THE PROBLEMS OF ESTONIAN R&D AND INNOVATION STRATEGY AND THE DEMAND-SIDE INNOVATION POLICIES[1]

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Abstract

The second larger Estonian R&D and Innovation Strategy 'Knowledge-based Estonia 2007-2013' is aimed at continuing the advancement of research and development efforts towards an innovative knowledge-based society and economic system in Estonia. Fostering of knowledge-based high-tech industries is seen as paramount for retaining country's competitive advantage. However, the mid-term evaluations indicate that several goals of the strategy might not be achievable by 2013. In fact, the policy measures have been much more successful in developing scientific research, as indicated by increased international publication, number of patents, and number of researchers and engineers. The advances in development of high-tech products and services through innovations are noticeable but less prominent. The purpose of this study is to suggest the role for demand-side innovation policies in helping to advance commercial development and innovation.

Keywords: R&D and innovation strategy, demand-side innovation policy, Estonia

JEL Classification: O31, O32, O33, O38

Introduction

In the competitiveness of EU countries, important roles are played by high-tech production, leading-edge service industries, and high productivity of resources. According to Innovation Union Scoreboard 2010, Sweden, Denmark, Finland, and Germany dominate as innovation leaders (IUS 2010, 2011). These countries have managed to build up strong innovation systems that balance out complexities between R&D inputs (like financing), intermediaries (entrepreneurship, networks, and intellectual property), and outcomes in terms of economic effect (high-tech turnover, exports, and productivity). Even for them it has not been an easy task to find that balance. The above average financing of R&D and innovations does not necessarily lead to desired development outcomes, for example, when crucial institutional capabilities are insufficient or missing. For that reason, countries tend to adopt well-established R&D and innovation strategies, which aim to reinforce several aspects of R&D activities and framework. Furthermore, these strategies often refer back to EU- level strategies like 'Europe 2020' (Europe 2020, 2011) in order to remain coherent with union-wide development vision.

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Estonia is small and open EU member state. It became again independent in 1991 and built the competitive advantage on a low-cost production with reasonably good quality. However, especially after accession to EU in 2004, the cost levels have been inflated considerably. This introduces an eminent need to find new competitive edge among the other countries. In fact, Estonian government took an initiative already prior to the accession by adopting Estonian Research and Development Strategy 2002–2006 'Knowledge-based Estonia'. The aim was set to transform Estonia into the knowledge-based economy as opposed to the cost-based economy. This strategy outlined some key sectors, like IT, biotechnology, and material sciences that should serve as leaders in the new competitive vision. It also established a set of policy measures and targets related to the advances in research and development.

At the beginning of 2007, Estonian Parliament approved the follow-up strategy 'Knowledge-based Estonia 2007-2013'. Now in 2012, the time has arrived to evaluate the progress towards target indicators provided in that second strategy, because the third generation strategy is already in preparation, and can benefit from the analysis of intermediate results. This analysis should pinpoint potential areas for readjustments in order to improve the match between the strategy, the adopted measures of enactment, and the dynamic environment. Fortunately, there are several related progress reports and domestic or international evaluations to rely upon. These reports tend to agree that the strategy has been a success story with mixed results. The results indicate that targets set for science and research have been realistic or even less challenging than initially predicted. Yet, in terms of commercialization, development, and innovation the initiatives fall short in achieving the indicated targets by the end of 2013, albeit some development trends are very positive as well. This implies that more attention is needed on the development and innovations in order to balance out the lag in progress. One option for facilitating the commercial usage of research results and the academy-industry cooperation is to use demand-side innovation policies.

The purpose of this study is to suggest the role for demand-side innovation policies in helping to advance the commercial development and innovation. The discussion explains the features of demand-side innovation policies in the light of R&D and innovation facilitation. Based on such theoretical and empirical contributions, as well as on the evaluative analysis of current strategy's results, suggestions are made how to incorporate the demand-side innovation policies into the implementation plans that go beyond current strategy period.

The study has following structure. It starts with the discussion of views describing the demand-side innovation policies, especially in the context of R&D towards innovations in production and services. The next section offers an evaluation of logic and results of the strategy 'Knowledge-based Estonia 2007-2013' including the EU-wide viewpoint. This analytical evaluation explains the major positives and problems in the process of strategy execution. The third section suggests the demand-side innovation policies and initiatives for improving the development and innovation activities as logical continuation academic research. The conclusions outline the results and limitations as well as suggest the paths for future research.

The demand-side innovation policies and R&D facilitation

In May 2011, OECD published a book 'Demand-side Innovation Policies' that explains the role of demand in a diffusion of innovations, in order to point out why various demand-side innovation policy instruments help to facilitate innovation. This more theoretical conceptualization is followed by the case studies about the usage of such policies in Australia, Belgium (Flanders), Denmark, France, Italy, Japan, Korea, Spain, United Kingdom, and finally European Union. This book summarizes the international project that was started in 2008. (OECD 2011)

The demand-pull theories of innovation suggest that the ability to produce innovations is relatively common, but it requires market opportunity in the form of demand. According to this view, the demand on market determines the resource allocations into particular innovations. Therefore, innovations are not the results of solely supply push factors, as early views suggested, but in most cases, the result of intricate combination between supply push and demand pull. This allows facilitating innovation by improving the demand conditions for innovative products or services. The demand-side innovation policies serve exactly that purpose. (OECD 2011)

The demand-side innovation policy measures are often linked to such policy aims like sustainability, energy efficiency, infrastructure, or health care system (Edler 2005). This shows the importance of demand facilitation on the way towards more forward looking and sustainable consumption pattern. Such policy aims combine R&D and innovations facilitation and welfare creation.

The demand-side innovation policy has been defined as 'a set of public measures to increase the demand for innovations, to improve the conditions for the uptake of innovations and/or to improve the articulation of demand in order to spur innovations and the diffusion of innovations' (Edler 2009, p. 5). This definition introduces novel aspects, like the conditions for the uptake and improved articulation of demand.

The demand-side innovation policies are used because (see Edler 2009):
1) innovation policy needs to help overcome market and/or system failures;
2) societal goals and policy needs determined for example by elected politicians;
3) industrial or economic policy that calls for modernisation via innovations;
4) industrial or economic policy seeks to facilitate forefront innovation production with local, national or regional companies and to create lead market potential.

The demand-side policy measures have more purposes than just overcoming deficiencies of the market for innovative solutions or systemic problems in the initiation or diffusion of innovations. Societal goals and policy needs as the set purposes involve considerable risks. Their subjective nature creates potential for emergence of biased solutions and corruption. Very transparent and well-founded goal-setting should help to reduce such dangers. The demand-side innovation policy tools are summarized on table 1.

Table 1. Categories of demand-side innovation policy tools

Demand-side policy tool:	Description:
SYSTEMIC POLICIES	
Lead market initiatives	Lead market initiatives support the emergence of lead markets. A lead market is the market of a product or service in a given geographical area, where the diffusion process of an internationally successful innovation (technological or non-technological) first took off and is sustained and expanded through a wide range of different services.
Support to user-centred innovation	User-centred innovation refers to innovation driven by end- or intermediate users.
PROCUREMENT INITIATIVES	
Public procurement of innovation	Public procurement of innovative goods and services relies on inducing innovation by specifying levels of performance or functionality that are not achievable with 'off-the-shelf' solutions and hence require an innovation to meet the demand.
Pre-commercial public procurement	Pre-commercial procurement is an approach for procuring R&D services, which enables public procurers to share the risks and benefits of designing, prototyping and testing new products and services with the suppliers.
Catalytic procurement	Catalytic procurement involves the combination of private demand measures with public procurement where the needs of private buyers are systemically ascertained. The government acts here as 'ice-breaker' in order to mobilise private demand.
PRIVATE DEMAND GENERATION AND REGULATIONS	
Tax incentives	Tax incentives can increase the demand for novelties and innovation by offering reductions on specific purchases.
Awareness raising	Awareness raising actions supporting private demand have the role to bridge the information gap consumers of innovation have about the security and the quality of a novelty.
Consumer policies	Consumer policies use regulations, standards, and other measures that channel social and cultural expectations towards the process of introducing new products/services.
Use of regulations	Use of regulation for innovation purposes is when governments collaborate broadly with industry and non-government organisations to formulate a new regulation that is formed to encourage a certain innovative behaviour.
Standardisation	Standardisation is a voluntary cooperation among industry, consumers, public authorities and other interested parties for the development of technical specifications based on consensus and can be an important enabler of innovation.

Source: based on Izsak, Edler 2011, p. 6 and OECD 2011, p. 53

Edler (2010) summarizes early signals of buyers to demand innovative solutions, economic ability to pay higher entry costs of innovations, critical mass of demand, a certain level of problem pressure in a market, pioneering regulations, conducive supply conditions (the conditions for rapid learning and adaptation by suppliers,

adequate technological competence within the value chain), and supporting services as the conditions that characterize lead markets in more detailed manner (Edler 2010). Appelquist et al. (2009) argue about the demand for innovation-based solutions that it needs to be stimulated by appropriate lead market policies. The policy focus should be on the introduction of measures, such as novel ways of using public procurement and support for user-driven innovation projects. The innovation policy should be fast and synchronised. This suggests quick reaction to the problems and reduced complexity of the policy portfolio, while having wider policy scope. In his recent publication, Edler (2011) stated that policies stressing the demand factors for innovation could facilitate the modernisation of economy and public services as well as accelerate the catching up process of less-developed countries or regions.

Successful innovation policy contributes to an increase in productivity by encouraging companies to modernise their production systems. Leading-edge technologies and innovative processes make the companies and the economy more efficient. However, an innovation-oriented industrial policy should be related to an analysis of domestic companies' capabilities to participate in this process. If local innovative capabilities are low, then the demand-side policies might contribute more to the import than to the development of national business setting. Knowledge transfers from abroad are also important. Ultimately, the national policies should create conditions for domestic innovations as well. (see also Edler, Georghiau 2007; Edler 2009)

Some forms of demand-side innovation policy are not new. Already in 1970s and 1980s several studies discussed public procurement as a policy measure that can impact innovations. (Edler, Georghiou 2007) However, the modern views on subject do make a considerable contribution by taking more interconnected and interactive standpoint. Each policy measure has to be viewed in a broader context in order to account for the general impact of the entire innovation policy. While the demand-side innovation policies have their own narrower focus, they should be also viewed in the framework of wider policy setting.

In 2006, the EU expert group led by Esko Aho released a report outlining the need for fostering the demand-side initiatives. Harmonised regulations, standards, public procurement, intellectual property rights, and innovative culture are in short the five key issues in the EU report. (Aho et al. 2006) This report and other documentation from the same period (see Moran et al. 2007; Zuleeg et al. 2007 for details) are steps toward EU-wide recognition of a need for better balance between supply-side and demand-side innovation policy measures. This requires more focus on the demand-side measures. However, it does not mean policy switch towards solely demand-side policies. The innovation policy mix should contain the supply-side measures as well as the demand-side instruments (Smits and Kuhlman 2004; Edler, Georghiou 2007).

Izsak and Edler (2011) conclude that in Europe there is a general trend in strategies and policy measures towards more demand-side approaches. Compared to 2009, the demand-side innovation policy is more prominently featured in majority of EU countries. In a number of countries, the demand-side innovation policy has become

an explicit part of recent innovation strategies, but majority of countries still focus predominantly on the supply-side instruments. Thus, there seems to be a EU-wide trend that the demand-side policy measures are gradually valued in the context of national R&D and innovation strategies.

In terms of policy measures, there is a strong focus on innovative public procurement and growing popularity describes pre-commercial procurement. Regulations retain their importance by influencing innovation activities particularly in the domain of sectoral and industrial policies, but not as an explicit part of innovation policy. There is a danger that the demand-side innovation policy measures are in some countries rolled out prematurely and with high transaction and learning costs. Such phenomenon happens usually when new trends emerge in European policy making. (Izsak, Edler 2011)

The strong interconnections with EU-level standards, procurement guidelines, and industrial policy regulations suggest that demand-side policy measures are to some extent to be governed union-wide. Still, the national R&D and innovation potential can be effectively facilitated only by using agile systems and good responsiveness to changes in economy and business environment.

To conclude, the demand-side innovation policies are important complements to the supply-side measures, which still tend to dominate in majority of innovation systems and policy settings. Within the EU, the major innovation policy challenge is to achieve shift towards demand-side measures, and there are some promising signs that various demand-side policy tools are being introduced into national R&D strategies and innovation policies by increasing number of EU countries.

The nature and early results of 'Knowledge-based Estonia 2007-2013'

Reid (2009) indicated that the adoption of the first R&D and Innovation Strategy 'Knowledge-based Estonia 2002-2006' and the first round of EU Structural Fund support 2004-2006 started in Estonia the initiatives of increasing the existing small funds for supporting enterprises seeking to develop new products or services. The general innovation awareness and university-industry cooperation were also fostered. This strategy focused on developing a R&D infrastructure in universities (centres of excellence program). By 2004, Estonia was seen from EU level as the leading innovation policy developer in the Baltic region and among new CEE member country.

However, thereafter the momentum has been somewhat lost, because second Knowledge-based Estonia Strategy for 2007-2013 describes predominantly the continuation of activities established in earlier strategy. Some new initiatives, like Development Fund, have emerged as well. Yet, the other countries have considerably closed the policy development gap by introducing their own innovation strategies and policy measures. The initial leader position was to some extent related to wide-range of learning experiences gained from policy development co-operation with Finland. (Reid 2009)

The R&D and innovation policy activities in Estonia are based on economic development plans, application plans of R&D and Innovation Strategy 'Knowledge-based Estonia 2007-2013', and on plans developed by Estonian Ministry of Economic Affairs and Communications. The Ministry has outlined four main activity groups (Estonian Ministry of Economic ... 2012): 1) technological upgrading of enterprises, the increase in their development capability and productivity growth; 2) the inflow of new innovative business ideas and their growth into enterprises; 3) knowledge and technology transfer; and 4) the development of innovative environment, creative industries, design, and service innovation.

Most of the activities in these categories focus still on a supply-side of innovations. Some programs do incorporate at least partial or implicit demand-side aspects. For example, innovation vouchers function as enablers of projects, which might be otherwise disregarded. Science and development programs for energy technologies and biotechnologies facilitate also demand for innovative solutions in these sectors. Innovation awareness measures and screening studies initiated by Development Fund lay at least a path for increase in future demand.

There are innovation procurement initiatives that include changes in the regulatory environment and subsidies to boost the usage of local energy resources. The public procurement and regulatory initiatives support also the collection of used packages, wind energy production, and changes in waste collection. However, several of these examples reflect the impact of EU-level policies on local standards. Thus, they are not novel in the broader international context, but still new solutions for Estonia. The holistic R&D and innovation policy mix is in Estonia still clearly dominated by supply-side initiatives. The comparatively low attention to demand-side innovation policies in Estonia is mentioned in the report by Cunningham (2009). According to him, Latvia and Lithuania have that policy debate, but Estonia does not.

Enterprise Estonia (EAS) is perhaps the main executive body in the support provision process. It was established in 2000, with the general purpose to promote business and regional development in Estonia. Subordinated to the Ministry of Economic Affairs and Communications, Enterprise Estonia provides financial assistance, advisory, cooperation opportunities and training for entrepreneurs as well as for research establishments, public sector and third sector. Since Estonia joined EU in 2004, the majority of programs and grants offered by Enterprise Estonia are co-financed from the EU structural funds. Enterprise Estonia is responsible for the governance of such innovation policy measures as product development grants, technology development centres program, job creation for development personnel, innovation vouchers program, and test labs program. (EAS 2012)

The important part of Estonian R&D and innovation policy is governed by the Estonian Ministry of Education and Research. Here the focus is on funding and other initiatives aimed at the development of research, teaching and training capabilities or opportunities. The main bodies subordinated to this ministry that govern research funding have been the Research Competency Council and the Estonian Science Foundation. More diversified research and educational programs

are governed by Archimedes Foundation, while Innove Foundation promotes lifelong learning. There are also other more specialised foundations like Tiger Leap Foundation and Estonian Information Technology Foundation aimed at facilitation of IT development in Estonia. Some units focus also on youth work or on popularisation of science. (Estonian Ministry of Education ... 2012) The Estonian Ministry of Education and Research and its sub-units have very important role in research funding and infrastructure development. This side of Estonian innovation system is, however, even more supply-side dominated than the activities governed by the Ministry of Economic Affairs and Communications.

The Estonian R&D and Innovation Strategy 'Knowledge-based Estonia 2007-2013' does mention the stimulation of demand for new technologies primarily through public procurement (Estonian Research... 2007). In policy practice, the explicit demand-side innovation policy measures are still relatively scarce and somewhat sporadic.

In order to monitor and develop the Estonian innovation policy schemes the Ministry of Economic Affairs and Communications has initiated several evaluations and studies. The early evaluation of Technopolis published in 2005 reveals that in Knowledge-based Estonia strategy for 2002-2006 the identified key areas were not always supported by policy mechanisms. The innovation policy practice was too focused on limited number of high-tech sectors and attention to low-tech sectors, which is stated in that strategy, had been minor. The evaluators suggested that attention has been predominantly on development of infrastructure, while the human capital and development personnel deserve more direct policy attention. They concluded that for the period 2007-2013 infrastructural investments should require active participation of enterprises as users in order to ensure more demand-driven approach. (Evaluation of the design... 2005)

The evaluation from 2007 suggests that more attention should be devoted on demand-side because the planned increase of R&D expenditures as percentage of GDP might be dangerous in a situation where the demand for innovations is relatively low, as it is the case in Estonia. In this document, the opposition from the academic sector against more demand-oriented innovation policy developments is seen as potential threat. A low demand by enterprises and small financial rewards for cooperative activities characterise also university-industry linkages. Both, the absorptive capacity as well as demand for new technologies are in Estonia limited by the level of development and the industrial structure of the country. GDP per capita in Estonia is still significantly lower than in the EU-25. The evaluators noted that the Estonian economy is dominated by SME-s from low- to medium-tech sectors, business expenditure on R&D is very low and economic growth is primarily driven by exports from traditional economical sectors. They also outlined occasional coordination problems and proposed innovation voucher system, which has now been implemented. (Evaluation of Estonian... 2007)

The visibility analysis of support measures for investments into technology suggests that such support should be oriented primarily to enterprises and entrepreneurs who:

1) aim to increase productivity; 2) export quality; 3) intend to extend markets; and 4) intend to enter into new target markets. The analysis points out that an investment program alone is not enough to achieve such goals, but extensive coordination with other policy measures is required as well as the involvement of decision makers with sector-specific competences. (Ettevõtete... 2008) The weakness of industrial demand and participation in the competence centres is evident also from mid-term evaluation of the competence centre (called also technology development centres) program. For example, in the field of nanotechnology, scientific expertise is there, but industrial linkages are weakly developed. This is further evidence about the dominance of supply-side, while market development lags behind. (Mid-Term Evaluation... 2008) The reduction of costs for employing R&D personnel is seen as one possible catalyst for an increase in the demand for R&D. Recent study suggests numerous tax incentives (including reduced personal income taxes for R&D employees) as one potential policy measure. (An Analysis... 2010) The following summary evaluation of positive achievements and problematic aspects in the framework of 'Knowledge-based Estonia 2007-2013' is based on latest available reports and expert evaluations.

The status of 'Knowledge-based Estonia 2007-2013' strategy implementation

Positive achievements

One of the positive aspects relates to the fact that the development of R&D and innovations has not been aim only in policies and statements, but it has been clearly reflected in funding, job creation and activities promotion. In EU funding schemes, the financing and co-financing of R&D has also increased considerably. According to Statistics Estonia, in 2010 the total spending on R&D activities was in Estonia 232.76 million Euros, which was about 1.63 % of GDP. From that total spending, all funds from public sector constitute slightly less than half (0.81 %), and private R&D expenses slightly more than half (0.82 %). (Statistics Estonia 2012) However, these statistics are unlikely to reflect the entire contribution into R&D activities, because the overview about various funding schemes offered by different ministries, which at least indirectly facilitate R&D, is partial.

Although, it is expected that the initial goal to achieve R&D funding at 3 % from GDP will not be met by 2014 (ERA Committee 2011), the growth of funding has still been considerable. The fact that initial goal will not be achieved might be even seen as positive, because several important perquisites for efficiency of development activities and innovations are not yet fulfilled. Therefore, the artificially elevated funding via budgetary allocations from government would be likely to contribute towards inefficient use of resources or possible even just crowd out private spending. Thus, it is positive that the growth in funding has not been boosted by attempts to achieve the 3 % level at any expense. In the more recent competitiveness plan 'Estonia 2020', the goals related to R&D funding have been revised so that by 2015 it would be 2 % from GDP and by 2020 3 % (ERA Committee 2011). Thus, now the 3 % level is to be achieved six years later.

The most positive effects of increased funding can be seen in research activities (ERA Committee 2011), because the combination of public and private financing and EU co-financing from framework programs has created opportunities for quantitative and qualitative development of research. Quantitative development has commenced in the form of several investments into the updating of research infrastructure as well as into new buildings and leading-edge equipment. The goals of strategy in terms of growth in the number of researchers and engineers per 1000 people will most likely be achieved too (Aruanne strateegia ... 2011). Yet, the development of human resources, in respect to the growth in the number of young scientists and to the international mobility of researchers, has not been as successful as improvements in infrastructure. The competitiveness of research as the field of activity needs to be increased among potential domestic and international candidates. The indicators of qualitative development in the research relate to the fact that the target value for the number of internationally acknowledged scientific publications per year has been already achieved (the target was raised in 2008 to 1500 publications per year) and the number of patents and patent applications has increased according to expectations (Aruanne strateegia ... 2011). The qualitative improvement is indicated also by the ability of Estonian scientists and research groups to participate successfully in the EU framework programs.

In the field of research, positive influence relates also to successfully implemented mobility programs 'DoRa' and 'Mobilitas'. By facilitating the multidirectional mobility of researchers, doctoral students, and post-doctorate students, these measures help to internationalize Estonian higher education and research. (Aruanne strateegia ... 2011) Yet, the funds provided for incoming mobility are internationally not very competitive for attracting the foreign teachers and post-doctoral students into Estonia. Despite limited funds, the recruitment has been relatively successful, because low interest related to long term stay in Estonia has been to some extent compensated by frequent recruiting activities. Thus, in general these mobility measures have functioned well.

From development and innovation aspect, one target that is likely to be reached relates to investments into innovation as percentage from the turnover of the companies (Statistics Estonia 2012). Achieving the target level is important, but it might be too low and not challenging for companies. Large share of these investments relates to non-R&D innovations. It allows concluding that companies do contribute into innovations, but things with low novelty or knowledge component are often already seen as innovative. On the way to knowledge-based society, this direction is not wrong, but such attitude towards innovation as development-oriented change is insufficient for achieving more substantial development leap. Thus, the statistics about the innovation investments are perhaps more positive than the essence of such investments in terms of contribution towards more knowledge-based production or service.

Considerable success has been achieved in the organisation and recruitment support for exporting provided by Enterprise Estonia, but the relationship of these measures with knowledge-intensity of export products tends to be more indirect. The measures

support exporting in more general terms than just in relation to R&D activities (EAS 2012). The positive results characterize also policy measure that supports the recruitment of development specialists as well as the innovation voucher system. The entrepreneurial support measures for R&D institutions reveal potential as well. In case of these, it is still too unclear, how effective they are.

With the ongoing establishment of Estonian Science Agency, which will merge several implementation agencies subordinated to Ministry of Education and Research into one unit, the steps have been taken towards reducing the fragmentation of research funding. At present the research funding is very fragmented between numerous support initiatives (ERA Committee 2011), thus the concentration into one agency is a rather positive step.

Problematic aspects

The fact that considerable share of funding and development efforts is channelled into research (growth in the number of scientists and publications), which is not followed by R&D and innovations in companies (in terms of growth in productivity and high tech or medium high tech sales and export) is problematic. It implies that Estonian research and development activities do not develop in integrated manner. (ERA Committee 2011) Naturally, one could argue that the research has to gain higher quality before it induces the development initiatives and innovations. However, business sector studies imply that there is no widespread cooperation between universities and companies. There are some very positive examples, but the weakness of these cooperative ties creates danger that the fast development of research will not transform into innovative businesses.

No overview about all public measures (sometimes in combination with EU-level funding) that directly or indirectly support R&D and innovation activities is available. Some of these activities (for example environment related activities) are supported by indirect measures about which statistics are sometimes not even collected. This lack of overview is reinforced by the large number of fragmented support measures.

In the strategy document, the key areas of development are defined very broadly. In this second holistic strategy, the added target topics relate to social and environmental aspects. As a result, very large share of entire funding is allocated to six key areas- information and communication technology, biotechnology, material sciences, healthcare, energy technologies, and environment protection and environmental technologies. Close to 45 % of all grants provided by Estonian Science Foundation were in 2011 given to these priorities, which is 49 % of all allocated funds (Estonian Ministry of Education and Research 2012). This reflects considerable growth within last five years. However, it is questionable if all subfields in these priority areas have leading-edge development potential, while other research groups with better potential might be unfairly discarded. Therefore, it would be beneficial to map the priority areas in a more detailed manner and in close

connection with the actual revealed development potential. (See also ERA Committee 2011)

In several key areas, the national programs of strategy implementation were not approved by government until December 2011. Only in two priority areas, biotechnology and energy technologies, such programs had been accepted earlier. In material sciences, there is suggestion to start the cycle with pre-program. However, strategy implementation procedure does not foresee such option. Although three programs were approved only in December 2011, the Ministry of Education and research launched some support measures already earlier, which is also legislatively problematic.

The delayed formation of national programs has created situation, where some innovation support measures were started by Enterprise Estonia prior to research measures in the field, which means that developments occur in illogical order (see EAS 2012). This is extremely problematic approach in terms of efficient use of resources. Research and development is usually seen as a holistic process, which is seriously undermined by governance failure and illogical solutions that expect results before contributing to preconditions.

The programs management is separated from implementation units responsible for funding. This creates situation that program managers outline certain goals, which are not matched by funding possibilities. Such structural and governance problems show the lack of institutional capabilities. The aim of funding should not be so much about the use of all available funds, but the effectiveness of the usage as well. Foreign experts even suggest that without appropriate institutional arrangement it is better not to launch some support measures at all (ERA Committee 2011). Thus, the governance and cooperative abilities of the public sector are to be seen as critical success factors.

The Ministry of Education and Research and the Ministry of Economic Affairs and Communications as the main bodies in judge of strategy implementation are often hampered by the low interest and involvement shown by other ministries, who are responsible for the development of some of these key research areas. Thus, the R&D related cooperation between various ministries is insufficient. The established national programs describe activities too vaguely and do not relate them with particular goals and funding (See also Euroopa Liidu tõukefondide ... 2011). The lack of holistic statistics about R&D spending complicates the goal setting in connection with funding schemes.

From the viewpoint of connections between research and development, it is problematic that in the evaluation of grant applications to Estonian Science Fund, the applicability of results and impact to society, which are included into an application, do not play considerable role in expert evaluation (according to data from Estonian Ministry of Education and Research 2012) Thus, the funding of research does not stress the applicability aspect of research that is very important to generate innovations. Publications are targeted by researchers as the primary output

exactly because research funding depends primarily on a publication history, while sustainability of funding from the applied science projects is far more unstable and might be discontinued when this EU programs period ends.

The fragmentation of funding schemes is considerable problem as well. Part of this problem relates to the fragmented nature of EU-level funding schemes that is then reflected on the national level distribution of funds. Still, it would be possible to implement similar schemes through one implementation unit that could offer them in packaged format. The mobility programs for researchers and students have been successful, but even in this aspect the fragmentation causes excessive bureaucracy related to numerous reporting and administrative obligations for beneficiaries. The concentration of funds could perhaps increase the competitiveness of sums in terms of attracting well-qualified researchers from abroad.

The measures and indicators in the strategy document and in the implementation programs are often to general in nature and it is difficult to determine causal relationships between the support measures and the progress towards goals. No regular data is collected at all about progress towards some indicators. Sometimes measures and indicators are described without initial and target levels, which makes them useless in terms of performance evaluation. (See also Euroopa Liidu tõukefondide ... 2011)

The funding of research has grown fast. The growth of human resources engaged in research has been considerably slower. Even in priority areas, the growth in number of researchers and PhD holders has not been in accordance with expectations. However, latest number for 2010/2011 of 250 new PhD holders per year is much closer to target lever 300 per year (Aruanne strateegia ... 2011). Still, shortage of personnel may create situation where newly built research infrastructure will be underutilized and inefficient. From the viewpoint of development and innovation activities, the employment in high tech sector and medium high tech sector has not grown considerably since 2006 (Ibid). Thus, the priority funding has not established sufficient conditions for the growth in high tech jobs. The positive and negative aspects of R&D and innovation strategy implementation allow defining policy areas, which require further attention and refinement.

The demand-side policy measures and R&D and innovation strategy in Estonia

The suggestion to use more demand-side instruments has also been provided by foreign experts, who express concern that supply push methods of innovation policy might not render expected results. The supply-side measures are inadequate when the current industrial structure in Estonia does not support more intensive knowledge transfers between research sector and companies. Thus, some demand-side impulses are needed to increase economy's capability for more elaborate knowledge-based cooperation. (ERA Committee 2011) As long as Estonian economy remains reliant on traditional low- and medium-tech industries, there is not much domestic potential for the absorption of leading-edge scientific knowledge. It is not to say that low-tech industries do not innovate. It is to say that knowledge

profiles nurtured in research institutions and knowledge requirements of incumbent industries are likely to mismatch.

The results of the evaluative analysis along with innovation policy context in Estonia suggest following possibilities for policy development:

- Because the current priority or key areas of the strategy are too broad, screening and monitoring studies are needed to identify narrower areas of excellence, which have perhaps lead market potential.
- The policy measures to support user-centred innovations should be considered as well, because it would also serve as an important tool for building innovation awareness in society. At present, there are some competitions of innovative ideas, but these ideas are not always user-driven. Thus, even more focused measure could be added to the policy mix.
- There is potential for using pre-commercial public procurement type initiatives in order to improve balance between research activities and innovations, it would help to reduce certain development risks. Here, as well as in other areas, private-public partnerships could have considerable institutional value.
- The Estonian research policy governed by Ministry of Education and Research should give more credit to the applied research, the application of research results in business practice, and the research partnerships with companies. Some grants and programs of Enterprise Estonia already try to serve that purpose, but general research policy is still too publication oriented.
- The fragmentation of Estonian innovation policy measures seems to be related to fragmented funding as well as to the governance dualities in Estonian innovation system. Thus, at least increased coordination is needed to foster innovations in connection with research, or perhaps even switch of coordination from education side to economic affairs side. In a long-term perspective, the strategy could be implemented by well-organized lead agency. Yes, there is a potential danger of increased bureaucracy, but (considering the smallness of Estonia) this could provide the intra-organizational transparency needed to develop R&D and innovations more holistically. It is a shift towards demand-side considerations throughout the entire system.
- Public sector should encourage the industry representatives to develop innovation-oriented standards for their industries by reinforcing the information provision about major global trends.
- There are possibilities of finding also a consensus in society about the consumer and producer regulations that would encourage switch to newer technological platforms. Some of such regulations could even be temporary to serve only catalytic effect of attracting critical demand.
- New wave of demand-side innovation policy could use three capabilities – research capability, cooperation and network building capability, and commercialization capability – as success factors in evaluation process of various projects. The second capability refers directly to the diffusion potential of research results into the business practice and thereafter to the diffusion of innovative ideas on the market. Both draw heavily on network building.

- The R&D and innovation strategy as well as the implementation programs and plans should explicitly include the demand-side goals and causally measurable indicators that would connect funding and training initiatives with long-term economic effect. This would reduce the impact of 'funds need to be used' thinking over 'efficiency needs to be achieved' thinking.

Some of these suggestions, especially the last one, may run counter to the unfortunately frequent logic about EU-supported funding, but they are vital to avoid insurmountable gap between funding opportunities and truly innovative and marketable business ideas. There is already onset of public discussion about the impact of various grants to companies. Without demand-side policy initiatives, such grants may indeed crowd out private investments instead of complementing private initiatives.

Conclusions and implications

The demand-side innovation policies are relatively new policy concepts that aim at advances in society. Some elements of them, like for example public procurement, are not new as such. The issue of procurement has been discussed in a literature for several decades. The modern views of demand-side policies add value by taking more holistic perspective on the role of demand for innovations, which is still relatively ignored in policy practice. However, there are positive tendencies towards greater awareness about demand-side measures across Europe.

According to evaluative reports, the innovation strategy and policy in Estonia has after 2004 to some extent lost its momentum, because the second or follow-up strategy for 2007-2013 does not provide many novel policy ideas and represents predominantly continuation of earlier initiatives. The innovation policy implementation in Estonia takes place via two main branches – the Estonian Ministry of Economic Affairs and Communications with its foundations like Enterprise Estonia and the Estonian Ministry of Education and Research with its own implementation agencies. This duality and other governance problems (as well as perhaps current industry structure in Estonia) have created situation where increased EU funding in combination with national funding has been successfully channelled into research. Thus, the strategy aims concerning the research infrastructure and development will be achieved and overachieved, but aims related to innovations and developments in companies are most likely not achieved on time.

The demand-side innovation policies offer several opportunities to seek balanced strategic approach that sets more focus to the connections between research and market demand. These include refined selection of key development areas, more support to user-centred innovations, pre-commercial procurement and public-private partnerships, more credit to applied research, better coordination and/or concentration of governance, various standards and regulations, valuing research-network-commercialization capabilities, or demand-side goals and indicators in strategies and programs.

The important limitation of this study relates to the lack of evidence about the particular demand-side innovation policies in Estonia. The evaluative reports and program descriptions offer in some respect too general view on demand-side aspects. Sectoral screening and monitoring studies could provide refined evidence about the local, regional and global demand for innovations in prioritized fields.

The theoretical implications of this discussion are related to a need for increased scientific discourse and studies about pros and cons of demand-side innovation policy measures. Despite the fact, that these policies have been holistically discussed for more than five years, there is still scarcity of literature beyond status reports and evaluations.

The managerial implications of this study relate to the fact that an involvement of industry leaders and managers in the discussions about the suitable demand-side innovation policy measures seems paramount in order to achieve substantial innovation cooperation instead of formal contacts. Management interest in more advanced innovations is one of the keys in building the commercial demand for research results.

The future research should focus on the comprehensive analysis of challenges and risks of using the demand-side innovation policy measures. There are also doubts about the efficiency of demand-side innovation policies in a small market setting that need to be addressed. The introduction of demand-side measures requires new governance structures and institutional capabilities. They need analysis as well.

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