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Emergence of a societal challenges based innovation policy in market-based innovation systems: Lessons from Estonia

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Abstract

The societal challenges based approach to STI policy is currently one of the key ways the EU seeks to break away from the linear and science-push driven policy thinking. This seems to raise complex challenges of policy legitimization, rationalization and institutionalization especially in countries that have tried to build market-based innovation systems. Based on the case study of Estonia, we show that in addition to developing new policy mixes and coordination instruments, such policy shift may also require re-thinking of core STI policy rationales and legitimization practices; and these may have to be further supported by experimental policy approaches and institutional innovations for changing the habits and routines of key STI system actors.

Keywords: STI policy; societal challenges; policy rationale; policy legitimization; institutional design; Estonia.

Introduction

In the light of the growing importance of the *societal challenges* based science, technology and innovation (STI) policy thinking in the EU (EC, 2012; Kallerud et al., 2013; Kuhlmann and Rip, 2014; Weber and Rohracher, 2012), many EU countries may have to re-think and even reverse their convergence on the Lisbon Agenda and “European Paradox” inspired STI policy approaches (Dosi et al., 2006). The predominant European STI policy models have been grounded in the *linear* and *science-push based* understanding of innovation and *market failures* based policy rationales have guided government interventions (see Bozeman, 2000; Edquist, 2014; Martin, 2013). In this framework, the preference is often also given to *horizontal policy interventions* that seek to influence the general framework conditions of the STI systems without much customization of policies for technological, sectoral, industry-based, or regional specificities (e.g. Teubal 1997). Of course, the actual innovation systems and policies still differ across Europe, especially between more market-based systems vs corporatist/coordinated and statist systems (see Amable, 2000; Bohle and Greskovits, 2012; Hall and Sockice, 2001; Edquist and Hommen, 2008), but there have been distinct EU policies driven pressures for convergence on common policy rhetoric (e.g. Izczak et al., 2014; Soete, 2007).

The societal challenges based approach to STI policies may raise most fundamental policy level and institutional conflicts in the more market-based innovation systems where the focus is on competition-driven

research and innovation activities and where the state has limited roles in carrying out, steering and coordinating these processes (see especially Amable 2000 who differentiates different types of *social systems of innovation and production*). Further, the shift towards societal challenges based STI policies seems to raise peculiar challenges for Central and Eastern European (CEE) economies (i.e. especially countries that have joined the EU since 2004) as they need to legitimize, rationalize and institutionalize a seemingly new policy approach that at the same time has some rhetorical and conceptual similarities with their socialist policy legacies, which they have tried to substitute with more market-based, or in some cases corporatist innovation systems and policies (see Bohle and Greskovits, 2012; Havas et al., 2015; Karo and Kattel, 2010; Suurna and Kattel, 2010).

In this context, Estonia stands out as an extreme case among the CEE economies. While the assessments of the innovation capabilities of Estonia may differ, it has always been among the leading CEE economies in the EU's Innovation Union Scoreboard (though, still as "innovation follower"). In early 1990s, Estonia became one of the most radical reformers of its economic policies among the ex-socialist countries. It was even considered as the most ideal-type liberal market economy in CEE where a conscious choice was also made not to pursue explicit industrial and innovation policies as part of the transformation from a socialist to an explicit market-based model. Yet, during the EU accession phase from the late 1990s to mid-2000s, Estonia established rather quickly a linear STI policy approach emphasizing the Lisbon Agenda rhetoric and goals. While STI policy rhetoric has emphasized broadly defined high-tech areas (e.g. ICT, biotechnology and material sciences), it has been mostly implemented via horizontal policy interventions affecting the STI system as a whole and not targeting specific sectoral, or technological needs. (Karo, 2010; 2011) At the same time, national STI strategies have also tried to propose already since the early 2000s some socio-economic challenges related policy instruments (National Programs for Research and Development – R&D). Yet, as we show, the implementation of these instruments has been rather difficult and delayed because such interventions have not fitted with the general linear policy focus, institutional set-up of the STI system, and the predominant policy rationalization and legitimization pathways. The emergence of the societal challenges approach in the EU policies seems to provide a new impetus for such policy initiatives.

In this paper we are interested in understanding what kind of *policy legitimization*, *rationalization* and *institutionalization* challenges may arise in such policy contexts once policies and STI policy mix as a whole need to be consciously shifted towards societal challenges based approach.

We assume that such policy shift is neither a simple question of adding additional layers of policy instruments nor a complete reversal of existing policy paths. Rather, the emergence of the societal challenges approach is part of the cumulative evolution and broadening of the STI policy arena, i.e. adding concerns related to public sector and societal innovations to the traditional focus of technological and market innovations (see more in EC, 2012; Fagerberg et al., 2013). While ideally such policy shifts – adding new policy rationales and critically reconsidering existing approaches – should lead to complementary policy rationales and processes and broader socio-economic impact of STI policies, given the path dependent nature of legitimizing, rationalizing and institutionalizing public policies (on path dependencies and positive feedback in the context of public policies see Pierson, 2004; in the context of public management, see Pollitt, 2008), we might witness potential conflicts emerging in this process.

Empirically, we analyse the Estonian case and concentrate on how have the policy makers sought to rationalize, legitimize and institutionalize societal challenge oriented STI policies and what have been the key challenges and conflicts emerging in this process. We use Estonia as an extreme case in the sense that we expect the exploratory case study (see more in section 2) to reveal most explicitly the key challenges of shifting STI policy towards societal challenges in the market-based STI systems. While we focus here on the societal challenges based approach, also other EU-led STI policy initiatives – especially *demand side innovation policy* and smart *specialisation* – may contribute to the broader policy shift (see Lember et al., 2014 and Karo and Kattel, 2015a on integrating these focuses into the Estonian STI policy mix). While tracing back the generic STI policy evolutions into the 1990s, we make use of various specific policy initiatives (most notably, National Programs for R&D – NP) to illustrate the details behind the emergence and institutionalization of more societal challenges oriented policies. In the final section of the paper, we summarize the experiences of the Estonian case into broader lessons. We argue that shifting STI policies towards societal challenges may require, especially in the more market-based systems and countries following the linear STI policy approach, in addition to new *policy* and *coordination instruments*, also re-thinking of *policy rationales* and *legitimization practices*; and these may have to be further supported by *experimental policy approaches* and *institutional innovations* for adjusting the institutional routines of key STI system actors.

1. Rationalization, legitimization and institutionalization of STI policies for tackling societal challenges

1.1 *The (non-) relevance of predominant STI policy rationales?*

While most innovation scholars seem to agree that modern STI policy rhetoric and practices in most Western economies have been driven by market failures based policy rationales and linear understanding of innovation, evolutionary economists have sought to complement this thinking with a more evolutionary system failures approach (see e.g. Malerba, 2009; Metcalfe, 1995; Nelson, 2009; Bleda and del Rio, 2013). The proposed alternative – the *systems of innovation approach* – has gained strong rhetorical legitimacy among policy makers in many countries (Albert and Laberge, 2007; Sharif, 2006). But as Bozeman (2000), Edquist (2014) and Martin (2013) claim, it has not meant a substantive shift away from a linear and market failures based STI policy thinking. STI seems to be an inherently complex or “wicked” policy field where simple economic rationales may not suffice for policy rationalization and legitimization. A recent large scale meta study of STI policy evaluations (MIOIR 2013) highlighted that first, there is no clear-cut evidence on how effective is innovation policy in general and especially how effective are different types of public interventions in isolation; and second, that different policy interventions in a same context may depart from contradictory policy rationales (see also Bleda and del Rio, 2013). In other words, the rationales of different STI policy interventions may be conflicting or interventions may even depart from non-economic considerations (might include social, cultural, geopolitical arguments) and find broader legitimacy (among politicians, general public and non-experts in STI policy) from different sources, including international policy fads and copying (for general argument, see Gulbrandsen and Etzkowitz, 1999; for recent case studies, see Dalitz and Toner, 2015; Vitola, 2014).

From a more historical-empirical perspective, Mowery (2009) has argued that the current academic debates and research may simply overestimate the practical and analytical relevance of failures frameworks (whether of pure neoclassical or more evolutionary blend). Most developed economies have had rather extensive history with some sort of *mission-oriented* STI policies (see also Ergas, 1987; Mowery et al., 2004) and in many developed OECD economies, mission-oriented R&D investment may have accounted for more than 60% of public R&D investments (however, mission-driven R&D programs are not well researched and one has to remain cautious to what extent the seemingly mission-oriented R&D programs actually follow the pre-determined goals or challenges). In this context, also Mazzucato (2013) criticises the failures approach by arguing that while it gives the government the role to mostly fix problems

that arise in markets (and STI systems), empirically we can see that fundamental radical innovations and transformative changes in the economy often require a more proactive and risk-taking *entrepreneurial state* (see also Block and Keller, 2011). Into this line of thinking we can also add the broader focus on *policy narratives* – such as the national defence narrative in the US (Weiss, 2014; Block and Keller, 2011) that is also emerging in the EU (Edler and James, 2015) – as potential tools for “freeing” (through other sources of legitimacy) STI policy from the often limited, complex and debatable perspectives of economic or failure-based rationales.

In sum, the market and system failure logics tend to downplay the non-economic *missions* and *interests* of governments in STI policies (e.g. technological goals, social returns, geopolitical concerns) and pay limited attention to the evolution of supportive institutional set-ups. The societal challenges approach seems to take an even broader public/social value based view of the role of the state in STI and we might have to move from economic rationales to “softer” legitimization of STI policies (see also Gulbrandsen and Etzkowitz, 1999). Governments can legitimize STI policy actions not only based on *economic rationales* (market and system failures) and patterns of *technological development* (entrepreneurial state argument), but also based on *societal needs* grounded in political values and interests where R&D and innovation is not only a goal *per se*, but a *means* for achieving the goals of other policy domains (see also Fagerberg et al., 2013; Hendriks, 2009; Weber and Rohracher, 2012). As there exist considerable differences between societal challenges (and technological trajectories) and how these are revealed in specific contexts, the rationalization and legitimization can hardly ever follow a common blueprint.

1.2 Emerging policy rationales and legitimization pathways of the societal challenges approach

The historical mission-oriented STI policy approach is treated as the closest practice to the current societal challenges based STI policy thinking. Mowery et al. (2010) argue that the original mission-oriented programs focused on *missions of technological development* (i.e. the government-led technology programs of the Cold War period, such as Apollo and Manhattan programs and later developments in the medical sector, i.e. the “war on cancer”). The direct goals and rationales of these missions were in general related to the *specific technological needs*, or demand, of the funding mission agencies implementing broader public policies. It was also recognized (as a secondary argument) that these policies may have potential for high social returns (Sampat, 2009) and that the broad-

er economic effects of mission-oriented STI programs may result from the general knowledge production (as part of the programs); and the latter may also support private innovation (similar to market failure argument) and/or technology spin-offs that have applications both in the civilian as well as in mission agencies (if necessary, supported by complementary policy measures such as public procurement) (Mowery, 2009). Still, even if one could try to construct explicit economic rationales – though, this would always remain debated between neoclassical and evolutionary perspectives – the US mission-oriented policies have been always legitimized also through broader *policy rhetoric* and *narratives* (i.e. defence capabilities and technological superiority) (see also Foray et al., 2012; Weiss, 2014).

And this applies to other countries as well. The Latin-American import-substitution industrialization policies were partly based on non-economic and national security driven goals of reducing the dependency on Western hegemony (see Adler, 1987). Similarly, the East-Asian *export-driven growth* has been partly based on “developmentalism” and later “technonationalism” as narratives of national autonomy (self-determination) and independence; and this has allowed policy makers to focus public resources into industrial and STI policy while neglecting social policy and compensation issues (see original argument in Haggard, 1990). Europe has had much more mixed policy pathways. Soete (2007) and Gulbrandson and Etkowitz (1999) argue that during the 1970-1990s Europe shifted from strong industrial and also “missionary” policies towards more horizontal and less interventions innovation policies supporting mostly the high-tech industry and smaller firms. While the CEE economies have had their own particular history of similar mission-oriented STI policies from the socialist period and especially in the economies closely integrated into the Soviet military-industrial complex (see Freeman, 2006), since the 1990s they have sought to distance themselves as well – either given the geopolitical concerns or generic ideological sentiment – from such STI policy models (Karo and Kattel, 2010).

At the same time, the “missionary” policies and programs have also evolved from focusing on technological needs of public policy actors towards diffusion and adoption of technological solutions and innovations across the STI systems and actors to solve socio-economic challenges in sustainable development, health etc. Table 1 summarises the main differences of “old” and “new” challenge oriented projects.

Table 1. Characteristics of different challenge, or mission oriented projects

Old: e.g. Defence, Nuclear and Aerospace	New: e.g. Environmental Technologies
The mission is defined in terms of the number of technical achievements with little regard to their economic feasibility.	The mission is defined in terms of economically feasible technical solutions to particular (environmental) problems.
The goals and the direction of technological development are defined in advance by a small group of experts.	The direction of technical change is influenced by a wide range of actors including government, private firms and consumer groups.
Centralized control within a government administration.	Decentralized control with a large number of involved agents.
Diffusion of the results outside of the core of participants is of minor importance or actively discouraged.	Diffusion of the results is a central goal and is actively encouraged.
Limited to a small group of firms that can participate owing to the emphasis on a small number of radical technologies.	An emphasis on the incrementalist development of both radical and incremental innovations in order to permit a large number of firms to participate.
Self-contained projects with little need for complementary policies and scant attention paid to coherence.	Complementary policies vital for success and close attention paid to coherence with other goals.

Source: Soete and Arundel (1993, p. 51); Arundel et al. (2011, p. 107).

Already in the EU's STI policy discourse of the early 1990s it was proposed that new societal challenges – such as environmental challenges – need to combine more systematically supply and demand perspectives and different policies *“in order to have pervasive effects on the entire structure of production and consumption within an economy”* (Soete and Arundel, 1993, p. 50). With the revisions of the Lisbon Agenda in mid-2000 one could further witness the strengthening of more focused and demand-oriented STI thinking (Rodrigues, 2009) leading to the societal challenges as the basis of the Europe 2020 strategy and especially the Horizon 2020 program (EC, 2012; Lund Declaration, 2009). Accordingly, tackling societal challenges through STI should be based on explicit focus on current and mid-term societal challenges where social and technological innovations can act *as means* to solve these challenges via *diffusion and adoption/adaptation* of these social and technological innovations by all relevant actors in society (from government to firms and individuals). In other words, policy focus should shift from affecting mostly the scale and speed of innovations towards steering the direction of STI activities and its' diffusion (Kallerud et al., 2013). While this policy focus could be rationalized in some form by standard economic rationales (current competitiveness of industries and economies) and technological development potentials (establishment of new technological markets), the legitimacy of this approach is importantly also grounded in societal and political considerations as the challenges are discussed and defined not within the STI policy discourse, but on a much broader context of politics and public policies. For example, one of the basic “rationale” documents of the Hori-

zon 2020 program (see EC, 2012) refers to different economic theories and rationales for STI policies, but by linking STI policy to Europe 2020 strategy, it also emphasizes the more abstract needs for “European transformation” (EC, 2012, p. 15):

In this the second decade of the 21st century, with a backdrop of a changing world order, Europe faces a series of crucial challenges: low growth, insufficient innovation, and a diverse set of environmental and social challenges. Europe 2020, the EU’s comprehensive long-term strategy, recognizes these challenges and argues that Europe faces a moment of transformation ... The solutions to all of these problems are linked: it is precisely by addressing its environmental and social challenges that Europe will be able to boost productivity, generate long-term growth and secure its place in the new world order.

1.3 Institutionalization of the societal challenges approach in STI policies

By now it is recognized that for introducing societal challenges oriented STI policies, not only predominant market failures based STI policy rationales need to be broadened and also legitimized, but there is a need to redesign STI institutions that both fund and conduct R&D and innovation related activities (see also Kuhlmann and Rip, 2014). Further, it is also recognized that the STI policy focus has to shift from regional and national economic concerns (mostly competitiveness) towards international cooperation and *co-creation* of (inter-related) technological and institutional solutions to societal challenges affecting specific regions and economies (see also EC, 2012; Kallerud et al., 2013).

One can expect that in more market-based innovation systems (and compared to more statist or coordinated/corporatist systems) not only the legitimization, but also implementation of the societal challenges based STI policies may be more difficult and require explicit discursive and institutional actions. Looking at the US STI policies, these barriers may be overcome by different approaches, from using the national defence or other policy narratives (similar to “war on cancer”, or “energy revolution” in the US) (see also Mazzucato, 2013; Weiss, 2014) to institutionally “hiding” the state-coordinated challenge orientation from the non-supportive political debates (see Block and Keller 2011). At the same time, in more statist, or corporatist systems, one can expect that the governments have much higher autonomy and legitimacy to deploy more conventional policy-making instruments (e.g. official strategies, direct public investments, public STI organizations) for such policy goals.

In other words, there is a high-likelihood, especially in more market-based systems and countries following the linear STI approach, that conflicts emerge between existing policy and institutional legacies and new expectations: path-dependent policy trajectories are likely to persist and policy makers may seek to link new policy initiatives to existing policy paths and governance systems without much changes in the latter. For example, if investments into biotech programs were an important part of Obama's fiscal stimulus pact in the US (Stephan, 2012), in austerity driven Europe this potential of combining STI and other economic policies was largely neglected, at least during the early phases of the recent crisis. Also, reorienting public procurement towards supporting research and innovation has been beyond rhetoric a rather slow process internationally (Lember et al., 2014). Overall, while in the US societal challenges tend to be linked with technological development and its broader potential, in Europe the most likely path-dependent step seems to be to link these issues to traditional linear R&D policies and activities (Leijten et al., 2012).

One can also argue that the "old" mission-oriented projects required next to broad external legitimacy also high degree of *bureaucratic* or *institutional autonomy* (of mission-oriented agencies) to initiate, finance, and organize such projects (Ergas, 1987 offers a concise comparison between the US, UK and France on these issues; Mowery et al., 2004 bring out the uniqueness of the US system compared to the rest of the OECD; for sectoral analyses see Mowery, 2012; Sampat, 2009; 2012). Still, these agencies could also be dependent on other public and private actors for the diffusion of these technologies and achieving their broader public policy goals and social impact (e.g. via technology diffusion, public procurement etc.). The current challenge oriented thinking in STI policy seems to be much more open and dependent on *co-productive* processes and international co-determination of societal challenges, how activities to tackle these challenges can be coordinated and financed (especially in Eurozone countries with limited monetary and fiscal policy space), and how the solutions will be diffused for achieving societal impacts. Consequently, as opposed to creation of new technological solutions for public policy goals (and creating new markets as a corollary impact), the current challenge orientation seems to be much closer to *re-invention* of existing markets and socio-economic structures of production and consumption via *diffusion* of newer/better technologies and institutions into already established markets, or into *complex established legacy sectors* (see also Bonvillian and Van Atta, 2011).

Thus, the limited lessons drawn by Mowery et al. (2010) and Foray et al. (2012) from the historical mission-oriented programs for the current societal challenges oriented policies emphasize the need to balance between

centralized planning of priorities, challenges and goals, and *decentralized management and implementation* of specific programs to balance between coordination of goals/challenges and managing the uncertainty of technological development and diffusion trajectories. The key question of institutional design is related to whether the existing STI policy institutions and organizational routines allow (both in terms of policy space and capacities) for active and coordinating role for the state, and how to “design” such routines if the system lacks them (see also Karo and Kattel, 2014; 2015b). The principal choices are between establishing *new challenge-oriented programs* (single measures) vs *creating new organizations* (or, reforming existing ones). The benefit of new programs is their relative ease of design and implementation by existing actors, but their weakness is often related to the fact that they are implemented by organizations with specific legacies and routines, and the latter may dominate over the original goals of new the measures. Thus, policy innovation “labs” or innovative agencies – equipped with different routines compared to other organizations and tasked with experimenting, establishing, and legitimizing new policy instruments – are discussed as popular model to foster dynamism and eventual policy shifts (Breznitz and Ornston, 2013; OECD, 2014; Tönurist et al., 2015).

1.4 Summary

From the preceding discussion, we emphasize two main conjectures. First, STI policies related to current societal challenges need to extend over broad set of policy domains and actors and inevitably need different bases for their rationale and legitimacy. In other words, traditional economic rationales may be less important than presumed in prevalent STI literature. Societal challenges driven STI policy most likely can not be sustainably rationalized and legitimized as explicit and *self-standing policy* (STI as goal), but STI policy may have to be seen as a *policy instrument* or *complementary addition* to the environmental, health, social, agricultural and other policies and policy mixes (STI as means) based on whatever rationales (often societal/public value based) and legitimization pathways these domains follow in specific capitalist systems. Importantly, this change in policy rationales should go beyond policy rhetoric and catalyse change also in policy implementation. Without this shift the STI policy implementation routines in various sectors and policy domains cannot be expected to substantively change. Second, especially in more market-based innovation systems and in countries to date dominated by linear STI thinking and related STI funding models and institutional setups, there seem to be strong legacy effects affecting how new policy concepts and rationales fit with existing policy and administrative routines. In the case of mismatches, new policy focuses may have to be rationalized, legitimized and institutionalized through complex processes

of local policy experimentation and institutional and organizational innovations. In other words, one can expect the complex inter-linkages between policy ideas, financing structures, political and policy institutions, and organization of societal actors to produce a specific set of policy challenges in introducing challenge-based STI policy in the context of market-based innovation systems.

2. Emergence of challenges oriented STI policies in Estonia

Estonian STI policy cycles overlap almost ideally with and are heavily influenced by the EU financial and strategic frameworks: the previous STI strategies “Knowledge-based Estonia” (KBE) were devised for 2002-2006 (KBE-1) and 2007-2013 (KBE-2) and the current strategy has been adopted for 2014-2020 (KBE-3). While the Estonian STI policy – jointly designed by the Ministry of Education and Research (MER) and the Ministry of Economic Affairs and Communications (MEAC; though, formally KBE strategies are adopted by the Parliament and coordinated by MER) – has in its rhetoric followed since the late 1990s a clear high-tech focus (emphasizing ICT, biotechnology and material sciences as the key priority fields for the future economy), the actual policy instruments and their implementation has been less targeted. In other words, the implementation of this policy has had a very clear logic of horizontal state interventions: innovation agency *Enterprise Estonia* has provided universal grants and subsidies (i.e. almost no sector is excluded from applying; grants are predominantly given based on open competitive calls) to companies and joint projects between universities and industries; finance agency *Kredex* has provided financial guarantees to companies; science agencies – Estonian Science Foundation and Science Competence Council (merged into *Estonian Research Council* in 2012) – have provided competitive and excellence-based funds for research projects predominantly in universities (and a few research institutes and firms); finally, since 2007, the *Estonian Development Fund* – a foresight and risk finance agency reporting to Parliament – has provided foresight capacities and initiated the venture funding system. There are also no significant regulatory policies that target different sectors or actors (i.e. there are no tax breaks for R&D). The role of other ministries and agencies in STI policy has been rather modest and *ad hoc*. It has been estimated that ministries other than MER and MEAC currently fund about 4-7% of public R&D in Estonia (see MER, 2013). Overall, while the rhetorical focus has led to more public investments in the high-tech fields, in policy documents and strategies no conscious understanding of and focus on specific needs of different sectors, societal challenges, or fields of technology has emerged.

As we show below, each of the KBE strategies has still tried to introduce some elements of societal challenge oriented STI initiatives (e.g. National R&D Programs – NP) next to horizontal policy instruments, but these have faced significant delays. According to the National Audit Office of Estonia (2012), it has been never fully clear what is the exact policy rationale behind these government initiatives, especially regarding NPs. Further, the main national strategic documents – starting with the current National Reform Program “Estonia 2020” that translates the Europe 2020 to Estonian context and defines Estonian societal challenges – have not linked societal challenges with STI policies and provided additional legitimization pathways (e.g. new narratives or treating STI as a means for other public policies). The Estonia 2020 strategy focuses on generic goals of increasing competitiveness, productivity and employment and while the STI is seen as a tool for these goals, the strategy only reiterates the Lisbon Agenda goal of raising the R&D investments to 3% of GDP and leaves the actual policy choices and implementation questions to the KBE and its implementation plans. Thus, how KBE strategies (and policy makers accountable for the strategies) rationalize, legitimize and institutionalize new initiatives is a crucial determinant of their success.

The following analysis is based on long-term research (since 2012 until mid-2015) carried out in the framework of the “Research and Innovation Policy Monitoring Programme” (initiated and financed by MER) that has allowed us to participate as observers in the design and adoption processes (internal policy design meetings and public strategy validation seminars throughout the 2012-2015 period) of *KBE-3* and the first challenges based STI strategy “Science and innovation into the service of health” of the Estonian Ministry of Social Affairs (MSA, 2015). During this period, we participated in most internal and public meetings related to drafting and discussing *KBE-3* and the STI strategy of MSA. Our goal was to follow and analyse the discussions in these meetings to craft the preliminary conjectures about the policy rationales, legitimization patterns and institutional choices of the *KBE-3*, especially related to the societal challenges. In addition, to test the validity of our preliminary conjectures, we interviewed experts (top STI officials) from 10 key organizations involved in STI policy design to validate and refine our key observations: two key STI ministries (MER and MEAC), four key mission-/challenge-oriented ministries (MSA, Estonian Ministry of the Environment, Estonian Ministry of Agriculture, Estonian Ministry of Defence) and four largest Estonian public universities. Stemming from the conceptual framework of the paper, we used semi-structured interview plans and focuses on how these actors understood recent STI policy developments (basic rationales and roles), the emergence of the societal challenges approach, its legitimization logics and implementation challenges. We also focused on the

evolutionary processes in the system: if and why actors changed their perception and also behaviour in the context of formal policy changes. The interviews were also used to corroborate the findings and conclusions we drew from participatory observations and document analysis (KBE strategies and policy drafts).

2.1 Institutional and policy innovations for challenges oriented STI policy

In *KBE-1*, there was almost no emphasis on challenges driven policy thinking. The main goals of the strategy were to: a) renew the knowledge base (scientific excellence), and b) to increase the competitiveness of companies (based on non-pre-selective and open-calls-based R&D grants and commercialization measures). Further, the strategy had to balance between two different logics: market failure based thinking that denied any space for industrial policy and “picking winners” vs understanding that in small countries governments need to specialize into something as it can not fund and sustain everything. The strategy proposed two logics of specialization: a) preserving national culture and language (this has remained a special “constitutionally” defined topic in all KBE strategies and discussed outside the main STI discourse; thus, we will not deal with this theme in this paper); and b) focus on key future technologies (user-friendly ICT and development of information society; biomedicine; material sciences). The latter specialization was to be further developed and steered through National R&D Programs (NPs) focusing on commercialization and entrepreneurial growth (in the case of biomedicine also public health applications were mentioned). Yet, the NPs were not formalized and adopted during KBE-1.

In *KBE-2*, the two goals of KBE-1 were complemented by a third: to support the emergence of long-term development-oriented and innovation friendly society. The strategy explicitly recognised that the government can design and implement STI policies through different logics: *research-driven research* (scientific excellence), *technology-driven research* (applied research and commercialization) and *problem-driven research* focusing on socio-economic challenges (also through smarter demand/procurement by the state). For the latter focus, health, environmental protection, energy, agriculture, and defence and security were mentioned as explicit examples. Further, the problem-driven research was to be supported through new type of NPs: next to NPs in key future technologies (ICT, biotechnology, material sciences), also NPs for socio-economic challenges were foreseen. Still, new NPs had to combine several policy goals: R&D related government demand; attraction of foreign researchers and talent to collaborate with Estonian partners (and work on Estonian socio-economic challenges); supporting the development and export of high-value-added products and services; supporting the adoption and diffusion of devel-

oped and imported technologies for improving the quality of life in Estonia. Given this variety of goals, the programs were planned as *coordinative mechanisms*: they had limited autonomous budgets and had to combine different horizontal policy measures (focus areas of NPs were positively discriminated in these measures); further, the exact focuses had to be specified through broad-based coordination between MER (coordinator of most NPs), MEAC and other “line” ministries, businesses and academia. Although KBE-2 was adopted in 2007, the concept of NPs was formalized in the *Organization of Research and Development Act* only in 2012. The NPs themselves were adopted between 2010-2011 both in key technologies (ICT and biotechnology; the program in material sciences was not fully developed) and in the domains of some socio-economic challenges (energy technologies, environmental protection and technologies, and health technologies), but still as R&D and technology programs.

In *KBE-3*, the goals of supporting scientific excellence and commercialization have been complemented by even more explicit emphasis on the applicability diffusion of R&D outputs. First, through the *smart specialisation* strategy process three specializations – some strongly related to public sector demand – were defined (horizontal application of ICT, healthcare technologies and services, more effective use of resources) and these are supported through coordination of different measures (e.g. scholarships to students, competence centres, applied R&D funding and innovative public procurement). Second, it is explicitly stated in KBE-3 that the organization of R&D activities for socio-economic goals has to be improved. For the latter goals, two new policy innovations have been initiated. First, MER finances from its own budget *R&D coordinator positions* in other ministries who should initiate and coordinate STI policy and strategy processes in these ministries (and provide more focused and challenges based policy insights). MER piloted this approach already during the end of KBE-2 in the Ministry of Environment and MSA (see also Karo et al., 2015). Second, MER co-finances (50-50 principle) *challenge-oriented R&D programs* (as a substitute to NPs) of line ministries (who are accountable for the content) to provide financial incentives for these ministries to initiate STI policies/programs.

2.2 Policy rationales and legitimization of the challenges oriented STI policy

Throughout the three KBE strategies, we can witness a gradual emergence of societal challenges based STI thinking and policy actions. While in early strategies mostly new coordinative programs were designed, in KBE-3, MER has sought to influence more directly the internal routines of other STI actors, especially line ministries. In policy debates and negotia-

tions MER refers to the *Organization of Research and Development Act* that explicitly states that the line ministries are responsible for the organization of R&D activities in their policy domains. Thus, there is a strong reference to bureaucratic accountability and vaguer STI rationales behind these developments; especially as most STI policy debate centres on market failures and linear approach to STI.

It was recognized in the context of KBE-2 that the NPs did not materialize in KBE-1 for two main reasons. First, the expected additional national funding for STI and NPs was not provided. Thus, it was expected that the EU cohesion policy funding available for KBE-2 will speed-up the adoption and implementation of NPs. Second, KBE-2 argued (and this was corroborated by our interviews) that during KBE-1 other partners from line ministers to business and academia lacked capacities for participation in such coordinative actions (i.e. there was no tradition of STI related policy planning in the ministries, business and academia were not used to participating in such meetings and providing input of specific demand and needs). It was also recognized that other ministries did not show sufficient initiative to take the responsibility of such NPs as this would have implied long-term policy responsibility for which there was no compatible funding available (i.e. NPs are multi-year activities, but the budgets of ministries are annual).

Yet, no significant institutional reforms were made to rectify these weaknesses. Thus, also in KBE-2 the initiation of NP was delayed by several years as the drafting and set-up of the programs was rather difficult. The eventual content of activities in all NPs was determined through public consultations between different interest groups. At the same time, the contradictory pressures of austerity in national budgets while speeding up the absorption of EU cohesion policy funding arguably pressured policy makers to roll out these measures without proper rationalization, coordination and planning (State Audit Office, 2012). As the implementation of these NPs is still on-going (in 2015), no formal impact assessment can be made yet. Interviews with experts indicated that the NPs ended-up unconsciously reflecting the differences of capabilities and specializations in different sectors (see also ERAC, 2012; National Audit Office of Estonia, 2012). For example, the NP on ICT ended-up focusing on scaling-up ICT education and R&D issues remained secondary as this was the main concern of industry. The design of the energy technology program suffered from high politicization and fragmented interests (competition between renewable energy and shale oil interest groups, between economic and environmental interests of the state) and this led to vague and broad focuses in the NP. In the case of NP for environmental technologies, the Ministry of Environment did not provide input due to internal

coordination failures; yet, this did not stop other ministries and agencies from proceeding with the program design and implementation. From the societal challenges oriented NPs, the most positive assessments have been given to the NP on healthcare technologies as in addition to academic interests, also MSA emerged as an interested partner.

Despite the gradual emergence of the societal challenges focus, the strategies and policy rationales of line ministries have not been consciously discussed within the broader STI policy and KBEs. Yet, many of these ministries (especially Ministry of Defence, Ministry of Agriculture, MSA, Ministry of Environment) have had their own R&D programs and/or strategies. It has been presumed that these ministries should be aware of their own needs and demands and would finance STI accordingly. Yet to date, official statistics show that the funding by other ministries has been minimal, i.e. less than 1% during KBE-1 period and before, between 4-7% since KBE-3. At the same time, interviews in these ministries have shown that to date the exact policy rationales and activities in these ministries are highly *ad hoc*: some ministries perceive STI in their domains as mostly procurement of policy analyses (i.e. in social, economic and environmental issues) and are not fully sure how much STI they actually fund (and what should be counted as STI funding). Even if in some ministries (e.g. Ministry of Agriculture) the societal challenges have been gradually become not only formal but more and more substantial basis for STI decision-making, it is still evaluation and measurement exercises rather than technology development that form the core of R&D spending. Further, most have financed STI through open calls similarly to MER and MEAC. Also, interviews with university administrators corroborated this assessment and further indicated that the precise policy rationales and logics of these ministries (why certain things are financed) remain often vague for other actors as well.

In sum, both the KBE-2 and KBE-3 challenge-oriented STI initiatives have emerged from the conflict between the generic market failures based STI policy thinking that has legitimized one-size-fits-all-type policy mixes (to be designed, financed and implemented by the MER and MEAC) and the legal framework requiring other ministries to be also accountable for parts of STI policy. Thus, there is no explicit “economics” or even “narrative” based policy rationale behind these new initiatives that try to differ significantly from the established STI policy trajectories. Rather, MER has referred to legal-bureaucratic arguments (in KBE-2) why there should be challenges driven STI initiatives and since KBE-3 also why these should be carried out by other ministries. Thus, we can argue that the NPs were “ahead of their time” – their rationale was coming from bureaucratic concerns of a single actor (MER) and it was insufficiently developed and

legitimized in the policy processes – and most likely implemented in their current form only due to the availability of the EU cohesion policy funds. Our findings support the argument by Vitola (2014) who has shown that policy makers in the Baltic Sea region where STI policies are divided between EU, national, intra-regional and regional level activities in general do not focus explicitly on thinking about the specific policy rationales and logics of different interventions and measures as they feel they have more practical issues to concentrate on (e.g. capacity to absorb EU funds, coordination of the increasingly complex policy arena) (see also Edquist, 2014). Thus, due to the prevalent funding logics, policy makers may accept and try to adopt policy ideas and measures that have emerged and been legitimized (as “best practices”) in other contexts without sufficient domestic rationalization, legitimization and institutional adaptations.

Still, we can bring out two more potential “rationales” why the socio-economic challenges have gradually emerged throughout KBE-2 and KBE-3. First, the drafting of KBE strategies has always taken place under significant fiscal strains. While the Estonian excellence-driven science output and quality has increased significantly over the last decade and more (and Estonia is one of the best performing CEE states – see also Allik, 2015), between 2009-2014 the national taxes based R&D funding did not increase (counting for inflation, the actual funding decreased) and only the use of EU funds for R&D has eased the fiscal strain. The calls for further STI funding by researchers have triggered discussions and debates over the “usefulness” and public value of research. Especially the Ministry of Finance and business/interest associations tend to ask openly what practical benefit (in terms of productivity, value added etc.) will emerge from more public R&D investments? This has further supported the legitimization through impact/efficiency narrative that is also partly linked to public sector demand and societal challenges (especially given the socialist STI legacies still influencing the specializations in science). Second, the difficulty of funding and managing specific STI fields with horizontal and excellence-oriented measures has become increasingly acute. Most importantly, the energy sector in Estonia is heavily reliant on oil shale and requires significant STI input for maintaining existing capacities and upgrading the sector, but oil shale research is rather unique niche on the global scale and competitive and excellence-oriented research funding systems may discriminate against this field. One can presume that more customized funding provided by line ministries (or other public bodies) could fit the needs of specific technology fields better.

Overall, if we look at the general STI policy arena, the emphasis on societal challenges (but also smart specialisation) has paradoxically faced limited problems of legitimization, even if the exact rationales have

remained unclear. Even scientists – the most organized and powerful stakeholder group in STI policy – who would have to change their habits and routines probably the most, seem to support this new focus. One of the probable explanations may be the tendency for the STI actors to re-interpret and hope to re-focus the challenges based approach so that it fits the existing policy legacies and routines (as also predicted by others – see Leijten et al., 2012). Another probable reason is that this focus may be a necessary step to get access to more R&D funding from different sources (i.e. from health insurance fund, environmental fees and military budget to gaining better position in the general state budgeting process), especially as in market-based innovation system the core R&D funding is constantly scrutinized through the market failures logic. In other words, challenges based funding is perceived as an *additional* financial instrument to leverage the existing activities rather than a motivator for more systemic changes. In sum, we can see that introducing new programs and coordination mechanisms (such as NP) into a system that has followed significantly different routines may easily fail as these single instruments will be “domesticated” by the most capable organizations (in our case universities and research groups). Yet, with the KBE-3 and by changing the institutional patterns – by bringing line ministries to the centre of the STI policy design and incentivizing the emergence of new routines in them – MER may achieve a more sustainable re-orientation of the policy towards social/public needs/demand. This is likely to be policy field specific both in terms of the exact definition of challenges (and their feasible policy rationales) and in terms of key policy actors to be engaged in these processes.

2.3 New initiatives in the new institutional context

Although, the KBE-3 is still in early phase, there are some indications that the broader STI policy focuses may be changing within the new institutional context. For example, experts from the Ministry of Defence argue that over the three KBEs, they have grown from research-driven to problem-driven STI actors. They also see that the institutional innovations by MER (co-funding for R&D of line ministries) seem to incentivize STI-thinking in traditionally more modest STI actors such as the Ministry of Internal Affairs who has shown interest in cooperation with the Ministry of Defence in the area of dual-use technologies. Other ministries have also recognized the need to re-organise sectoral STI coordination and investment policies and here, MSA provides a key example.

In 2014, MSA started to draft the strategy “Science and innovation into the service of health” (MSA, 2015) partly on the initiative of MER (the process was funded by the NP on healthcare technologies), partly on the

initiative of scientists (genome researchers) and doctors. After more than a year of design and deliberation, the new strategy has a clear focus on a specific challenge: to maintain through STI the sustainability of the Estonian health sector given the increasing aging of the society and declining pool of working-age people. The strategy seeks to take a systemic approach to STI by combining policy interventions to support innovation *within* public sector (using STI to improve the quality and effectiveness of the health system as a whole – including regulations, financing etc. – and specific health services) and innovation *through* public sector (supporting public and private health related R&D to increase the capabilities and competitiveness of health sector related companies in Estonia). Further, the strategy seeks through pilot projects (in e-health, personal medicine) and use of public procurement instruments to focus on demand/needs driven STI actions (as opposed to financing STI via open calls for R&D projects). As the current financial and demand articulation capabilities of the ministry are still limited, there is no clear rationale and model to finance specific technological developments (i.e. new medicines, or health system equipment). Rather, the emphasis is on searching for whatever solutions that can be deployed in and diffused across the health system. Thus, the policy process has been again somewhat ahead of the need/demand articulation and the latter needs to be engineered and legitimized.

Still, as the definition of the societal challenge has become more specific (sustainability, effectiveness and efficiency goals of the health system) compared to general KBE discourse, different actors seem to understand – even without explicit rationalization – much better the implications of the STI policy shift and how the expectation fit with their existing priorities and routines. As MSA led this process for the first time and lacked sufficient experience and skills, the strategy process – to engage transparently different science groups and interests – was coordinated by a project team (financed by the NP) that formally worked under the Permanent Committee for Medical Research and Healthcare Strategy of the Estonian Academy of Sciences, but had strong contact with the MES (heads of departments, R&D coordinator). While this solution increased the ownership and legitimacy of the process among different groups of scientists, it also limited the clarity of the public accountability system in the strategy process. As a result, some organizations also took somewhat reserved positions. For example, in the strategy discussions the Estonian Health Insurance Fund acted rather conservatively as it felt the pressure to start financing STI from health insurances funds that are themselves in rather critical state in the long term. MEAC who will manage some of the funding instruments potentially deployed for the health STI strategy – innovative procurements – raised concerns that especially activities

related to innovation within government and health system (probably most easily financed via procurements) are vaguely related to their core mandate to increase the productivity and export capabilities of the Estonian firms. In addition, MER repeatedly raised concerns that given the manner how the strategy was drafted (by outside experts), the strategy may end-up as wishful thinking without clear owners and financial commitments. MSA has responded to these doubts by establishing in the ministry a position of vice secretary general responsible for e-health and innovation and by reorganizing the strategic and analytical units of the ministry to clarify its approach to STI. Thus, we see an attempt to mainstream the new policy approach and STI for the health policy in general in order to engage other system level actors with the rather specific problems of the health system. Also, we can witness several policy and institutional innovations – all rather experimental and growing out of the KBE-2 legacies and also from the strategy formation experiences – that were necessary for the strategy drafting and legitimization processes.

Looking at the legitimization of the health STI strategy at lower levels of system, the main challenge seems to be convincing other health system actors (nurses, doctors, hospital managers, contractors) of the value of STI in the health system. To date many of these actors seem to treat any kind of new solutions – starting with new IT programs – as a cost (hospital managers), or another distracting factor (doctors who need to work with several partly overlapping e-systems). This is strongly related to the general approach to health policy in Estonia where the clear emphasis is on cost-efficiency (Estonian health system is considered as one of the most cost-efficient in Europe) achieved mostly via semi-market competition (between hospitals, “family doctors” etc.). This seems to limit the openness to experimentation and risk-taking and willingness to adopt systemically new technologies, solutions and approaches. Thus, to legitimize STI among these health system actors, the strategy seeks to emphasize the innovation *within* public sector rationale and plans to use innovation awards and innovation challenges to foster a culture of openness, innovation and experimentation and support the diffusion of new STI-based solutions. Overall, this example reflects the complexity of introducing challenge orientation into a market-based system: the rationales and activities have to be designed from scratch, but these will most likely create new conflicts into predominant linear STI policy model, and this in turn need to be overcome by policy and organizational innovations influencing the core routines of relevant STI actors on different policy levels.

Conclusion

We have analysed the gradual emergence of challenges based STI policy in Estonia that represents a case of market-based innovation system where most policy instruments and institutions have departed from the market failures based and linear STI policy model. Through the analysis of three strategic periods of Estonian STI policy, we have shown that the initiation of challenges driven STI policy focus in such context is a long-term process where conflicts between different (predominant vs new/emerging) policy rationales are likely to emerge. Thus, in addition to new policy measures and coordination practices, such policy initiatives may also require the development and utilization of contextually fitting legitimization pathways (shifting STI from a goal to a means) and policy and institutional innovations capable of fostering changes in the routines of key STI actors from line ministries and STI financiers to research performers.

Overall, our case study seems to confirm our argument that at least market-based innovation systems that follow predominantly linear and market failures based STI policy approaches may face particularly difficult challenges related to the operationalization and thereafter legitimization of policy rationale changes emerging with the societal challenges approach. Though, similarly to the recent smart specialisation experiences (see Karo and Kattel 2015a), the strong EU rhetoric and funding opportunities (from Horizon2020 to EUs cohesion policy) supporting this policy change could turn the questions of rationalization and legitimization largely into a non-issue, especially as austerity is pressuring most EU member states to increasingly rely on EU-level funding for STI (see also Veugelers, 2014). Yet, this may in turn increase policy design and implementation challenges in the later stages of the policy cycle as existing policy and administrative routines are not designed for challenges driven and necessarily co-productive, or participatory policy practices. In other words, the question of how to bring about changes in policy and administrative routines remain acute even if new policy rhetoric is quickly legitimized.

In terms of policy design and planning, the above lessons seem to indicate that STI systems need to maintain policy space for experimental policy initiatives within the general policy approach and institutions. National and domain-specific differences in understanding, rationalizing and prioritizing different challenges will determine the most suitable policy rationales and legitimization pathways (i.e. when in the case of US the political determinants seem to determine to large extent the institutional design of STI policies, in many European smaller states political interests seem to be much vaguely linked to STI policies and budgetary conditions or academic interests may be more important determinants). The key

policy design challenge is to combine policy rationales and legitimization pathways that cater to “mainstream” STI actors (political elite, key ministries, universities, business representatives) and potentially new actors in the policy arena (line ministries and agencies) who will treat STI not as a policy goal per se, but as an instrument in the service of other policies. Following the conceptual framework of the paper, this most likely requires expanding the scope of policy rationale – from market failures to domain specific public demand/needs and developing broader narratives – and complementing “traditional” innovation policy logic – innovation *through* public sector – with that of innovation *within* public sector.

In policy implementation, the crucial institutional capacity challenge is how to bring together domain specific mission/challenge competencies (of line ministries and mission agencies) and technological development and diffusion skills (of R&D and innovation ministries and agencies). We have shown that introduction of new (coordinative) policy instruments may not suffice. When large countries can achieve this effect through domain-based organizational variety (using a heterogeneous mix of organizations with different routines and profiles, see e.g. Block and Keller, 2011; Bonvillian and Van Atta, 2011; Weiss 2014), smaller countries have an alternative to establish experimental challenges driven policy coordination bodies and/or challenges driven *policy labs* whose task is to combine the “mainstream” supply and demand based policy instruments, coordinate their implementation and through these processes create new forms of policy and administrative intelligence (see e.g. Breznitz and Ornston, 2013; Tönurist et al., 2015; Karo and Kattel 2015b).

Finally, societal challenges approach requires the development of international, or cross-border, policy perspective for policy and resource coordination, technology diffusions etc. In the case of Estonia (and many other EU economies), this may be one of the key issues overlooked in the current STI policy processes.

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