE policy makers to follow those recommendations (like before Washington Consensus) launch similar innovation system and apply also similar targets. In short CEE catch up economies fall into the trap of policy imitation without analysis.

4. Copying paradox in the designing of Estonian national innovation system

After the regaining of its independence in 1992 Estonia faced typical problems of ex-soviet economy in the process of building market based economy – liberalisation of markets, privatisation state owned firms and stabilisation financial market. Therefore during the first half of 1990's the problems of building national innovation system were not in agenda for Estonian policy makers. They moved ahead without having defined innovation policy and one could define Estonian innovation policy as „no-policy policy"(term proposed by Kalvet et al., 2002).

But in the second half of 1990's awareness about the need for the systemic approach toward innovation spilled slowly from the neighbouring Finland over to Estonia. Already during the Soviet period Estonians tried to use their closeness to the Scandinavian countries, first of all Finland, in order to learn about the principles of market economy, new trends in technologies etc. Estonian policy makers, for above mentioned reasons started to compare their country to their Nordic neighbours also in the field of research and innovation policies. Finland was used as the role model for the systemic approach toward innovation as it has been among the first countries in the world declaring that they build their society using national system of innovation approach. In addition massive inflow of Finnish foreign direct investments into Estonian economy created strong firm level cooperation between Estonia and Finland. Historically close links between Finnish and Estonian universities also facilitated this process.

Late 1990s based on the Finnish model two important documents about the Estonian innovation policy were prepared: The Estonian State Innovation Programme (approved in 1998) and the National Development Plan for the years 2000–2002 (1999), but unfortunately none of these were actually implemented. The major reason was reluctance of allocation of resources to the fulfilling objectives defined in those plans (see detailed analyses in Tiits et al., 2003). Simply speaking the policy makers applied wishful thinking and forgot the differences in the starting positions of Estonia and Finland. In order to provide some insights how deep was the gap between those two countries following Table 1 is constructed with some key indicators about economic development, funding of research and development and higher education.

Table 1: Estonia and Finland compared by some indicators of economic development and funding of research and development and higher education in 1995

Indicators	Finland	Estonia	Estonian level from the Finnish (in %)
GDP per capita in Purchasing Power Standards from EU-27 average (%)	108	36	33
Labour productivity in industry per employee (1000 EUR)	53.5	3.9	7.3
Gross research and development expenditures from GDP (%)	2.26	0.58	25.7
Business research and development expenditures from GDP (%)	1.43	0.08	7.7
Research and development expenditures per full time researchers in higher education (EUR)	71656	9840	13.7
Patents (total EPO filings)	717	3	0.4
Total researchers (full time)	20857	2978*	14.3
Business enterprise researchers	10378	291*	2.8

*Earliest available data from 1998 used by Estonia

Nonetheless, Estonia defined its research and development (R&D) strategy in a document, “Knowledge-based Estonia: Estonian Research and Development Strategy 2002-2006”, passed by Estonian parliament end of 2001. The document established a very ambitious goal – to increase the share of R&D expenditures to 1.5% of the GDP by 2006. It also defined three key areas of R&D activities in Estonia: user-friendly information technologies and development of the information society, biomedicine and material technologies. Ironically enough list of Estonian priority technologies was proposed after statement - “ no small nation can manage to be successful in all areas of RD&I or to solve all RD&I problems simultaneously“. (p.19 Knowledge based 2002-2006.) The proposed actual list of key technologies mirrors the list in Finland and many other highly developed economies and did not considered the real structures of Estonian industry with its dominance of less R&D intensive sectors, which are not likely to change overnight. (Koch et al, 2007).

Still the positive was that the new strategy document outlined the role of state to tackle with different market and other failures and should act as an investor, catalyst and regulator. But due to its political nature, the document was full of value statements and did not provided specific action plan. But without properly functioning public policy instruments, the document remains just a document (Kalvet, 2001:34-35). In short by building this strategy Finland was used as the model for copying, but in reality policy makers were able to copy only tiny fraction of Finnish national innovation system - very linear approach, were expenditures on research and development were seen as the main aim and three key technologies. Unfortunately the whole system of learning aspect of Finnish NIS was not copied - attention was not given to the development of the system of absorption and diffusion of knowledge produced in the world. Estonia is so small country that even in case of increasing its relative R&D expenditures to the level of world leading countries the domestic research potential is extremely limited. It could not alone solve the problems of upgrading the technological capability and productivity of Estonian main economic sectors. Consequently the success of Estonian economy depends heavily on the capability and willingness of firms to search, adapt, utilise knowledge produced outside Estonia (see also Varblane et al, 2007).

Unrealistically high targets set in “Knowledge-based Estonia: Estonian Research and Development Strategy 2002-2006” remained again unfilled. Expenditures on research and development were by far below the targets. Planned by the strategy launching of national programmes in key technologies was also not achieved. But instead analysing reasons why target could not be met a new strategy document was quickly prepared Estonian Research and Development and Innovation Strategy 2007- 2013 “Knowledge-based Estonia” (often referred as Knowledge-based Estonia II), which proposed even more ambitious aims: “the target of 3% of GDP expenditures on research and development, as agreed in the Lisbon strategy, is planned to be achieved by 2014” (p. 15 KBE II). It foresees also to double Estonian GDP by 2014, increase productivity by 80% of EU average level etc. In setting such a high targets document often refers to Finland as the model country, which invested in 2004 already 3.51% of GDP in research and development.

Now specifically after the serious economic crises becomes clear that targets set in the Knowledge-based Estonia II strategy remain unfilled too. Following Figure 3 is presenting the actual and planned levels of expenditures of research and development in Estonia 1995-2015. First line about the planned level of gross research and development expenditures (GERD) is derived from the "Knowledge-based Estonia: Estonian Research and Development Strategy 2002-2006" and second from the Knowledge-based Estonia II.

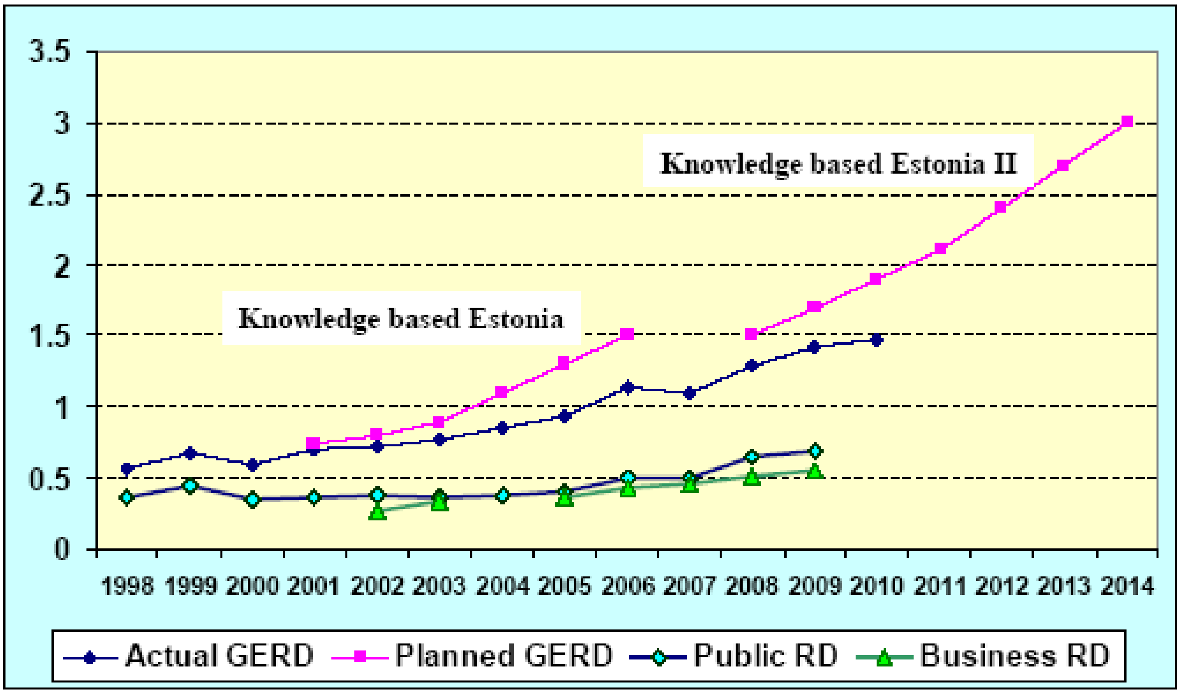

Figure 3. The planned and actual expenditures on research and development in Estonia 1998-2014 (% from GDP)

But one should raise a question - why this 3% objective in so near future makes sense in an Estonian context. Knowledge-based Estonia II strategy reveals serious misunderstanding of policy-makers about the mechanistic relationship between increased R&D spending and higher per capita GDP. The proposed rapid increase of R&D expenditures up to the proposed level of 3% in 2013 without significant reforms in the structure of R&D spending would be waste of resources. Experience of Finland, Ireland and Korea revealed that increased R&D spending and GDP per capita goes together with the growing share of private sector R&D. It means that private sector should be involved into this process, but it means that innovation policy should not be limited to promoting only R&D. Important is to keep in mind that this is input target – expenditures, which say very little about how efficiently those expenditures will be made. If not accompanied by sensible policy measures, there is also the risk of spending money not wisely, which is clearly not to the needs of the Estonian innovation system (see Koch et al, 2007).

Instead of talking about unrealistically high level of R&D expenditures Estonian innovation system should address the issue how firms obtain skills to search, understand, use and adapt the knowledge. Estonian firms are in general small and therefore mechanism about the awareness of available innovations and access to the relevant channels of communication should be organised. This system should help to avoid situation that firms are not able to identify which technologies they need and may therefore use inappropriate technologies. But in the Estonian context the technology transfer is really a problem of learning. Hence the future of Estonian society depends heavily about the success to implement learning (technical, managerial etc.) in organisations. Learning is not an automatic process, but certain motivation to enter the learning cycle must exist. Competitive pressure from the world market should be driver for learning. But from the other hand governmental policy should support creation of various learning networks (regional, sectoral clusters) with the aim to increase the capacities of the firms. It reflects the current trends in the innovation policy where the earlier models of science push or market pull interpretations of the innovation model have been further developed and innovation as the social process model is used instead. The importance of social networks in the innovation process is acknowledged. In conclusion the human capital is the major production factor of Estonia and therefore Estonian economy and its innovation system is competitive only when it could utilise the existing and improve the knowledge base in the society.

Smart specialisation as the tool to overcome "copying paradox"

The previous sections revealed the copying paradox in the process of building the innovation systems of the new member states of EU. Hence logical question arises - how to develop national innovation system avoiding „copying paradox". In answering the question we refer first to the D.Rodrik(2007) who stresses the importance of the contextual understanding about the process of innovation and economic development. Three major elements – growth diagnostics; policy design; institutionalization should be taken into consideration. Central importance is playing the self- discovery process of designing national innovation policies. (see Rodrik 2007 and Karo, Kattel, 2010:10).In the context of EU new member states it means that the problems are contextual, the end goal of policies and actions may be universal and consensual, but the path of development has to take into account the content and context of the problem and provide suitable solutions and development patterns. Instead of copying national innovation systems of advanced economies we need contextual understanding of the innovation processes and economic development.

Independent advisory group „Knowledge 4 Growth“ (K4G) launched by EU research commissioner J. Potočnik in 2005 and headed by prof. D.Foray has revealed similar trends also by the other countries in EU. Among the most important findings of the K4G Group was the observation that the tendency of countries and regions to do the same things, to « de-specialize » exists, which leads to the uniformization of the knowledge base of Europe as a collection of sub-critical systems. Technology foresight tends to produce the same « priority » ranking regardless of the « clients » (Foray, 2007). The problem is that countries are designing their science and technology policies, investing into their research institutions using copy and paste strategies. Public policies in all over the Europe are designed in order to give priority to the new science based technologies. But this approach results in greater and greater uniformity of their national knowledge bases.

How to overcome this copying paradox Europe wide? The major recommendation of the experts from the K4G group proposed the idea about the smart specialisation as the solution to this antagonism. It means that countries and regions must invest in a particularization process to identify areas for focus while maintaining what makes the knowledge base distinctive and original.

But here is a problem - how is possible to behave smartly by those EU new members states with significantly weaker knowledge base and less experienced public sector. The smart specialisation presumes that countries know and address their system failures. But reality is rather different as describe above – the research and innovation policies of the new member states are trying to copy the policies of old EU member states. They do not take sufficiently into consideration of the specificity of those countries. The whole approach is very far from the smart specialisation idea proposed by the K4G expert group.

It leads to the major problem faced by the new member states - do they have a vision to develop diverse knowledge base. Creation of a vision for the development of knowledge base of the country is extremely difficult task. It requires execution of foresight exercises, but they need to be linked with the deep analysis of the specificity of the certain country, its development path, cultural, social, demographic etc. background and trends. New member states should try to maintain what makes their knowledge base distinctive and original. Otherwise they reach to the outcome, which has happened so far in majority of the new EU countries and described before - the strategic importance is given to the same three major areas – bio-, nano and info technologies.

In the process of creating diversified knowledge base is important to answer at least to the following questions:

a) how narrow or wide is the selected niche;
b) how simple is for the potential competitor to imitate prioritised niche of the knowledge base;
c) how well is it linked with our previous development path, could it use the previous knowledge base;
d) how easy is attract interest of foreign investors to invest into the development of this knowledge area;
e) which way is it related with the existing or emerging high potential markets;
f) how probable is the emergence of spillovers from the selected knowledge niche to other parts of the economy, to be used as the innovation sources by different sectors of the economy

The new member states should pay attention to the development of less capital intensive areas, where integrated knowledge is needed and maybe also technology-based services such as health care, energy, and environment. Particularly important is to find niches inside the broad areas of implementing new technologies in mature industries and services. Here is extremely relevant to link new technologies with the already existing strengths. Diversified knowledge base requires also diversified policies, which help to create well-developed knowledge infrastructure and connectivity or networking, which guarantees knowledge flows. Thus new member states could solve or at least soften the three major groups of systemic failures – capability, infra-structure and networking failures.

Diversified knowledge base requires also strong commitment of private investors. Governments in new member states should be active not only in providing public R&D but also in supporting private R&D with public funds. Unfortunately new member states have been very weak in this direction. But the previous experience indicates to the scale economies and external effects in the public funding of private R&D. The data show that larger EU economies provide relatively more support for private R&D (see Van Horst et al, 2006). Diversified knowledge base could be also attractive to the foreign multinationals in order to channel part of their research and development funding into the research in new members states. This is extremely important task as the majority of the new member states have very high FDI penetration rate and the urgent problem is how to integrate foreign firms better into the domestic research and technology development process.

Oil shale industry as an example of smart specialization in Estonia

Finally the following section is trying to provide an example how Estonia is seeking to re-establish its field of specialisation and create diversified knowledge base in the use of oil shale. First oil-shale mining in Estonia was opened 1918 and by 1940 the annual production reached 1.7 million tons (excellent historical overview in Holmberg, 2008:83-187). In 1921 Estonian researchers improved the technology how to extract oil out of oil shale and Kiviter technology process was launched. Soon the majority of oil shale in Estonia was used for oil production and upgraded for use as transport fuels.

After the World War II in Estonia being incorporated into Soviet Union the oil shale production increased dramatically peaking in 1980 when 31.4 million tons was mined. (Reinsalu, 1998). It was around two thirds of the world production (see Figure 4). But majority of oil shale was used as a fuel for electric power plants and Estonia was electricity exporter to Russia in that time. Due to the extremely low oil prices in Soviet Union the oil shale was very little used for oil production.

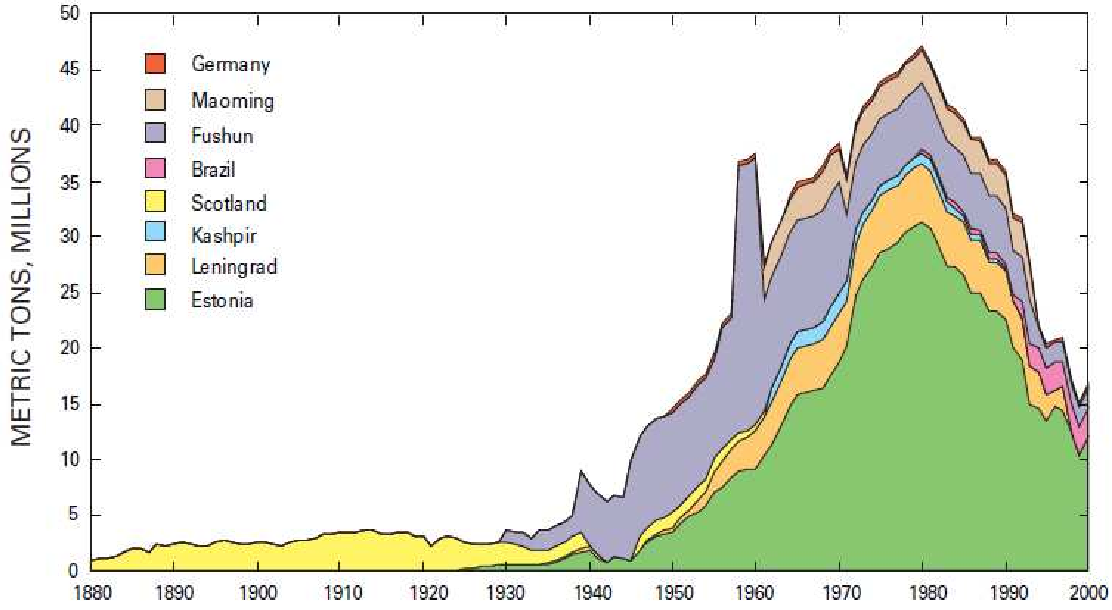

Figure 4. Production of oil shale in millions of metric tons from major deposits of the world 1880-2000 (Source: Dyni, 2006:38)

After the collapse of Soviet Union and regaining independence in 1992 the production of oil shale of Estonia declined rapidly down to 10.7 million tons in 1999, partly because the whole industrial sector was smaller and also due to the relatively low price of competing energy sources like natural gas and oil. In that period the Estonian national innovation system almost ignored the existence of such a valuable knowledge – how to mine, process and use oil shale. Particularly unique was the knowledge how to extract oil out of oil shale. Estonia was among the few countries in the world, where these technologies not only existed, but were also commercially used. In 2008 almost 40 % of world extracted oil shale was produced in Estonia (World Energy Council, 2011). But following the copying logic the Estonian public funding to oil shale oriented research was heavily reduced. Instead the priority was given to the popular bio-, information- and nanotechnologies (see analysis above). The knowledge base of Estonia was de-specializing – trend was toward doing the same things as others do.

The positive turnaround started from the business sector state-owned Estonian energy company Eesti Energia, which got in early 2000 a new enthusiastic and strategically thinking management team. They quickly understood that knowledge about the extracting oil out of oil shale has a strategic value. The potential world resources of shale oil are huge. Total world resources of shale oil are conservatively estimated at 4.8 trillion barrels (World Energy Council, 2011). This is 3–9 times more than the current proved oil reserves on the earth (Liive, 2007). The biggest oil shale resources are in USA, Brazil, Jordan and Morocco, which are still almost unused. Petroleum based crude oil was cheaper to produce than shale oil due to the extra costs of mining and extracting the energy from oil shale. But the higher global prices of oil products suggest that shale oil production will be increasingly profitable and competition for the best technological solutions is started.

Therefore Eesti Energia behaved strategically and activated a development plan with the aim to become an important player in the field of oil shale based oil production technologies in the world. Eesti Energia has developed in close cooperation with the Tallinn University of Technology a novel technology for extracting oil shale. In order to further optimise its current industrially proven technology in November 2008 Eesti Energia formed a joint venture with Finnish Outotec OYJ for the development and marketing of sustainable, energy-efficient and economically viable oil shale processing methods (Outotec, 2008). It combines Eesti Energia current experience in oil shale mining and processing and Outotec's expertise in circulating fluid bed (CFB) technologies. It will be used already in Narva plant, where by the 2012 Eesti Energia plans to double its shale oil production.

In late 2006 Eesti Energia obtained exclusive right to study about one third of the resources of the El Lajjun oil shale deposit in Jordan. According to the feasibility study company will establish a shale oil plant with capacity of 36,000 barrels per day and construction is planned to begin by 2015. In 2010 Eesti Energia acquired 100% of Oil Shale Exploration Company, a US company with one of the largest tracts of privately owned oil shale properties in Utah. Eesti Energia is planning to construct an oil shale plant with a capacity of 57,000 barrels of shale oil per day at full production within next 5-7 years. „It is a unique opportunity for Estonia to be able to provide one of the largest countries in the world with something they need – technology - which enables them to utilize their domestic oil shale resource and therefore increase the country's energy independence," commented Eesti Energia's CEO, Sandor Liive by the signing of the agreement.

Once those transactions are closed, Eesti Energia will be both the developer of international projects and a provider of the Enefit technology for shale oil production. The presented oil shale case provides an example how the national innovation system could still start to generate smart specialization and abandon simplified copying model.

5. Conclusions

This chapter discussed the application of the national system approach in the catching up economies. It criticized the assumption that there exists an optimal one-size-fits-all national innovation system model. Chapter shows why this unreflexible copying of recommendations happened among policy makers in Central and Eastern Europe. In the beginning of transition process the governments faced with serious macroeconomic problems and their major political attention was given to the stabilisation process. The relative importance of systemic development of innovation policies was extremely low. Country specific approach toward solving economic problems was almost unused by governments in CEE. The Washington Consensus suggested by IMF assumed that all countries face fundamentally similar problems and hence also recommendations to face those issues could be similar. Central and Eastern European countries followed these rather simplistic restructuring recommendations with remarkable discipline.

Similar rather unreflexible copying of recommendations about building national innovation systems happened among policy makers in Central and Eastern Europe too. An example is the Estonia-Finland case, in which Finland's national innovation system is being applied to Estonia. In chapter author argues that innovation is path dependent and that factors such as distance from the current technological frontier (latecomer or frontrunner) and different national knowledge bases must be considered when developing a national innovation system for a specific country. The future of Estonian society depends heavily about the success to implement learning (technical, managerial etc.) in organisations. Learning is not an automatic process, but certain motivation to enter the learning cycle must exist. Competitive pressure from the world market should be driver for learning. But from the other hand governmental policy should support creation of various learning networks (regional, sectoral clusters) with the aim to increase the capacities of the firms.

Chapter tries to answer to the question - how to develop national innovation system avoiding „copying paradox". Instead of copying national innovation systems of advanced economies we need contextual understanding of the innovation processes and economic development. The idea proposed by the experts group of K4G (Knowledge for Growth) about the smart specialisation could serve as one potential solution to this antagonism. It means that countries and regions must invest in a particularization process to identify areas for focus while maintaining what makes the knowledge base distinctive and original. CEE countries should develop diverse knowledge base. Creation of a vision for the development of knowledge base of the country is extremely difficult task. It requires execution of foresight exercises, but they need to be linked with the deep analysis of the specificity of the certain country, its development path, cultural, social, demographic etc. background and trends. Final part of the chapter is trying to provide an example how Estonia is seeking to re-establish its field of specialisation and create diversified knowledge base in the use of oil shale.

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