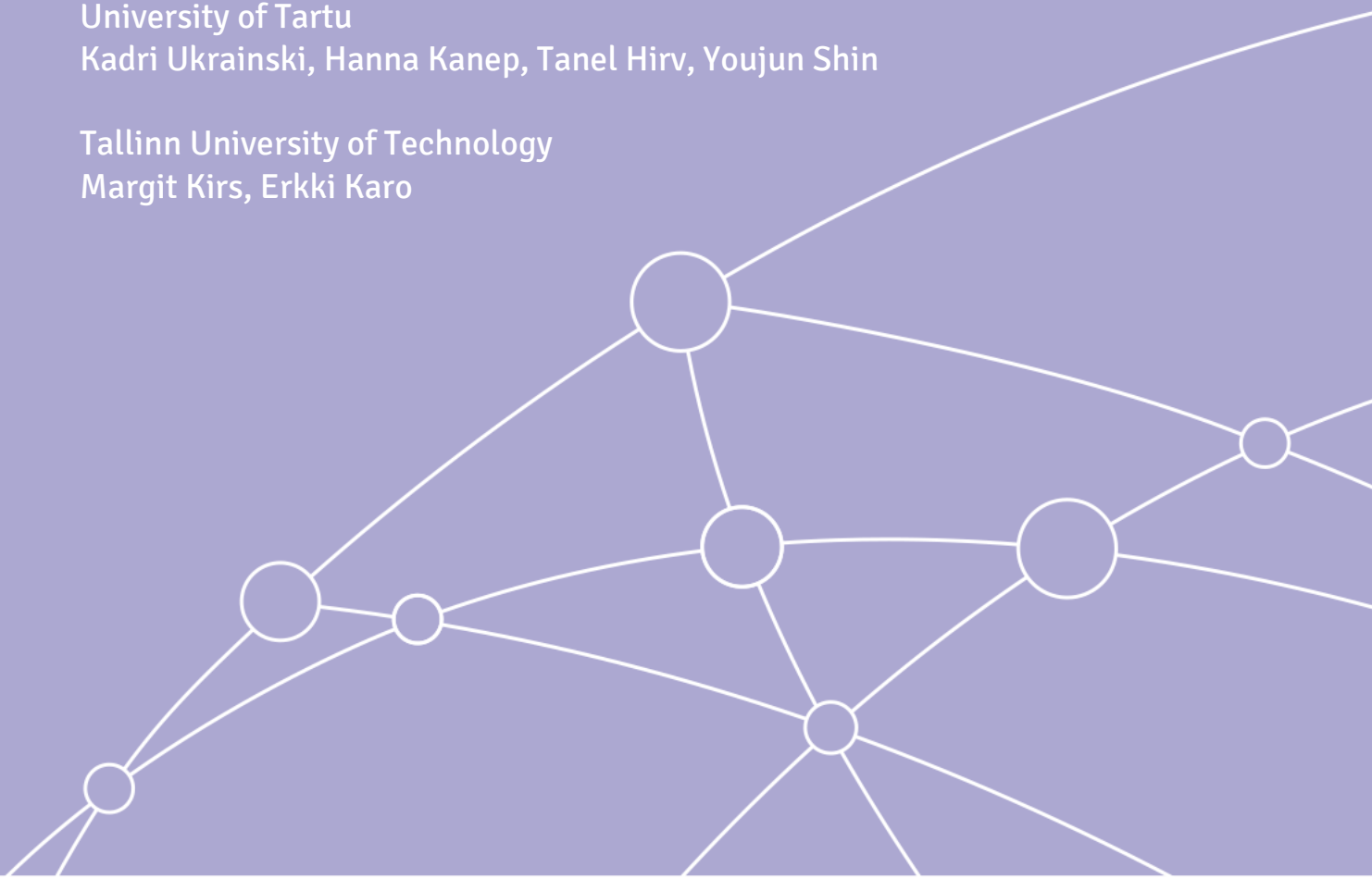
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Estonian Potential in Framework Programmes: Analysis and Policy Options

Final Report

University of Tartu
Kadri Ukrainski, Hanna Kanep, Tanel Hirv, Youjun Shin

Tallinn University of Technology
Margit Kirs, Erkki Karo



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Project in brief

The study evaluates the Estonian experiences and potential in the EU Framework Programmes (FP) and provides input for Estonian negotiations over the next FP. It compares the efficiency of Estonian FP beneficiaries compared to beneficiaries from other countries across similar participation indicators and highlights the strengths and weaknesses of Estonia. The assessment of the FP participation potential across different fields of science provides input for setting new policy goals, and interviews and case studies provide input for a better design of policy measures.

The main research questions of the study are:

1. How actively do Estonian researchers, research institutions and companies participate in FP sub-programs in comparison to other countries?
2. What are the profiles of FP participants, and what are their motivations, experiences and barriers to participation in FP? What has been the impact of FP participation on activities and development paths of researchers, research institutions and companies?
3. What is the Estonian potential in FP, and how could this be realized?
4. How can the public sector support Estonian researchers, research institutions and companies to participate more actively?

This study was carried out with the support of the RITA Programme, supported by the European Regional Development Fund. The program aims to increase the capacity of the state in the strategic management of research and the capabilities of R&D institutions to carry out socially relevant research and development activities. In the framework of the program, the Estonian Research Council (ETAg) funds socio-economic applied research based on the needs of the state.

DISCLAIMER: This study relies on both quantitative data, case studies and interview input from stakeholders. The analytical interpretations by the authors do not necessarily reflect the views of all participating organizations.

List of Abbreviations

Abbreviation	Description
Art. 185	Article 185 of the Treaty on the Functioning of the European Union (TFEU) enables the EU to participate in research programs undertaken jointly by several Member States, including participation in the structures created for the execution of national programs.
BONUS	BONUS is a joint Baltic Sea research and development program producing knowledge to support the development and implementation of regulations, policies and management practices specifically tailored for to the Baltic Sea region.
CEF	Connecting Europe Facility
COFUND-EJP	European Joint Programme Cofund
COSME	European Union Programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises
COST	European Cooperation on Science and Technology
CSA	Coordination and Support Action
EC	European Commission
EIP	European Innovation Partnership
EIT	European Institute for Innovation and Technology
ERA	European Research Area
ERA-NET	European Research Area Net
ERC	European Research Council
ESIF	European Structural Investment Funds
ETP	European Technology Platform
EU	European Union
EU13	BG – Bulgaria, CY – Cyprus, CZ – Czech Republic, EE – Estonia, HR – Croatia, HU – Hungary, LT – Lithuania, LV – Latvia MT – Malta, PL – Poland, RO – Romania, SI – Slovenia and SK – Slovakia
EU15	AT – Austria, BE – Belgium, DE – Germany, DK – Denmark, EL – Greece, ES – Spain, FI – Finland, FR – France, IE – Ireland, IT – Italy, LU – Luxembourg, NL – Netherlands, PT – Portugal, SE – Sweden and UK – United Kingdom
EUA	European University Association
FET	Future and Emerging Technologies
FP	Framework Programme
FP7	7th Framework Programme
H2020	Horizon 2020
HEI	Higher Education Institution
HES	Higher or secondary education institution
IA	Innovation Action
ICT	Information and Communication Technologies
JPI	Joint Programming Initiative
JRC	Joint Research Centre
JTI	Joint Technology Initiative
KIC	Knowledge and Innovation Community
LEIT	Leadership in Enabling and Industrial Technologies
MSCA	Marie Skłodowska-Curie Actions

OTH	Other institution type
P2P	Public to Public Partnership
PCP	Pre-Commercial Procurement
PPI	Public Procurement of Innovation Solutions
PPP	Public-Private Partnerships
PRC	Private firms
PUB	Public body (excluding research and education)
RDI	Research, development and innovation
REC	Public-sector research institutes
RI	Research Infrastructures
RIA	Research and Innovation Actions
S2E	Stairway to Excellence
SC1	Societal Challenge 1: Health, demographic change and wellbeing
SC2	Societal Challenge 2: Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy
SC3	Societal Challenge 3: Secure, clean and efficient energy
SC4	Societal Challenge 4: Smart, green and integrated transport
SC5	Societal Challenge 5: Climate action, environment, resource efficiency and raw materials
SC6	Societal Challenge 6: Europe in a changing world – inclusive, innovative and reflective societies
SC7	Societal Challenge 7: Secure societies protecting freedom and security of Europe and its citizens
SEWP	Spreading Excellence and Widening Participation
SGA	Specific Grant Agreement
SME	Small or Medium-Sized Enterprise
SWAFS	Science with and for Society
TRL	Technology Readiness Levels are indicators of the maturity level of particular technologies. This measurement system provides a common understanding of technology status and addresses the entire innovation chain: TRL 1 – basic principles observed; TRL 2 – technology concept formulated; TRL 3 – experimental proof of concept; TRL 4 – technology validated in lab; TRL 5 – technology validated in relevant environment; TRL 6 – technology demonstrated in relevant environment; TRL 7 – system prototype demonstration in operational environment; TRL 8 – system complete and qualified; TRL 9 – actual system proven in operational environment
UNI	Universities
WoS	Web of Science

Executive Summary

This study evaluates the Estonian experience in Framework Programmes (FPs) and in particular in the current Horizon 2020 (H2020). The **statistical data analysis** estimates the potential of Estonia that could be achieved given its resources and describes FP participation activity, success rates, and cooperation patterns.

With H2020, the FPs started to put much more emphasis on ***innovation*** and ***societal challenges.*** The majority of H2020 is not about research, but increasingly about development and innovation activities and the diffusion of research output in economy and society. This implies that besides the academic sector, the participation of various other mostly **demand/user-side actors** (firms, public-sector organization, non-governmental organizations and citizens) has become increasingly relevant for achieving the desired goals of the FP. Thus, next to academic performance indicators and outcomes (co-publications, patents), also outcomes relevant for other actors (diffusion of innovations, take-up of new solutions) should be taken into account. These outcomes are notoriously difficult to measure quantitatively.

Therefore, we also carried out **interviews** with Estonian research performers and policy makers as well as **case studies** of different types of FP participations. The aim of the qualitative research has been to collect more recent perceptions and experiences that might not yet be revealed by the statistical analysis but could be relevant for improving the Estonian success rates in H2020 and for preparing the design of FP9 and its supportive EU-level and national policies and instruments. Given the complexity and dynamism of the FPs, the policy recommendations for improving future participation in FPs try not to address single instruments, but rather focus on types of instruments and the broader context of policy-making.

Main findings

Patterns of FP participation

- **The FP application activity of Estonian actors is high and quite comparable to the best countries in the geographical proximity in Scandinavia and Baltic Sea Area.** Yet, atypically for EU13 countries (countries that have joined the EU since 2004)**, Estonia seems to be relatively successful in coordinating H2020 projects.** While the overall application success rate is 13%, in coordinated projects it is 11%.
- Sectorally, **FP participation is concentrated in the higher-education sector, which has received 48% of FP contribution, and this has dynamically increased in FPs**. While the

share of private firms has remained stable (35%), public-sector participation has increased (7%), and the participation of research institutes has decreased (6%).

- **Our findings further indicate that the participation of the higher-education sector is concentrated in a few pockets of active research groups who carry the Estonian success flag in H2020.** Our interviews with these research groups revealed threats of **organizational and individual fatigue**, as H2020 is increasingly competitive and/or requires significant efforts to build and maintain cross-sectoral international networks and prepare extensive applications. Therefore, the improvement of Estonian success requires both rethinking the national and organizational support systems and expanding the pool of capable higher-education, business, and public-sector organizations that could apply and implement H2020 projects.
- **Thematically, Estonia is quite similar to other EU13 countries**, for whom the **pillar of Societal Challenges is the most relevant** (48.7% of all participations), followed by Industrial Leadership (21.3%), Excellent Science (18.4%), Spreading Excellence and Widening Participation (SEWP, 6.7%). While SEWP makes up a relatively small proportion of H2020, our findings – especially the concentration of FP participations in limited research groups – indicate that **instruments with SEWP-like capability-building goals (networking, transfer of skills and experiences) might still be relevant for Estonia** for expanding the domestic pool of capable actors who could enter FPs in the future.
- Regarding the **instrument types, Estonia has been more successful in bottom-up (or horizontal[1]) instruments (RIA, CSA, SME)**. In more complex instruments (JTI, PPI, PCP), Estonia has either not submitted any applications (PPI, PCP) or, like the rest of EU13, experienced weaker success**.** This may stem both from the weak individual capabilities of actors and from the system failures in leveraging ESIF and in cooperating with partners internationally.
- Our analysis also indicates that **Estonia does not fully take advantage of joint initiatives, mainly because of limited political will and funding**. Estonia participates in many joint initiatives as an associate partner or observer, and therefore the research performers have limited access to the funding and networks of these initiatives, and overall there are quite few projects actually performed under these partnerships.
- **Given the current inputs (esp. regarding human capital and R&D investments) and estimated potential for participations, Estonia has managed to perform quite well, but the efficiency of H2020 participation has dropped in 2015 and 2016.** We can witness efficiency drops in many thematic fields, and only a few fields have remained efficient in 2015-2016: Innovation in SMEs, Societal Challenges and SEWP (2015).

[1] In innovation studies, **horizontal policies** are generally understood as supportive of research and innovation, regardless of the sector (e.g. general basic research support, support form commercialization of technologies, innovation support etc.).

Main motives for and perceived impact of FP participation

- The case studies and interviews show that **financial sustainability (of research groups and R&D-intensive companies) is perceived as the most important motivator for participating in H2020**. But FP projects are also perceived as **indicators of quality of excellence** for applying for national funds or for advancing personal careers. Quite logically, this incentive is less important for the research groups and principal investigators (PI) with significant national funding (in nationally prioritized fields) and track record. Overall, active participation in FPs may be the "sink or swim" period in the career path of a PI and until the FP projects bring new returns in the form of longer research funding and stability.
- **FPs help to create international research (publishing) networks for Estonian researchers**. FP funded publications are above the performance levels regarding citation compared to other publications. They also have higher citation impacts compared to the publications funded by the Estonian Research Council (ETAg). This result is not unique but has also been shown in the cases of other small countries (e.g. Denmark) and implies that small-country research systems should explicitly incentivize international networking also in domestic excellence-oriented funding mechanisms.
- Our interviews and case studies further highlight that FP projects provide much broader **networking and learning platforms for research groups, firms and public-sector organizations.** These platforms also work as **self-reinforcing arenas for transnational cooperation and future FP project/consortia building.**
- **Estonia's industry seems to prefer more instruments that fund sole beneficiaries than other more collaborative instruments**. This potentially points to the failures in domestic and international networks of Estonian companies and industries.

<u>Main policy recommendations</u>

Policy makers should try to constantly improve the framework conditions of the Estonian innovation system to motivate Estonian actors to participate in FPs and increase their chances of success.

1. Given the indications of declining efficiencies and also the feedback from interviews and case studies regarding the potential fatigue effect, policy-makers needs to both **encourage a broader pool of research performers to apply for FP projects** and negotiate for **increasing the actual EC contributions per project** (to balance the remuneration rates between EU15 and EU13), or encourage applications where EC contributions are more substantial. In addition, Estonian policy discourse should also

emphasize and incentivize the applications in Excellence pillar and support ambitious scholars in applying for ERC grants and disseminating the best-practice lessons. This could be achieved by more selective and extensive nation-level motivation packages (bonuses for passing thresholds, selective ex-ante funding of preparing key strategic applications or applications in areas where Estonia has been less active).

2. The criticism of the leading researcher groups regarding the soft impact of the SEWP instruments partly overshadows the **potential of SEWP instruments to support building networking and research capabilities in groups whose prior experience and track record in FPs is limited so far**. In other words, SEWP-type instruments could work as instruments of widening the participation within different EU13 countries, given that the positive experiences of more successful groups in applying and managing FP projects are also transferred to them. **More emphasis should be put on informing, training and incentivizing groups with limited experience in FPs to try to enter SEWP measures and other soft networking tools (COST, etc.)**.
3. Given that Estonia is coping relatively well in research-oriented segments of H2020, but less so in applied R&D projects, policy should also focus more on **increasing the R&D capabilities of the business sector**. In other words, industrial and innovation policy should not only focus on networking, demand and export-oriented support activities, but should also tackle the challenges of basic-capabilities development in R&D.
4. On the national policy-coordination level, there still seem to be **unresolved coordination issues regarding the roles of specific ministries and ETAg as the central coordinator of research activities**. In the current system ETAg acts as the central policy coordinator, but it lacks the domain-specific capabilities to select and prioritize research fields and issues to be tackled. Estonia is involved in many different EU initiatives with limited funding (as associate partner, observer, etc.), and this seems to create general dissatisfaction on the research-group level. At the same time, much of the domain-specific policy knowledge resides in particular ministries whose R&D advisors and other specialists could be empowered to make more policy-level decisions regarding priorities and funding allocations. One option would be to **pilot with new forms of deliberative decision-making tools in specific policy/priority areas**, i.e. specific mini-conferences where leading researchers and representatives from the industry debate the priorities of Estonian national participation in EU partnership instruments and vote on the priority of topics where Estonia should be a full vs. associate member, into which to invest national resources etc.

Given the increasing discussions and legitimacy of the mission-oriented innovation and research policies in the EU, the government can also show greater policy leadership and try to

trigger qualitative shifts in the attitudes and visions regarding the internationalization of research and innovation actions of Estonian stakeholders.

1. As FP is no longer about research as such, but about steering the processes of research and innovation towards tackling societal challenges and pursuing specific missions, **public-sector organizations need to become more proactive in FPs as project leaders and partners**. So far, the participation of ministries, intermediary organizations, local municipalities etc. has remained limited and concentrated in a few proactive pockets. Yet, especially Innovation Actions of H2020 need these organizations as end-users to participate in the co-creation and piloting actions. If public organizations understand FP projects as tools for investing in innovation and development and become proactive partners, this could, in addition to bringing investment and development funds to these organization, also increase the possibilities for research performers to join innovation-oriented project in FP.
2. While Estonia has emphasized innovative public procurements as a potential tool for supporting innovation, **the government could also provide symbolic leadership** by demanding (as a first pilot) specific agencies to participate in certain numbers of FP applications per year as the leader or partner of a national mini-consortium; or to create **innovation-support units** within government which have to self-finance some parts of their activities via joint research projects and FP grants (like Forum Virum in Helsinki).
3. There is also a significant **unused potential in bridging Estonian R&D institutions and firms to apply for FP projects that focus on new/novel research and innovation avenues**. Public policies could again lead the way by creating bridging/matching events and financing *ex ante* the preparation of FP proposals between new partners (who have not collaborated before and lack trust) in selected priority areas.

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1. Introduction

To widen the participation of Estonian research performers in the European Research Area (ERA) and in the EU Framework Programmes (FPs), especially in the current FP8/Horizon 2020 (H2020), the wider benefits of participation in FP funded projects, but also difficulties associated with conducting FP projects, need to be better understood and more broadly communicated.

This study evaluates the Estonian experiences and potential in the FPs and provides input for Estonian negotiations over the next FP. Estonia belongs to the group of new EU13 member countries, and even though it is one of the more successful countries of this group, it still shares many systemic challenges common for the group, e.g. fragmentation of the innovation systems and little collaboration between academia, enterprise and public sector organizations, weaker policy prioritization, international networking and domestic administrative capabilities. A recent analysis by Ukrainski et al. (2017) has shown that EU13 as a whole has not fulfilled the expectations on the speed and scope of wider integration into ERA.

The study uses different methods – document and statistical analysis, interviews with policy experts and research performers, a compilation of illustrative case studies – to gather information on different levels of analysis regarding the current practices, potential and main challenges regarding the participation of Estonia in the EU FPs. The general conclusions are drawn using the triangulation method, i.e. two or more methods are used to study the same subject. The interviews with Estonian H2020 participants are selected based on the eCORDA database, and the results of the interviews are in turn validated by using the eCORDA statistical analysis. The cut-off date for eCORDA analysis is 28 February 2017.

The report starts out by reviewing the studies that focus on the FP participation experience of especially EU13 countries to give the reader the relevant context for evaluating the Estonian experience. Thereafter, several chapters describe the Estonian experience in FP research collaborations from different perspectives. This analysis is based on the statistical data of eCORDA, which is an FP participation dataset compiled by the European Commission and provided by the Estonian Ministry of Education and Research for the current analysis.

Next, two statistical exercises are performed. First, the dynamics of bibliometric indicators related to visibility of research is presented to bring out the benefits for scientists from participating in the FPs. Next, the efficiency analysis of Estonian participation compared to other countries is performed combining eCORDA data with EUROSTAT indicators. This report highlights the Estonian strengths and weaknesses in EU-wide comparison and gives the reader

an idea how Estonia has succeeded in FP so far in comparison to its FP participation potential, given its limited resources dedicated to R&D investments and human-capital inputs. The analysis is also performed across different pillars of H2020, which provides insights to policy-makers how to improve policy goal-setting and redesign policy measures across thematic fields.

The statistical analysis is complemented by in-depth case-study analyses conducted based on both eCORDA data and interviews with individual actors to systemize their perceptions regarding the evolution of FPs, the main challenges as well as the perceived impacts of participation in FP projects. With H2020, the FPs started to put much more emphasis on innovation and societal challenges. This implies that besides the academic sector, the participation of various other mostly demand/user-side actors (firms, public-sector organization, non-governmental organizations and citizens) has become increasingly relevant for achieving the desired goals of the FP. Thus, next to academic performance indicators and outcomes (co-publications, patents), also outcomes relevant for other actors (diffusion of innovations, take-up of new solutions) should be taken into account. These outcomes are notoriously difficult to measure quantitatively. Thus, the aim of the qualitative research has been to collect more recent perceptions and experiences that might not yet be revealed by the statistical analysis, but could be relevant for improving the Estonian success rates in H2020 and for preparing the design of FP9 and its supportive EU-level and national policies and instruments.

The final section offers policy recommendations for improving the overall context and success rate of Estonia's participation in the EU FPs. Given the complexity and dynamism of the FPs, the policy recommendations for improving future participation in FPs try not to address single instruments but rather focus on types of instruments and the broader context of policy-making.

2. Key factors affecting participation in the EU Framework Programmes: FP7 vs. H2020

2.1. Key changes from FP7 to H2020

The importance of European FPs has increased considerably during its lifetime since 1984. This may be best illustrated by the budget increase from just below EUR 4 billion of FP1 to around EUR 75 billion of the current H2020 (European Commission 2017a, 22; Lepori et al. 2015, 2149-2150; Enger and Castellaci 2016, 1611-1612). Over time, the *policy rationales* behind the FPs have become more oriented towards overcoming existing structural differences and the creation of the integrated European Research Area (ERA) (Nedeva 2013; Lepori et al. 2015, 2150). However, the ambivalence of the European RDI policy – to rely on the same institutional and policy frameworks for simultaneously strengthening the competitiveness of its leading parts and also improving the performance of the lower-performing parts – may exacerbate the existing structural problems of the innovation system(s) of the EU (Young 2015; Lepori et al. 2015, 2175; Karo and Kattel 2018).

In this context, the H2020 has tried to provide a break with the past through the considerable changes in distribution mechanisms of FPs, the stated ambition to cover the entire innovation cycle, and the focus on closer-to-market applications and major societal challenges (Table 1).

As this shift has been pursued in the context still influenced by the last economic crisis (see European Commission 2017b; Karo et al. 2017; Young 2015), it has had a two-fold impact on participation patterns in H2020. On the one hand, all national governments across Europe have set participation in the EU research funding schemes as a central focus on their R&D policy agendas, in particular to compensate for cuts in the investments in R&D at the national level (Enger 2017, 2; Enger & Castellaci 2017, 1613). Private-sector activity has also intensified considerably as the total number of applications submitted by private actors has increased by over 130% between FP7 and H2020 (European Commission 2017a, 24). On the other hand, as the competition for H2020 funds has become fiercer than ever (30,000 applications per year over the first years of H2020 in comparison to 20,000 in FP7), vastly outstripping the supply, considerable problems of oversubscription have emerged (European Commission 2017a, 5, 61; European Commission 2017c, 55). According to the evaluations by the European University Association (2016, 31), it seems that universities may be hit the most by these changes, as they experienced a drop in the success rate for proposals to about 14% in the first 100 calls of H2020 (in comparison to around 20% in FP7).

Table 1. Key changes from FP7 to H2020

Recommendations from FP7 ex-post evaluation	Horizon 2020 goals
Focus on critical challenges and opportunities in the global context	- focus on major societal challenges - boost private-sector participation, including SMEs - maximize synergies between different areas of research and innovation and new digital technologies
Align research and innovation instruments and agendas in Europe	- support the alignment of national research strategies - better coordinate with EU regional funding - help the EU countries reform their research and innovation strategies - identify obstacles to research and innovation - ensure that research proposals support innovation
Integrate different sections of research-funding programs more effectively	- focus on better consistency across the funding programs - ensure that cross-cutting issues are considered - simplify access to research and innovation funding - apply a single set of rules consistently - coordinate effectively across the Commission in managing funding
Bring science closer to citizens	- better communicate with the general public on science issues in general and Horizon 2020 in particular - strengthen open access to research publications and data - involve citizens in research strategy and topics
Establish strategic program monitoring and evaluation	- better monitor and evaluate funding and socioeconomic impacts - improve feedback loop from project results to policy-making

Source: European Commission 2017b, 26.

In this context, one has to keep in mind that the analysis of the factors affecting the participation of researchers and other actors in the FPs is full of complexities.

1. Different **types of actors** (e.g. nation-level actors, independent organizations, individuals) may have **different motivations** to participate in FP projects and other EU instruments (e.g. Åström et al. 2012; European University Association 2016; Polt et al. 2009; European Commission 2016a).
2. Given that FPs have evolved over 30 years and through complex and cumulative political compromises, the **instruments of FPs cover different policy rationales** (see, e.g., Bach et al. 2014; also Reale et al. 2013; Lepori et al. 2014; for the change in FP vs. H2020, see European Commission 2017b, 34-35, but see also Annex 1). This implies that not all policy instruments should be of equal importance and suitable for different nations (given the differences in development stages), or specific research fields, organizations, and individuals (given their missions and interests). In the following, we briefly use the existing literature to dissect the main issues/debates regarding the participation of countries like Estonia, and EU13 in general, in FPs and especially in H2020.

2.2. Motivations to participate in FPs: actor perspective

The key incentives for participating in different EU research instruments can be distinguished as follows (based on Åström et al. 2012; Polt et al. 2009, 28; Reale et al. 2013; Lepori et al. 2011; Lepori et al. 2014):

- development of technology/knowledge/research excellence;
- networking/finding new partners;
- cost sharing/obtaining funding;
- commercialization of innovation output and market;
- career-boosting/visibility-enhancing motives.

Even though several evaluations on previous FPs, especially since FP6, have indicated that the impact of FPs on networking and knowledge/capabilities development is generally more appreciated than the direct economic impacts[2], the situation in the context of H2020 seems to have become reversed. Especially participation of *R&D institutions* is strongly driven by the need to find solutions for domestic austerity-driven funding problems (European University Association 2016, 33-40, see also Table 2). In addition to the formal change of FPs' focus on innovation diffusion and societal challenges in H2020, R&D institutions also see the increased competition by the industrial partners and limited attention to the funding of basic research and disruptive innovations as the main negative elements of H2020 (European University Association 2016, 15).

At the same time, one has to keep in mind that the actual decisions and preparation of project proposals are led by *researchers and research groups* who may act independently of the abovementioned organizational considerations (Nokkala 2008; see also Åström et al. 2012, 43). On the level of the researchers and research groups, assuming some level of stable institutional funding, the main substantive motivator for participating in FP instruments is arguably not related to funding, but the possible "window of opportunity" to enter into or extend existing international networks (Reale et al. 2013, 20-22).

The same has also been stated in the previous surveys of ERA-Nets: "*For low performing (high potential) countries ERA-NETs are a great instrument allowing for better and easier integration of researchers into 'old boys' networks"* (Updated Policy Brief on the Impacts of Networks 2016, 23; European Commission 2016b, 8). Nevertheless, a strong path-dependency of these networks has been demonstrated, and even in the latest rounds of FPs, the majority of "new"

[2] This is especially interesting in the context where research funding as such appeared as the number one objective for research centers and universities to participate in FP5 and in EU-15 (incl. Austria, Finland, Ireland) (see Åström et al. 2012, 23).

consortia in ERA-Nets have been built based on pre-existing partnership arrangements (Doussineau 2014, 7)

Table 2. Assessment of H2020 changes by university and industry actors

The change from FP7 to H2020	Universities	Industry
Perceptions of nature of activities supported	"*Unfortunately there are so few other funding sources, institutions have to engage in [Horizon 2020] no matter what the success rate"* (EUA 2016, 39). "*Funding in Horizon 2020 is not evenly spread across all areas of the R&I value chain which is to the detriment of the university sector. … funding for disruptive innovation based fundamental and applied research is considered to be scarce"* (EUA 2016, 15). "*Within these innovation-related activities, such as piloting, demonstration, test-beds, and support for public procurement and market uptake, universities only play a minor role, act as a (research) service provider and are not on the same level playing field with the industry*" (EUA 2016, 19).	According to stakeholder consultations (European Commission 2017c, 53-54) carried out in the interim evaluation of H2020, business representatives perceive the shift towards innovation most positively, especially given the previous underemphasis of the issue in FP6/FP7. The main criticisms of H2020 is that there are limited opportunities for projects on the technology-readiness level (TRL) 3 to 5 (see also European Commission 2016a, 7-8).
Perceptions of forming networks and collaboration	In H2020, private companies and not research organizations are increasingly the main partners for consortia formed by the academic sector (European Commission 2017a, 72).	The questions of improving collaboration with academia are not very relevant for industry representatives; rather, the need to be more involved in evaluation committees to steer the direction of H2020 has been emphasized (European Commission 2017c, 54-55).
Administrative burden, costs of application	According to EUA (2016) the administrative burden at all stages of application, participation and project administration still needs to be reduced. 20% of R&D institutions found the administrative costs of H2020 to be higher than those of FP7 (European Commission 2017c, 39).	Important, but not so decisive for industry (European Commission 2016a, 7; European Commission 2017c, 39).

Source: European University Association (2016); European Commission (2016a); European Commission (2017a); European Commission (2017c).

In recent years, it has been emphasized in academic literature that for a better comprehension of participation dynamics in FPs, there is a need to get a more detailed picture of the participation processes regarding *self-selection*: not only why and how successful the applicants are applying for EU funding, but also whether or not the organizations decide to invest time and resources in developing a project application and apply for FP funding in the first place, i.e.,

differentiating between successful, unsuccessful and non-applicants (Enger and Castellaci 2016). It has been hypothesized that the decisions to apply for the first time (or not) are rather different from decisions and motivation to keep applying, while strengthened research capabilities and funding may have a counteractive effect on the organization's propensity to apply.

On the side of the *industry*, SMEs tend to strongly emphasize financial incentives and tangible results, for example developing new or improved tools, methods or techniques. For large companies, H2020 projects are not so much considered tools for technology commercialization, but often function as "technology-watch" instruments which allow companies to stay informed about the latest R&D developments as well as to network and establish relations with partners to gain access to knowledge and expertise (Performance of SMEs within FP7 … 2014; European Commission 2016a; also Polt et al. 2009). In other words, most evaluations and analyses argue that SMEs and large firms should be treated as complementary actors in H2020, e.g.:

> *… SMEs are particularly needed for their capabilities of coming up with new ideas, and their speed and flexibility in developing new concepts. However, they [SMEs] do not have the capacity and resources to go into product development, nor to get innovations quickly into the market. Thus, much closer interaction with large companies is needed. … It is unclear whether this arbitrary measure of share in participation and budget really reflects the real added value of SMEs.* (Ex-Post-Evaluation of the 7th FP … 2015, 65; Performance of SMEs within FP7 … 2014, 95).

In the context of *EU13 countries* two aspects need to be emphasized, first, the high level of dissatisfaction with the H2020 program (only 18% of respondents expressed satisfaction with the program in H2020 stakeholder consultations) (European Commission 2017c, 35), but even more importantly, the increasing lack of interest in trying to contribute to the functioning of the program. The latter is particularly reflected in the low submission of position papers for H2020's interim evaluation by different stakeholders from EU13 (4% in comparison to 68% in EU15), as Poland, Estonia and Slovenia were the only EU13 countries that had stakeholders represented (European Commission 2017c, 50-51). The reasons behind this tend not to be related to practicalities (e.g. the costs of H2020 are not found to be higher than is the case of other international programs), but are rather substantial in essence, primarily related to negative perceptions of the lack of appropriate solutions to tackle the knowledge divide and concentration of funding at the institutional level in ERA (European Commission 2017c, 35; Issue Paper for the High Level Group … 2017, 54). The second aspect concerns the hypothesis raised by MIRRIS that the overreliance on European Structural and Investment Funds (ESIF) in EU13 has contributed to building a path difficult to break out. While the ESIF has been more

relevant for R&I capacity-building, but also for meeting the short-term incentives regarding funding, etc., as expected by EU13, it has been argued that the reliance on it has become detrimental to the building of strong networks and synergy with EU15: "*This path in particular became a barrier towards internalization, access to networks and building of strong partnerships and consortia. It also became a barrier in progressing towards excellence as EU 15 Member States continued to build on that path and moved the threshold bar significantly higher*" (MIRRIS 2014b, 2).

2.3. Main challenges to participation in H2020 for EU 13 countries

As converging/catching-up economies, the EU13 countries seem to expect different impacts from FPs than the leading EU15 economies. Thus, the debates regarding the participation of EU13 countries in FPs are by necessity more critical and emphasize the challenges (as opposed to specific opportunities) of entering and participating in FP activities. In this subchapter, specific challenges of the EU13 countries (also summarized in Table 3) are further analyzed from different perspectives on actors' capabilities, but also networks between them.

Lower competitiveness of and strategic focus in EU13

The major challenge for the EU13 countries[3] is the *participation divide* between EU15 and EU13 in FPs. The issue found heavy criticism in academic debate already in the context of FP7 (e.g. Rauch and Sommer-Ulrich 2012; Schuch 2014; also MIRRIS 2014a) and has recently become particularly visible in policy debates (e.g. *Ex-Post-Evaluation of the 7th FP …* 2015, 34; *Issue Paper for the High Level Group …* 2017; European Commission 2016c, 39; European Commission 2016d, 25). According to the latest data, the total share of funding allocated to EU13 remains relatively low and has increased only slightly from 4.2% in FP7 to 4.4% in H2020 (as of 1 January 2017). In the same vein, the participation rate has increased from 7.9% to only 8.5%, while the success rate of applications from EU13 has fallen from 18.0% to 11.1% (European Commission 2017a, 24, 65). Furthermore, the EU13 countries have not been able to achieve higher participation rates in the particularly well-financed FP areas (e.g. Rauch and Sommer-Ulrich 2012, 9-10; *Ex-post Evaluation of the 7th FP …* 2016: Annexes, part 2/3, 17; European Commission 2016d, 84-85, 90-91, 100).

On the side of industry participation, there are relatively more SMEs and public-sector organizations from EU13 involved in FPs, while the share of large companies remains

[3] Here one also has to acknowledge the high diversity and heterogeneity inside the group of EU13 (see, e.g., Rauch and Sommer-Ulrich 2012, 15).

considerably smaller in comparison to EU15 (*Ex-Post-Evaluation of the 7th FP …* 2015, 36). This trend has also continued in H2020, and according to the latest evaluations, Estonia and Cyprus have the largest share of SME participation: around 30% vs. 21.3% for EU28 as a whole (European Commission 2017b, 88-89; also European Commission 2016d, 211).

While the European Commission (EC) (European Commission 2017b, 88) has pointed out that some smaller EU13 countries (Slovenia, Cyprus, Estonia) outperform the EU15 averages, one also has to consider the variations of wages and reimbursement rates between EU15 and EU13, which arguably account for up to 80% of the total variation in financial returns from FP (Council of European Union 2011, 5). The low salary level of EU13 is also a major reason for dissatisfaction in and brain drain from EU13 and also for the low motivation to take up the role of coordinator in H2020 (Ukrainski et al. 2017, 32-33; *Issue Paper for the High-Level Group …* 2017, 54). Also, the EU13 countries tend to be involved in H2020 projects where average contributions per participant and coordinator are lower (Ukrainski et al. 2017, 33).

It seems that in the context where the EU13 countries are under great pressure to obtain funding from H2020 while simultaneously limiting the growth of, or cutting, national funding for R&D (see also Veugelers 2014), the current EU funding patterns are limited in their ability to foster structural reforms at the national level in EU13. At the same time, research based on EU15 has shown that the complementarity between national and FP funding is one of the key factors incentivizing R&D actors to design and pursue excellent research projects at the European level (European University Association 2016, 38-39; also Rauch Sommer-Ulrich 2012; Schuch 2014; Fabrizi et al. 2016) and to increase one's competitiveness in FPs. While the Estonian and Latvian success rates (higher than 16%), may look as pointing to different arguments and conclusions despite the declining national funding, (European University Association 2016, 38) the recent Baltic Science Network (BSN) study showed that the "success rate" of these countries is driven by EU13 targeted "widening" measures: The ERA Chair instrument explain much of the high rate in Estonia and a single Teaming project in Latvia (Ukrainski et al. 2017, 36-37).

Weaker networking capabilities and relational proximity in EU13

The successful participation in FPs is found to be strongly dependent on organizational research capabilities (academic reputation, size of research personnel) (see in particular Lepori et al. 2015) as well as on learning and network effects gained from previous participation. This means that for weaker-performing research systems, the entry barriers in FP-like international research networks are not only high but highly structural in their essence.

Regarding the patterns and networks of collaboration within FPs, there seem to be two competing interpretations of the current state. On the one hand, EC argues that H2020 has opened up the existing "clubs" of R&D actors (European Commission 2017b, 95). This trend is detectable mainly due to the increase in participation by newcomers from the industry (here the attractiveness of the SME instrument can play a role) and also from EU13. Still, during the first 3 years of H2020, each institution from the academic sector applied on average 28 times in comparison to 2.6 times for industrial partners (European Commission 2017b, 60). The representation of the private sector among the top 100 beneficiaries of H2020 has remained limited, as well (European Commission 2017b, 92; see also European Commission 2017c, 56).

On the other hand, the academic research argues that there is still a strong "Matthew effect" on the side of R&D organizations, and certain strong "closed clubs" of research groups have been formed and are hard to break into (Enger 2017; Enger and Castellaci 2016; Lepori et al. 2015). In the case of EU13, even though the EU accession has had a positive impact on the international scientific collaboration regarding the rising number in co-publications, it has also been found that this collaboration is more significant within EU13 than between researchers/groups from EU13 and EU15 (Makkonen and Mitze 2016). The recent BSN study found particularly evident proof of segregation between EU13 and EU15 countries in general (building consortia for FP7 and H2020 applications) and even in the case of region-specific Baltic Sea collaboration instruments (European Commission 2017a, 175; Ukrainski et al. 2017, subchapter 2.1).

While in the case of FP7, it was argued (see MIRRIS 2014a, 7) that EU13 countries were often involved in research consortia due to their "favourable position" (geographical location, size, etc.), in H2020, and given its revised logic vis-à-vis FP7, the dominant role of larger and EU15 countries as consortia coordinators and members seems to be reinforced again, especially as they possess higher levels of international and national (user-level) collaboration partners, and newcomers from the EU need to buy into the "closed clubs", often without strong international and domestic networks of partners (Enger 2017; Enger and Castellaci 2016; Lepori et al. 2015; see also Council of European Union 2011). According to the recent BSN study, while some EU13 countries (e.g. Cyprus, Malta, Estonia) are relatively successful as coordinators in comparison to the others from EU13, it could potentially be explained by submissions of relatively few strong applications by the leading groups of these countries (Ukrainski et al. 2017, 33). In other words, these countries may already have already maximized their current potential.

Further, whereas EU partnerships (in particular Article 185, ERA-NETs and Joint Programming Initiatives (JPI)) are considered strategic instruments for building alignment between joint programs and national research strategies, there have been concerns that for EU13 countries

the expected impacts are not materializing. The EU13 participation in JPIs is argued to remain limited not only regarding participation in calls and committed funding but also regarding participation in management activities at the instrument level (European Commission 2016e, 35). Previous reports have argued that these issues stem from a lack of understanding of the instruments and commitment at the policy-making level: "*Many funders, and ministry decision-makers have still not clear ideas how to work with partnering / P2Ps and ERA-NETs*" (*Updated Policy Brief on the Impacts of Networks* 2016, 22).

Lower administrative and project-management capacities in EU13

Many experts have claimed that the EU13 countries have focused less on the reforms of their RDI Systems than EU15 (MIRRIS 2014a; Rauch and Sommer-Ulrich 2012; Schuch 2014, 15). The limited capacities of EU13 countries to successfully participate in FP found severe criticism already in FP7:

> *Some of most important reasons for the comparably lower share and lower success rates of the EU-13 organisations are information and language barriers; lack of professional contacts and research networks; lack of leading Universities and Research organisations leaders in proposal matters; limited understanding of FP7; weak training in preparing successful proposals; insufficient motivation to participate in FP7; lack of practice in project management; little experience in cross-country cooperation; generally low focus on R&D in policy and in business; few options for exploitation of research results at the national level*. (*Ex-Post-Evaluation of the 7th FP* … 2015, 36; *Issue Paper for the High Level Group* … 2017, 50).

In light of the significant increase of applications between FP7 and H2020 (nearly 100% in the case of Estonia), one could assume that at least the more active EU13 have managed to increase their readiness to participate in FPs (European Commission 2017a, 113-115). However, the relatively low success rates indicate that the effectiveness of participation has remained limited. We can only conjecture that given the shifts in H2020 towards innovation and societal challenges, this may be due to the imbalances in domestic RDI system (fewer capable public-sector user-level partners and large firms) as well as limited capacities to coordinate and manage the more substantial diversity of domestic and international partners required in current H2020 projects.

Table 3. The key challenges of EU13 in participating in FP

Key barriers	National level (EU13)	Program level	Organizational/ individual level
Lack of resources	• Insufficient R&D investments to maintain institutional stability	• Oversubscription of calls • Lack of relevant areas/ topics for calls	• Large administrative workload to be carried by individual applicants
Unclear strategies/priorities	• Lack of strategic aims/targets for participation in FP at the national level; limited functional synergies between national research systems and EU research foci	• Variety of different instruments and lack of synergy between them, incl. overlaps and competition for national resources in EU partnerships; plus not enough synergies with widening mechanisms	• Organizational choices are driven by bottom-up initiatives of top researchers, *ad hoc*
Limited leverage from networks/collaboration	• Insufficient access to existing networks, relying strongly on academic reputation at the international level	• Building consortia: often consortia tend to be overly large and complex; but also the nature of instruments supporting collaboration networks for a limited time period	• Networks within EU13 are weakly constructed; structural imbalances create limitations for building consortia and engagement of participants (user-side) from own countries
Lack of coherence and relational proximity (administrative systems, logic)	• The gap in variation of wages	• Different policy-administrative structures, causing potential problems of trust and collaboration; in EU partnerships unpredicted commitment by other partners (reflected also in the difference between pre-call budget commitments and the actual investments)	• Accumulation of experience and management skills, but also transnational connectivity (central position in networks) from repeated participation remain low
Shortage of capacities and commitment	• Limited experiences with project applications and management and the respective support structures	• Overly complicated administrative procedures and low political commitment at the national level; inequality of financial contribution by partners, leading to high over-subscription/low success rates for certain countries (including the problem of *juste retour*)	• Cost-benefit considerations, in particular in the increasing oversubscription conditions

Source: Svanfeldt 2009; Rauch and Sommer-Ulrich 2012; *Issue Paper for the High Level Group* … 2017; *Updated Policy Brief on the Impacts of Networks* 2016, 13-15; European Commission 2016b, 39-40; European Commission 2016e, 57; Makarow et al. 2014, 47; Enger and Castellaci 2016.

In summarizing the EU13-specific vital barriers to participate in H2020 (Table 3), many different ones can be found. These are related to the RDI and cooperation capabilities of different types of actors within the innovation systems but also related to the formal and informal institutions (such as networks, commitment, agreement on strategic aims) shaping the cooperation.

2.4. Main Findings

- The changing nature of H2020 – i.e. the growing emphasis on innovation and societal challenges – should also form the context in which the participation experiences and their different aspects are evaluated. This implies more specifically that besides the academic sector the performance of various other actors (e.g. business firms, public offices, etc.) is relevant, but also different outcomes should be evaluated besides the overwhelmingly academic ones discussed so far in analyses (related to co-publication and visibility among scientists).
- The motivations for participating in H2020 seem to be more focused on financial issues than in FP7. In EU13, the specific logic and rules of ESIF funds seem to create some unintended barriers for widening participation in FPs: while ESIF is much more bureaucratic, the competition for funding is lower and creates incentives to shift away from FPs, for which also networking etc. capabilities are weak. The main barriers of EU13 are associated with the RDI and cooperation capabilities of different types of actors within the innovation systems, but they are also related to the formal and informal institutions (such as networks, commitment, agreement on strategic aims etc.) shaping the cooperation. EU13 countries need to use ESIF funds in synergy with FP for achieving broader impacts.
- As the EU13 country group is quite diverse and Estonia is standing out in many aspects (as recognized by previous evaluations), the specific analysis of the Estonian experience in H2020 is justified as it brings out unique elements.

3. Estonian experience from FP7 and H2020: Application and Success

3.1. Overview of Estonian Participation in H2020

Estonia is standing out in the EU13 country group in its number of coordinated projects, which seems very high even in absolute numbers, ignoring the small size of the country (Table 4). It has the fourth highest number of coordinated projects after Poland, Hungary and Slovenia. Regarding proportions from all projects, the share of coordinated projects is the highest in EU15 (27.0%), the ratio is even higher than in many EU15 countries. In fact, quite similar proportions can be found in the Netherlands (25.5%) and Spain (28.1%), and higher ones in Ireland (30.8%), Denmark (30.7%) and the UK (36.3%).

This is quite a surprising result given the interviews with Estonian actors, especially from academia. They bring out several administrative and legal barriers for taking up the role of the coordinator, as well as actors who have been discouraged by the FP7 experience with covering the expenditure of the realized risks, for which the funds were not available, leaving research groups in financial stress.

A closer look at the coordinated projects by Estonian partners reveals that the majority of those are projects with a single beneficiary (62.9%), mostly from SME or MSCA action types. Almost a third (30.6%) of coordinated projects have 2-9 partners, and 5.6% have more than 10 partners. Latter examples are from IA, RIA, CSA and MSCA action types (see Annex 9 for a more detailed explanation of action types). Probably we can conclude that Estonia is quite close to the potential of its coordinator capabilities, given its current resources, but the total number of applications could be more massive, pointing towards the need for broader participation of Estonian actors in H2020.

Table 4. Overview of the number of participations, coordinators and average EC contribution by countries

Country group	Country	COORDINATOR	PARTICIPANT	Total participations	Average of EC contribution per coordinator per project month	Average of EC contribution per other partners per project month
	MT	15	81	96	14494	3655
	LV	23	154	177	17673	3821
	LT	32	171	203	8938	2939
	HR	20	227	247	10421	3293
	CY	53	207	260	12853	6055
	EE	**72**	**195**	**267**	**18968**	**4069**
EU13	SK	32	241	273	14197	5039
	BG	22	256	278	8613	3629
	SI	81	424	505	21445	5511
	HU	93	441	534	18009	4839
	RO	39	497	536	8134	3910
	CZ	66	555	621	17772	4953
	PL	141	819	960	15617	4824
	LU	30	165	195	17325	6263
	IE	302	677	979	20134	7455
	FI	248	940	1188	23554	7872
	PT	248	1010	1258	14617	5960
	DK	419	945	1364	17138	7757
	AT	334	1292	1626	18478	7682
	EL	253	1408	1661	13167	7211
EU15	SE	366	1429	1795	22372	8948
	BE	478	2138	2616	26598	7786
	NL	945	2757	3702	21267	8462
	FR	1250	3967	5217	20033	8724
	IT	1178	4268	5446	17156	7503
	ES	1675	4283	5958	16199	7185
	DE	1544	5725	7269	23524	9757
	UK	2696	4740	7436	17549	8952

Source: Authors' calculations based on eCORDA.

The analysis of success rates seems to confirm the above. Overall Estonia's success rate (Figure 1) is quite high in EU13 comparison being 13%, whereas Malta has the highest success rate of

14% compared to top-level countries in the EU (France, Belgium, Luxemburg 18%). If one looks at the project partnerships, the most successful country from EU13 has been Slovakia with 17%; Estonia has a rate of 14% here. Estonia has quite a high success rate in projects where it has the coordinating role (11%). Among EU13 countries, only Malta has a higher success rate (12%). It is still lower compared to EU15 nations' top levels, the Netherlands, UK, Austria, and Belgium (15%).

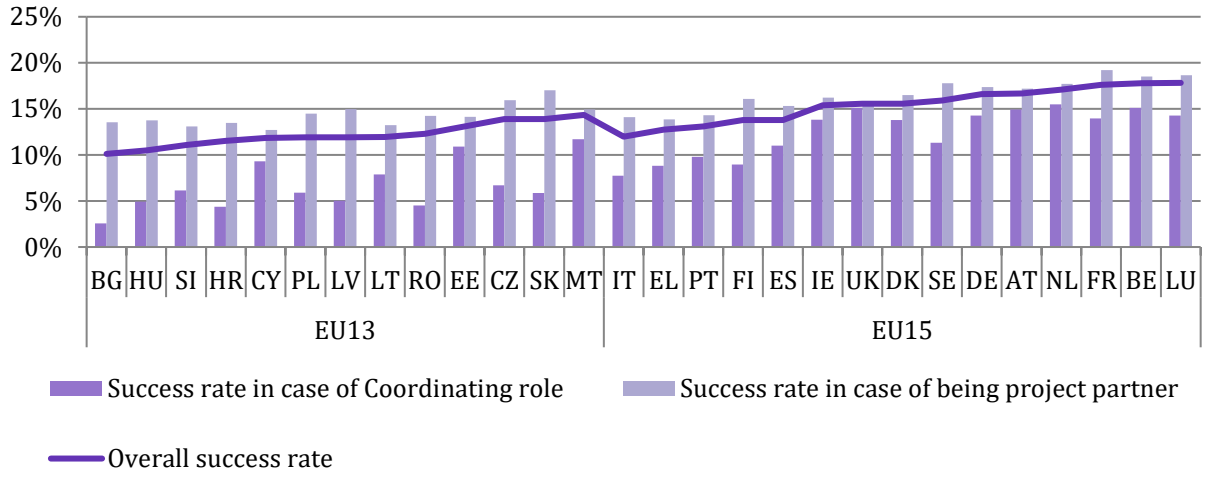


Figure 1. Success rates in H2020 by coordinating and partner roles. Source: Authors' calculations based on eCORDA.

However, as visible from Figure 2. Average EC contribution per project by coordinating and partner roles. Source: Ukrainski et al. (2017, 33). Figure 2 only relatively few strong applications have been handed in. As Ukrainski et al. (2017) point out, the relevance of coordinating roles is recognized rather in longer and more enduring benefits, such as in the continuance of the networks, where coordinators play key roles, because there are relatively few of them and they are most influential in selecting the project members. As larger countries possess higher levels of inter-country collaboration partners, their role as coordinators is reinforced.[4]

[4] Commission analysis of September 2011, at the request of the Polish Presidency, see http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%2014728%202011%20INIT.

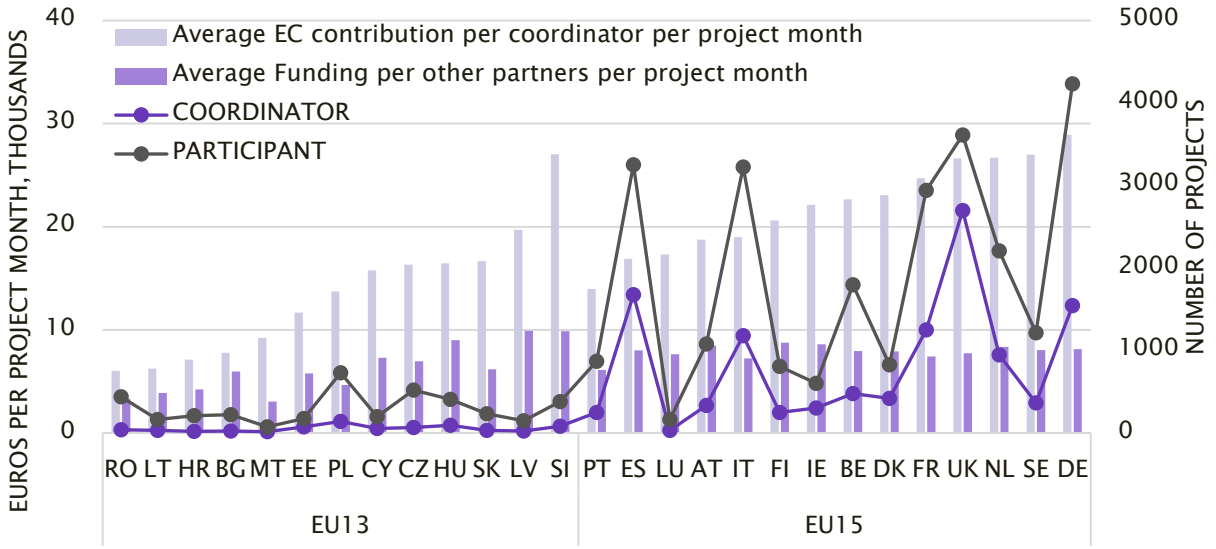


Figure 2. Average EC contribution per project by coordinating and partner roles. Source: Ukrainski et al. (2017, 33).

Thematically[5], EU13 countries have larger shares of projects in the Societal Challenge and SEWP pillars and fewer in the Excellent Science pillar (Table 5). Here Estonia follows quite a general pattern, with almost half (48.7%) of all projects belonging to the Societal Challenge pillar. The second largest component is Industrial Leadership (21.3%), and third is Excellent Science (18.4%). In pillars with a smaller number of projects, Estonia has 6.7% in SEWP, 3.4% in Science with and for Society and 1.5% in other thematic pillars. This relatively low number of SEWP projects (18 out of 267) might explain why the Estonian researchers we have interviewed consider SEWP instruments not to be relevant for them or to contradict to some extent the excellence-driven logic, but also not to be sustainable in the long run.

In financial terms, the proportions of projects seem quite similar, where Societal Challenge projects receive 40.9% from the total EC contribution to Estonia (Table 5). The second largest category is the Industrial Leadership pillar (20.3%), and the third largest is SEWP (19.4%). The projects of Excellence Science amount to 15.8% of the total, Science with and for Society to 2.7% and other topics 1%.

[5] Here, the division of thematic priorities (called also thematic pillars) is constructed following the HLG suggestion based on priorities and budget allocations: https://ec.europa.eu/research/evaluations/pdf/hlg_issue_papers.pdf.

Table 5. Overview of the number of projects by thematic priorities and countries

Country Group	Country	Excellent Science	Industrial Leader-ship	Societal Challenges	SEWP	Science with and for Society	Other	Grand Total
	MT	22	22	40	5	7	-	96
	LV	21	31	110	9	2	4	177
	LT	34	44	99	3	8	15	203
	HR	37	31	156	11	6	6	247
	CY	67	48	111	17	14	3	260
	EE	**49**	**57**	**130**	**18**	**9**	**4**	**267**
EU13	SK	57	53	135	10	5	13	273
	BG	61	45	142	12	10	8	278
	SI	76	128	248	21	10	22	505
	HU	116	102	261	22	15	18	534
	RO	78	137	282	15	8	16	536
	CZ	156	142	246	11	15	51	621
	PL	219	264	413	18	24	22	960
	LU	30	60	93	7	5	0	195
	IE	306	237	410	3	12	11	979
	FI	290	316	517	11	13	41	1188
	PT	308	309	570	41	16	14	1258
	DK	468	231	636	7	16	6	1364
	AT	391	425	737	18	41	14	1626
	EL	365	476	760	5	35	20	1661
EU15	SE	512	379	831	12	11	50	1795
	BE	555	597	1326	13	33	91	2616
	NL	1190	690	1686	22	43	71	3702
	FR	1606	1342	2013	19	37	194	5211
	IT	1267	1508	2498	34	51	88	5446
	ES	1389	1718	2657	13	63	118	5958
	DE	2110	2033	2840	61	65	160	7269
	UK	3241	1301	2621	42	60	171	7436

Source: Authors' calculations based on ECORDA

Table 6. Overview of the EC contribution by thematic priorities and countries, million EUR

Country Group	Country	Excellent Science	Industrial Leadership	Societal Challenges	SEWP	Science with and for Society	Other	Grand Total
	MT	3.97	1.75	8.99	0.97	0.58	0.00	16.27
	LT	4.19	5.52	11.28	0.30	0.98	1.78	24.05
	HR	8.56	3.18	19.23	4.51	0.78	1.06	37.32
	LV	2.65	5.41	17.43	12.68	0.09	0.38	38.64
	BG	5.94	5.36	18.01	13.86	1.45	0.72	45.34
	SK	8.96	9.09	35.58	14.36	0.32	1.88	70.19
EU13	**EE**	**11.24**	**14.41**	**29.07**	**13.75**	**1.91**	**0.68**	**71.06**
	CY	16.29	11.35	28.51	19.25	2.35	0.39	78.15
	RO	12.73	15.97	51.32	5.97	0.78	2.85	89.62
	SI	16.03	36.20	66.17	15.43	1.34	8.35	143.53
	HU	43.40	21.79	49.68	22.47	2.66	4.03	144.03
	CZ	54.01	29.59	51.99	10.49	2.93	10.81	159.81
	PL	64.34	54.70	81.90	10.19	3.95	4.88	219.96
	LU	13.07	18.68	25.76	1.06	0.71	0.00	59.29
	PT	110.98	85.97	153.83	27.39	2.41	5.88	386.46
	IE	145.32	97.43	164.66	0.79	3.29	7.98	419.47
	FI	149.02	115.73	217.10	1.70	3.05	14.18	500.78
	EL	107.28	150.89	229.21	0.88	6.28	7.07	501.61
	DK	235.98	80.18	257.86	1.66	3.79	2.55	582.02
	AT	211.63	155.91	261.38	4.08	10.88	6.65	650.53
EU15	SE	283.55	149.23	363.79	5.63	3.19	17.77	823.16
	BE	281.37	265.65	441.45	2.25	11.67	32.44	1124.46
	NL	704.32	315.82	773.85	5.23	11.27	33.02	1843.50
	IT	524.13	478.55	853.66	5.90	12.89	65.17	1940.30
	ES	580.77	536.52	925.53	2.45	14.37	41.46	2101.10
	FR	941.41	528.70	873.16	2.78	6.58	88.04	2440.67
	UK	1687.62	536.25	1254.50	18.76	14.27	85.71	3597.11
	DE	1287.77	870.67	1382.54	17.77	18.29	358.43	3935.47

Source: Authors' calculations based on eCORDA

On average, the EU15 countries have a significantly larger share of projects compared to EU13 (27% vs. 19%) and even more in EC contribution (32% vs. 19%). A less apparent dominance can be seen in Industrial Leadership projects (25% vs. 21%) and EC Contribution (22% vs. 17%). In the case of other pillars the average shares are reversed. In the case of Societal Challenges, the EU13 average proportion in projects is bigger (49% vs. 44%) and also with respect to EC

contribution (44% vs. 41%). The greatest differences in proportions occur in the case of SEWP in projects (4% vs. 1%) and EC contribution (15% vs. 1%) in favor of EU13. Also in the case of Science with and for Society there is moderately smaller difference in average proportion of projects (3% vs. 1%) and EC contribution (2% vs. 1%).

3.2. Application activity of Estonian Participants by Type of Organization

Application activity is described below by the following organization types: Higher Education Sector (HES); Research Organizations (REC); Public-sector participants (PUB) including ministries, regional and municipal authorities, but also hospitals etc.; Private for-profit Companies (PRC) including both large companies and SMEs; Other participants (OTH); and those, where the type could not be identified (N/A). Here the basis for international comparison rests on Finland, Sweden, Latvia, and Lithuania. The former two countries seem to have quite a similar archetype of innovation systems regarding reliance on the higher-education sector and business enterprises (OECD 2013), and the latter two are chosen for comparison in the context of path-dependency aspects.

Table 7. Number of Applications in Estonia and other countries

Country					HES					
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EE	229	103	134	123	139	140	131	207	292	147
FI	1066	506	713	457	683	753	601	1244	1393	766
SE	1833	960	1224	865	1350	1355	1005	1754	2100	1296
LV	124	67	82	74	70	86	64	122	208	129
LT	210	93	103	105	129	112	100	166	248	165
					REC					
EE	85	54	46	67	50	53	36	104	110	64
FI	518	286	434	306	373	331	240	501	491	351
SE	645	382	447	427	476	430	288	561	595	468
LV	53	39	29	35	31	43	43	62	85	65
LT	89	41	53	56	68	47	43	73	99	99
					PUB					
EE	32	29	18	20	14	25	18	31	34	44
FI	104	62	62	62	67	92	60	78	93	105
SE	190	116	78	82	111	108	67	118	141	116
LV	17	18	15	14	8	22	9	19	30	37
LT	42	25	12	21	19	19	13	19	37	33
					PRC					
EE	143	98	97	91	110	86	68	267	335	286
FI	568	302	467	401	608	519	345	1017	1150	1149
SE	852	569	660	605	910	799	525	1190	1346	1296

LV	75	55	46	45	62	45	45	132	256	238
LT	106	72	68	56	88	50	36	159	267	240
					OTH					
EE	52	28	20	24	19	122	31	47	47	26
FI	142	83	57	58	54	275	95	72	99	103
SE	241	148	79	63	104	413	110	106	108	101
LV	43	22	18	15	15	60	22	23	39	40
LT	50	47	16	19	21	83	23	30	45	16
					N/A					
EE	20	7	9	5	10	17	7			
FI	260	132	105	195	258	340	151	2	1	1
SE	525	182	196	251	326	420	190		2	1
LV	5	6	4	11	13	5	1			
LT	19	6	21	18	11	6	3			1

Source: Authors' calculations based on eCORDA

First, it has to be noted that the application activity ceased in all countries in 2016 (Table 7), presumably reflecting the experience of low success rates in the early years of H2020. Still, Estonian application activity peaked in the case of higher education, research organizations, public-sector units, but even more remarkably in the case of private firms in 2015. In fact, the number of applications handed in by companies exceeded that of the higher-education sector. This aspect is similar to Latvia and Lithuania but is quite different from Sweden and Finland.

Table 8. Applications of HES per 1000 R&D FTE in Higher Education Sector

	EE	FI	LT	LV	SE
2007	95.18	64.59	28.57	31.97	104.59
2008	43.11	31.69	12.22	17.74	54.54
2009	49.85	43.24	13.79	25.26	64.91
2010	49.90	25.50	13.65	22.53	44.43
2011	50.82	43.10	18.81	20.63	67.47
2012	46.67	46.64	17.19	24.31	62.21
2013	45.96	38.22	15.50	19.77	47.85
2014	66.71	77.59	26.52	38.40	78.27
2015	101.04	89.78	43.23	64.18	98.36
2016*	50.87	49.37	28.76	39.80	60.70

Source: Authors' calculations based on eCORDA and EUROSTAT. Note: * means that the R&D FTE is calculated based on the figures of 2015.

If in the FP7 and early H2020 years, Estonia handed in more applications in absolute numbers than Latvia and Lithuania, then in 2016, these countries had caught up and even surpassed Estonia (Lithuania in the HES, Latvia in the OTH and both in the REC categories). It has been

argued by Ukrainski et al. (2017) that Estonia's relative success compared to other EU13 countries is conditioned (at least partly) by its relatively high application activity. Indeed, the application activity in the higher-education sector has been very high compared to Latvia and Lithuania, and quite similar to Sweden (Table 8).

Table 9. Applications of PRC per 1000 R&D FTE in Business Enterprise and Private Non-Profit Sectors

	EE	FI	LT	LV	SE
2007	78.83	17.52	49.07	79.53	15.62
2008	50.26	8.99	37.04	44.68	9.64
2009	47.92	14.24	44.53	44.75	11.81
2010	44.61	12.88	27.07	35.71	11.03
2011	49.71	19.12	42.21	71.26	16.53
2012	41.33	16.45	28.23	50.85	14.23
2013	31.53	11.15	14.99	45.87	9.25
2014	140.97	33.66	48.08	95.51	20.64
2015	186.94	37.91	101.52	223.58	22.84
2016*	159.60	37.88	91.25	207.86	21.99

Source: Authors' calculations based on eCORDA and EUROSTAT. Note: * means that the R&D FTE is calculated based on the figures of 2015.

Table 10. Applications of PUB and RECs per 1000 R&D FTE in Government Sector

	EE	FI	LT	LV	SE
2007	149.62	84.91	44.11	51.06	256.69
2008	111.11	48.86	22.37	37.35	169.56
2009	89.14	73.08	22.12	36.33	201.54
2010	112.69	53.83	30.15	48.13	163.67
2011	82.47	63.94	39.03	33.36	173.26
2012	100.78	66.51	30.97	55.56	160.17
2013	63.45	47.48	25.15	44.14	110.35
2014	168.75	98.47	41.37	68.64	199.47
2015	184.14	129.23	63.08	97.13	173.83
2016*	138.11	100.91	61.22	86.15	137.93

Source: Authors' calculations based on eCORDA and EUROSTAT

In the case of companies, it has to be noted that Estonia, Latvia, and Lithuania have relatively low levels of R&D employment in international comparison. Recognizing this evidence, the relatively high application activity is not surprising (Table 9). However, the dynamics regarding very rapid growth in all Baltic countries in H2020 seems very positive regarding the innovation

orientation of the H2020 program. However, the need to increase the R&D capabilities of business-sector firms seems to matter.

The activity level of public-sector institutions in Estonia is above those of other Baltic countries and Finland, and relatively similar to Sweden in H2020 (Table 10). However, again, as in the case of PRC, R&D employment is the lowest among the observed countries (the max number in FTEs was 851 in 2013).

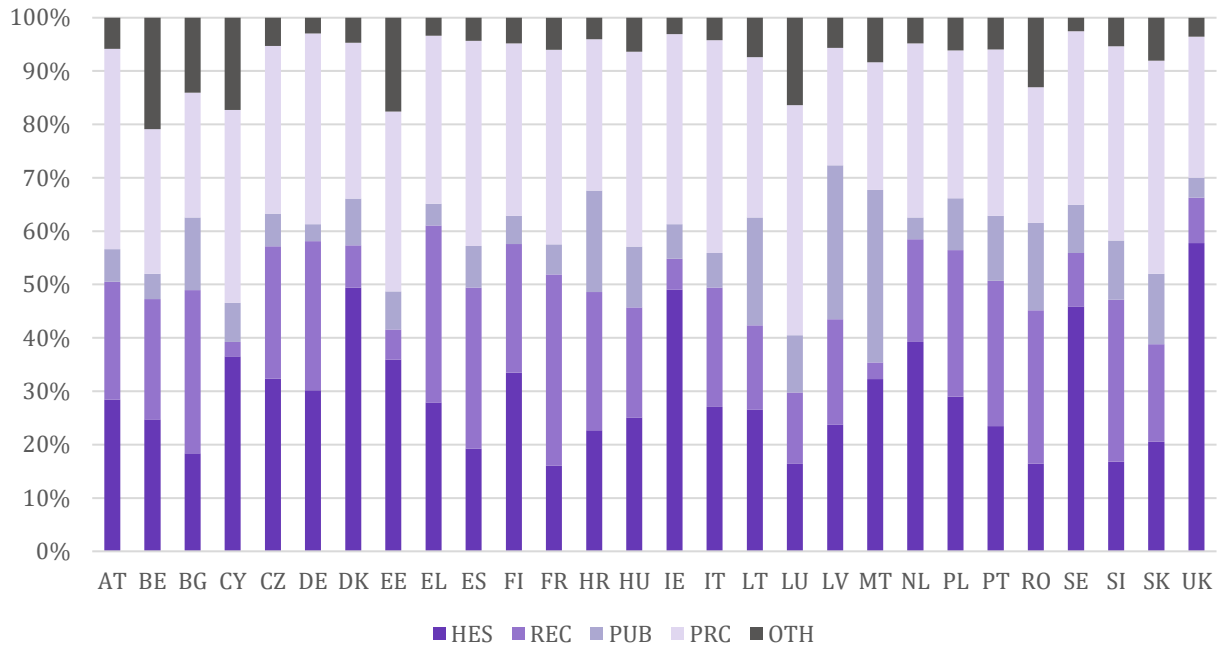


Figure 3. Distribution of participants in H2020 by type of organization. Source: Authors' calculations by eCORDA.

Considering the proportions of different types of organizations, Estonia is quite similar to other advanced small countries in the EU in terms of HES (Netherlands, Finland). However, the share of PRC is lower, which is clearly related to the smallness (as the research system cannot be as large incorporating many PRCs, similarly to Malta and Cyprus). The share of firms is also quite similar to successful countries, but here it has to be said that this is because of the SME instrument (involving single companies with small projects). Estonia has quite a large proportion in the OTH category, but here some public agencies can be found as ETAg, so to some extent it overlaps with the PUB category.

3.3. Application Experience in Different Types of (Thematic) Instruments

As described in the previous sub-chapters, the relative success and activity level have been quite high in EU13 comparison. If we attempt to compare the dynamics of the quality of the

proposals, we use the average share of grades given to the applications with Estonian participants from the maximum grade received in specific instruments.

Ideally, we would also like to assess the quality of the applications above the threshold, but since in different instruments diverging grading scales, as well as thresholds, are used (which is not public information), we use the average of all applications. If we take a look at thematic instruments (see Annex 10), we understand that during FP7 the quality of applications was very diverse, and it has surely converged in H2020, but the bulk of fields concentrate in average grades within the range of 0.6-0.8 of the maximum grade obtained. In many fields, the average grades of applications dropped from FP7 to H2020 (except for SEWP), but in many important areas for Estonia (Societal Challenges, Excellence Science, LEIT, and SME innovation), the average grades have moved upwards, which could imply some "learning effects". The fields where the quality of applications has been shallow are related to transport topics, but also the fields that could not be incorporated under any thematic fields.

Leaving aside the thematic distribution and success rates, which seem to reflect relatively successful experience in H2020, the in-depth picture on different instruments shows somewhat contradictory results. It seems that the new instruments are more complex and require more participants outside the business and academic sectors, but also financial commitment on behalf of the beneficiary (EC contribution varies highly, ranging between 20%, 33%, 50% and 100% in the case of different instruments), which is also reflected in Annex 1.

Annex 11 describes the success rates by action types, whereby the upper part of the table reflects the EU13 countries and the lower part the EU15 countries. The advantages and disadvantages in success rates are color-coded, where the darker color reflects stronger advantage (in green-colored cells) and disadvantage (in red-colored cells). A first glance at Annex 11 shows many white cells in the case of EU13 (Estonia included), implying that these countries do not even apply in many instruments. This is evident because of the mix of failures on the organizational level (related to the capability problems), but also systemic level (no strategic aims and decisions with funding commitments pointing to ESIF complementarity issue). For example, PPI and Cofund-PPI (which are the instruments not used by EU13 countries) require the highest own contribution financially (80%), but on the other hand, they require the co-application by at least two procurers from different countries (Appendix 1). Similar cooperation is required by Joint Technology Initiative (JTI) partnerships, which are also rarely used or show strong disadvantage in applications from EU13 countries. The white and red areas of ERC instruments also show no use or disadvantage for EU13 countries (mainly in capabilities of individual or organizational actors of science systems). Similar disadvantages in

all EU countries seem to prevail in MSCA and SME instruments and similar advantages in ERA-NET and EJP Cofund activities.

Table 11. Overview of Estonian participation in H2020

Pillars and Specific Objectives	Number of Projects	EC Contribution MEUR
Excellent Science	**49**	**11.24**
European Research Council (ERC)	2	3.50
Future and Emerging Technologies (FET)	1	0.36
Marie Sklodowska-Curie actions (MSCA)	30	5.61
Research infrastructures (INFRA)	16	1.78
Industrial Leadership	**57**	**14.41**
Innovation in SMEs (SME)	13	0.23
Leadership in enabling and industrial technologies (LEIT)	44	14.18
Societal Challenges	**130**	**29.07**
Climate action, environment, resource efficiency and raw materials (ENV)	15	2.78
Europe in a changing world – inclusive, innovative and reflective Societies (SOCIETY)	19	4.42
Food security, sustainable agriculture and forestry, marine and maritime and inland water research (FOOD)	19	2.83
Health, demographic change and wellbeing (HEALTH)	17	3.81
Secure societies – Protecting freedom and security of Europe and its citizens (SECURITY)	12	1.91
Secure, clean and efficient energy (ENERGY)	35	11.90
Smart, green and integrated transport (TPT)	13	1.42
Spreading excellence and widening participation	**18**	**13.75**
ERA chairs (ERA)	4	9.70
Teaming of excellent research institutions and low performing RDI regions (WIDESPREAD)	5	0.51
Transnational networks of National Contact Points (NCPNET)	1	0.04
Twinning of research institutions (TWINNING)	8	3.49
Science with and for Society	**9**	**1.91**
Develop the governance for the advancement of responsible research and innovation (GOV)	3	0.29
Integrate society in science and innovation (INEGSOC)	1	0.16
Make scientific and technological careers attractive for young people (CAREER)	3	1.15
Promote gender equality in research and innovation (GENDEREQ)	2	0.32
Grand Total	**263**	**70.38**

Source: Authors' calculations based on eCORDA

The overview of Estonian participation shows that Estonia follows a pattern quite similar to other EU13 countries, where the Societal Challenges dominate with the participants having the

most experience in that area. In some relevant new instruments (e.g. FET, ERC, but generally also in SWFOS), there are only very few projects and the knowledge and experience is small.

3.4. Main findings

- The application activity of Estonian actors is high and quite comparable to the best countries in the geographical proximity region (Nordic and Baltic). However, our interviews have shown that the FP-related activities are sometimes limited to a handful of stronger research groups, which are already operating at their capacity limits. Therefore, for expanding the integration with ERA, the wider and increased domestic capabilities regarding international cooperation in higher education, business and public sectors seem necessary.
- Estonian experience seems to be successful regarding coordinated projects, which is not typical of EU13 countries.
- Thematically Estonia is quite similar to other EU13 countries for whom the pillar of Societal Challenges is relatively more relevant following Industrial Leadership, SEWP and Excellent Science. In the last two pillars, the differences between the shares based on the number of projects and EC contribution are the largest. In the case of SEWP, relatively fewer projects bring along higher EC contribution, and the reverse is true for Excellent Science, pointing to a relatively larger impact of lower unit prices of research in EU13.
- Regarding the instrument types, it seems that success rests more on bottom-up (or horizontal) instruments, such as mono-beneficiary instruments (SME), research and innovation actions in the Societal Challenges and Excellent Science pillar. In more complex ones (e.g. requiring actors from different sectors or different countries) no applications or weaker success rates were identified in Estonia, as is generally true for EU13.
- This result points towards both weaknesses in the individual capabilities of actors and systemic failures in leveraging, e.g., ESIF, but also in cooperating with (public-sector) partners internationally.

4. Estonian experience from FP7 and H2020: Partners and Networks

4.1. Networks and Partners by Countries

A recent review on H2020 commissioned by the EC revealed that the co-publication networks within the EU have remained quite stable between FP7 and H2020 (despite the lower number of publications in the last FP).[6] Larger and more R&D-intensive countries share more frequent collaborations compared to the smaller countries, which tend to cooperate with each other and at least one of the R&D intensive country. Germany, the Netherlands and the UK, which formed a cooperation "cluster" in FP7, expanded their networks towards Belgium and France in H2020 (**Error! Reference source not found.**). Spain and Italy formed another cluster, which broadened t o smaller MSs like Cyprus, Romania, Croatia and Greece. The Nordic countries and Ireland formed a separate group in FP7, which extended more towards Eastern European nations (including Estonia) in H2020.

When looking at the project-based cooperation in FPs, the top Estonian partnerships (if calculated based on the number of cooperations in projects) have also stayed relatively stable between FP7 and H2020. Estonia cooperates most frequently with Denmark, the UK, Italy, Spain and the Netherlands. Belgian cooperation has increased, as well as Portuguese cooperation. Among the Nordic countries, Finnish alliances have been stable, but Swedish ones have decreased substantially in H2020. The decrease is also visible in the case of France but also other EU13 countries (especially Hungary, Romania and Slovenia). Estonian cooperation with domestic partners within FP projects has also decreased in H2020 compared to FP7 (Figure 4).

[6] European Commission (2017b, 216-217) based on an Elsevier study of FP7 and Horizon 2020 publications.

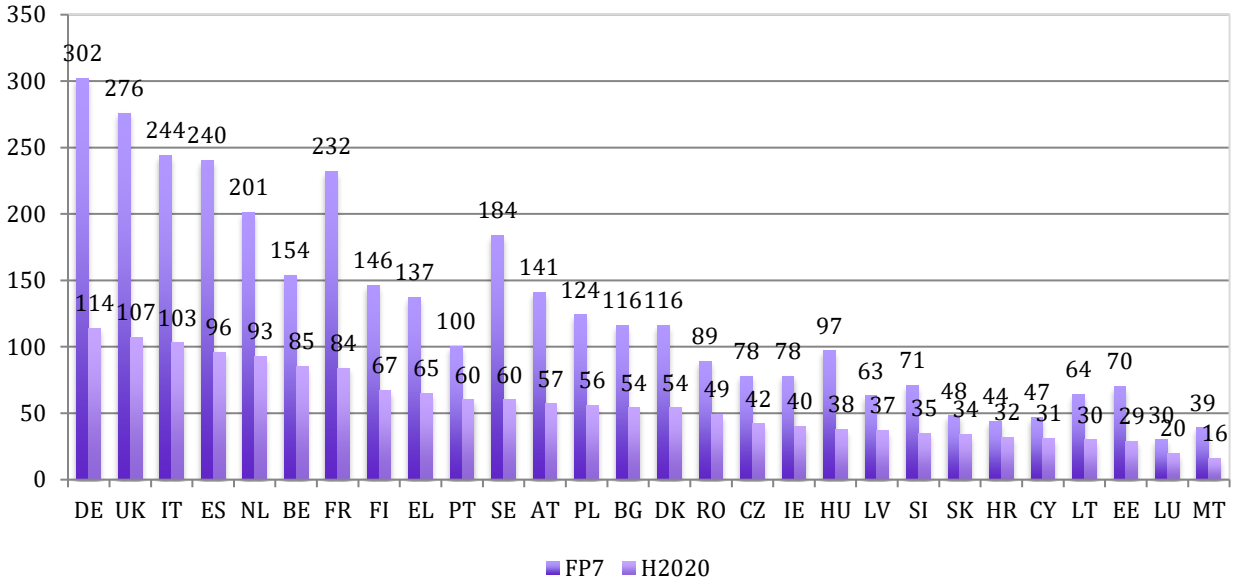


Figure 4. Number of Estonian cooperations by partner countries in FP7 and H2020 projects. Source: Authors' calculations based on eCORDA. Note: Estonian cooperation numbers denote the projects where the number of partners from Estonia is more than 1.

Overall, Estonia had 3480 partnerships in FP7 and 1559 in H2020. The color-coded matrices in Annex 2 and 3 reflect that the cooperation patterns are quite homogeneously distributed in both FPs. As expected, the smaller number of partnerships is formed with small member states and EU13 countries.

4.2. Participations by Types of Organizations

The following tables describe the distribution of organizations in FP7 and H2020 by country groups. It is visible that the share of private companies (PRC) has increased in EU13, EU15, and other countries as well, but in the case of Estonia, the proportion has remained at 35% in both programs. Estonia has been remarkably stable, i.e. only the research institutions (REC) have decreased, and higher education (HES) and the public sector (PUB) have grown. It certainly reflects the changing nature of H2020 described in the first chapter, but also ongoing structural changes in the Estonian research system towards strengthening the higher-education institutions.

It is interesting to note that in the EU13 group, public-sector actors have higher shares among participants, and this percentage has increased between FP7 and H2020 from 8% to 12%. In the

Estonian case, the category OTH seems overwhelming, which can reflect partly disguised public participation via agencies.

Table 12. Distribution of partnering organizations by types based on the number of participation

Program	FP7				H2020			
Country/Organization	Other	EU13	EU15	**EE**	Other	EU13	EU15	**EE**
HES	43%	34%	37%	**33%**	40%	27%	33%	**37%**
REC	24%	25%	25%	**10%**	19%	22%	23%	**6%**
PUB	8%	8%	4%	**5%**	10%	12%	5%	**7%**
PRC	22%	29%	32%	**35%**	27%	31%	34%	**35%**
OTH	3%	4%	3%	**16%**	4%	8%	5%	**16%**

Source: Authors' calculations based on eCORDA

The universities were afraid that the new innovation-oriented agenda would hit them most, which seems somewhat true in case of both EU15 and EU13 countries, but not in the case of Estonia. The shares calculated by EC contribution reflect more considerable dominance of HES actors (Table 13), and as the industry is SME-dominated; their share in funding is substantially lower, and their share in participation numbers has increased somewhat.

Table 13. Distribution of partnering organizations by types based on EC contribution

Program	FP7				H2020			
Country/Organization	Other	EU13	EU15	**EE**	Other	EU13	EU15	**EE**
HES	54%	39%	42%	**42%**	50%	32%	37%	**48%**
REC	20%	28%	25%	**36%**	22%	32%	29%	**30%**
PUB	20%	27%	28%	**10%**	20%	23%	27%	**6%**
PRC	2%	2%	2%	**8%**	2%	4%	3%	**6%**
OTH	3%	4%	2%	**4%**	5%	8%	4%	**10%**

Source: Authors' calculations based on eCORDA

The analysis of cooperation partners in different action types (Annexes 12 and 13) shows that HES actors are more active in CSA (together with the partners from the OTH category), RIA (together with PRC actors) and MSCA actions. PUB actors are involved in CSA, ERA-NET and RIA actions. Private companies are naturally more active in IA and RIA. Still, it is visible that in these action types, Estonian partners are mostly scarce and not among the coordinators of the projects.

Table 14. Participation of Estonian public-sector institutions (PUB) in H2020 projects by pillars

H2020 Pillar	Name of the Institution	Action Type	Number of Projects	EC Contribution
Societal Challenges	Estonian Environment Agency	RIA	1	20,087.5
	Estonian Environmental Inspectorate	CSA	1	34,913.75
	Ministry of the Environment	CSA	1	30,625
		ERA-NET-Cofund	1	109,066
	Ministry of Rural Affairs	ERA-NET-Cofund	4	249,542.76
	Ministry of Economic Affairs and Communications	CSA	2	97,576.25
		IA	1	305,125
		RIA	1	108,750
	Police and Border Guard Board	CSA	1	30,590
		RIA	1	108,200
	Tallinn Environmental Board	CSA	1	99,333
	City of Tallinn	RIA	1	125,000
	City of Tartu	IA	1	5,408,375
	Estonian Maritime Administration	IA	1	100,000
SEWP	Ministry of Economic Affairs and Communications	SGA-CSA	1	36,438
Total			19	6,863,622.26

Source: Authors' calculations based on eCORDA

Among the Estonian public-sector institutions, the most active ones are the Ministry of Economic Affairs and Communications with five participations and the Ministry of Rural Affairs with four participations in H2020 (Table 14). Besides ministries, two larger cities (the City of Tartu in a more substantial project covering EUR 5.4 million) are also participating as partners in the Societal Challenges pillar in IA and RIA action types. Mostly the projects are very tiny, implying that the activities are still an early part of the process and serve to gather experience, rather than being ones with broader impacts.

4.3. International Cooperation Partners by Types of (Thematic) Instruments

The cooperation patterns by thematic fields are described in detail in Annexes 4-8. Brought together (Figure 5) it is fair to say that the partnerships seem to be quite stable across thematic fields – the most frequent cooperation partners seem to come from similar partners across themes. Still it seems that in Societal Challenges, Germany, UK, Spain, and Italy seem to be the most important partners with over 60 partnerships. In Excellent Science, the partnerships have

concentrated on fewer countries – again, Germany, Belgium, the Czech Republic, Bulgaria, and Austria. Industrial Leadership quite closely follows a pattern similar to Societal Challenges, except for France having more cooperation and Spain, Austria, Finland, and Sweden less cooperation. It is interesting to note that here Latvia and Lithuania, but also Poland and Romania seem to be relatively more important. In the case of Science with and for Society, the number of partnerships is smaller, but Italy, Spain, Germany, Cyprus, and Belgium seem to have equal importance. In the case of SEWP, the UK and Denmark seem to be essential partners, but also Estonian partnerships seem relevant in these instruments.

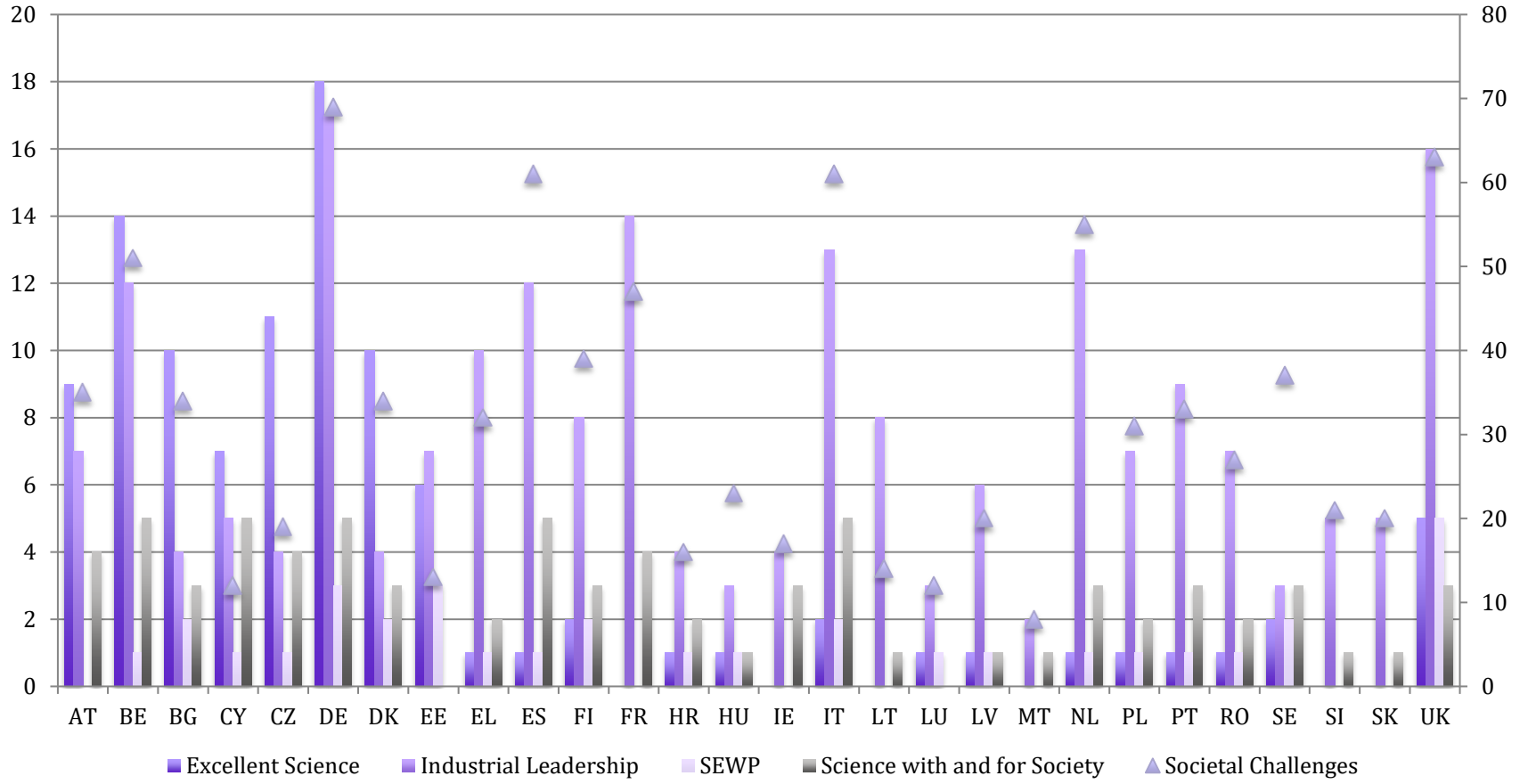


Figure 5. Number of Estonian cooperations by partner countries in H2020 projects (Source: Authors' calculations based on eCORDA). Note: Estonian cooperation numbers denote the projects where the number of partners from Estonia is more than 1; Societal Challenges on the right axis.

Partnerships involving public-sector actors (such as PCP, PPI, different Cofund actions, see also Annex 1) seem to be spread more widely across Europe, and the most frequent partners are from Spain, Finland, Italy, the Netherlands, Sweden, the UK, Denmark, Belgium, and Bulgaria. It is interesting that domestic partnerships among Estonian public offices do not exist (Figure 6).

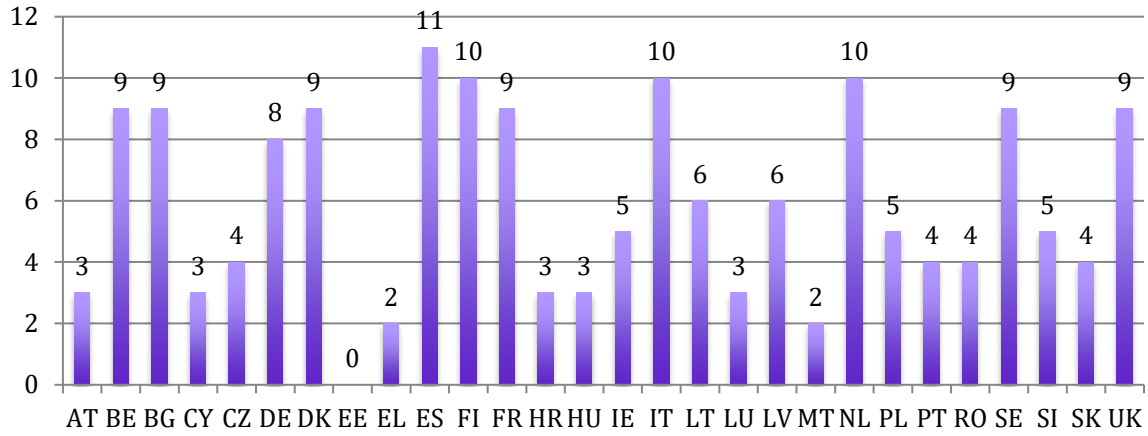


Figure 6. Number of Estonian public-sector cooperations by public-sector partners in H2020 projects. Source: Authors' calculations by eCORDA

By reviewing in a more detailed way the participations of Estonia in joint initiatives (See Annex 14), it is visible that although Estonia is formally participating, there are quite a few projects actually performed under these partnerships (except for only some programs, e.g. BONUS). This implies that the potential of those joint initiatives is not fully used.

4.4. Main findings

- Cooperation patterns are quite similarly and widely distributed in both FPs. As expected, the smaller number of partnerships is formed with small member states and EU13 countries.
- Estonian participation shares point towards more considerable dominance of the higher education sector, which has dynamically strengthened in FPs, the shares of private firms have remained stable, public-sector participation has increased, and research institutes have decreased in importance.
- Still, it is visible that in more complicated action types, Estonian partners are mostly scarce and not among the coordinators of the projects.
- Societal Challenges and Industrial Leadership partnerships are more widely distributed across European countries as well as Science with and for Society (although the last one involves the smaller number of partners).

- Excellent Science projects are concentrated among fewer partners as well as SEWP instruments, and the latter also supports domestic partnerships to a more considerable extent.

5. Estonian experience from FP7 and H2020: Visibility of Collaborative Research

5.1. Methodology

The analysis is based on the Web of Science Database (WoS) by Thomson Reuters, where the articles that have at least one author from Estonia and that have been published between 2008 and 2014 are included. Citations in WoS are the most common measure of visibility among scientists (Wagner 2005; Gonzalez-Brambila et al. 2013; Mali et al. 2016). For determining the FP and other public funding sources, we use the funding acknowledgments section, included in WoS since 2008 (Breschi and Catalini 2010). The publications with group authorship (over 400 authors in WoS) and publications with more than 16 authors are dropped, as the exclusion of highly collaborative papers restricts the analysis to the papers that have a substantial contribution from Estonian authors (Mohallem and da Fonseca 2015).

The FP funding is determined by the acknowledgement field, where it is marked which of the following funding agencies was used: *European Union (EU); European Research Council (ERC); European Community (EC); European Commission Joint Research Centre: European Science Foundation (ESF); European Cooperation in Science and Technology (COST).* For determining public funding, we use *Estonian Science Foundation (ETF, later reorganized into Estonian Research Council)* and *Ministry of Education and Research, Estonia.* If an article got funding from the public sector and also from the EU, we categorize it as "*Both*". A publication that has FA but does not belong to any categories mentioned is defined as "*Other*". This category is too fragmented to bring out precise funding agencies. It mostly contains different foreign funding agencies like *Wellcome Trust* or *Academy of Finland* etc. Unfortunately, this category may also include EU collaboration if a funding agency was not on our EU-affiliated funding agencies list.

For five types of FAs (without FA; Public; FP; Both; Other) different measurement variables were calculated: percentile in the subject area; the portion of articles in the first quartile, the portion of items with international and domestic collaboration; the journal impact factor; and the number of authors. The percentile in the subject area in which the paper ranks in its category, document type and database year is based on total citations received by the article. The higher the number of citations, the smaller the percentile number. The maximum percentile value is 100, indicating 0 quotes received. In the context of this paper, we can define it as the distance from the top. Percentile in the subject area as a measurement of visibility (dependent variable) is preferred to category or journal normalized citation impact because it is less sensitive to outliers. Domestic and international collaboration is based on the article's address section. If there is some other country's address in addition to Estonia, we understand

it as a product of international collaboration, and if there are two domestic addresses in the addresses section, we read it as a domestic collaboration. Statistical analysis was conducted using Stata 14.1 and IBM SPSS 23 (including the comparison of the means (Welch's t-test), and a decision-tree analysis).

5.2. Dynamics of Articles and by Funding Sources

EU funding is seen as one pre-requisite for international collaboration leading to more comprehensive visibility, but also ensuring the high international co-publication rates which characterize small countries in Europe (Ukrainski et al. 2014). It is evident that international co-publication rates have grown faster than the general number of publications in WoS, considering here also the exclusion of group-authorship data from the sample (Figure 7). Internationally co-published papers amounted to around 45% of all WoS articles with Estonian authors in 2008, and by 2014, this share had increased to roughly 55%. During this period 10,826 publications were included in our analysis.

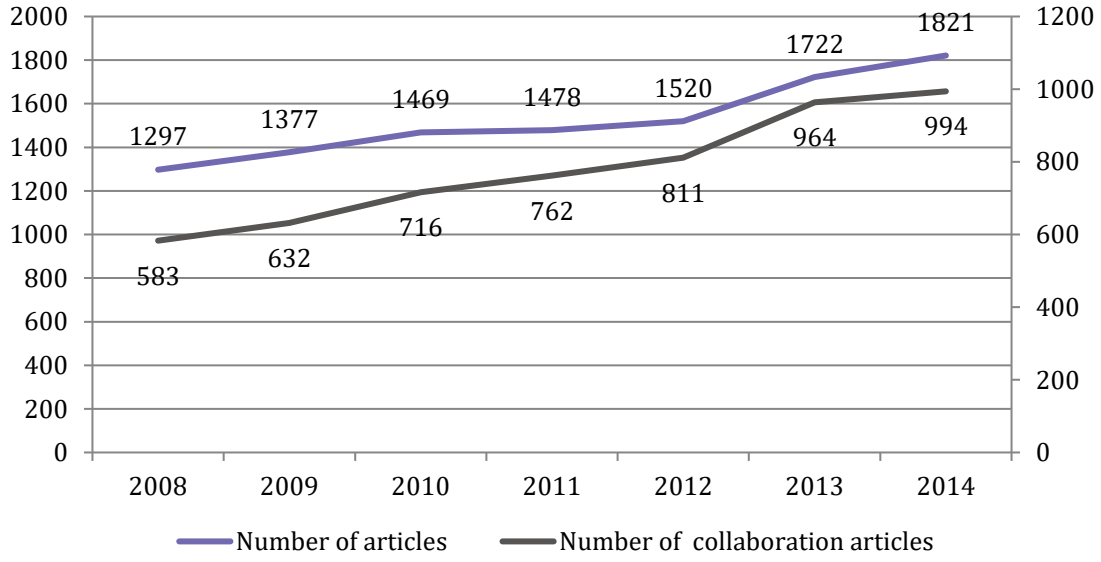


Figure 7. Number of articles in 2008-2014. Source: Authors' calculations based on WoS

In 2008, the proportion of articles without FA has decreased substantially, this decline of 27 percentage points could be associated with different events: changes in national reporting regulations demanding the FA notion, but also a more extensive awareness increase (the FA section was introduced in WoS in 2008) and a spread of project-based funding instruments more generally. In later years, funding types have stayed relatively stable, and therefore we consider in the further study the articles published in 2009-2014.

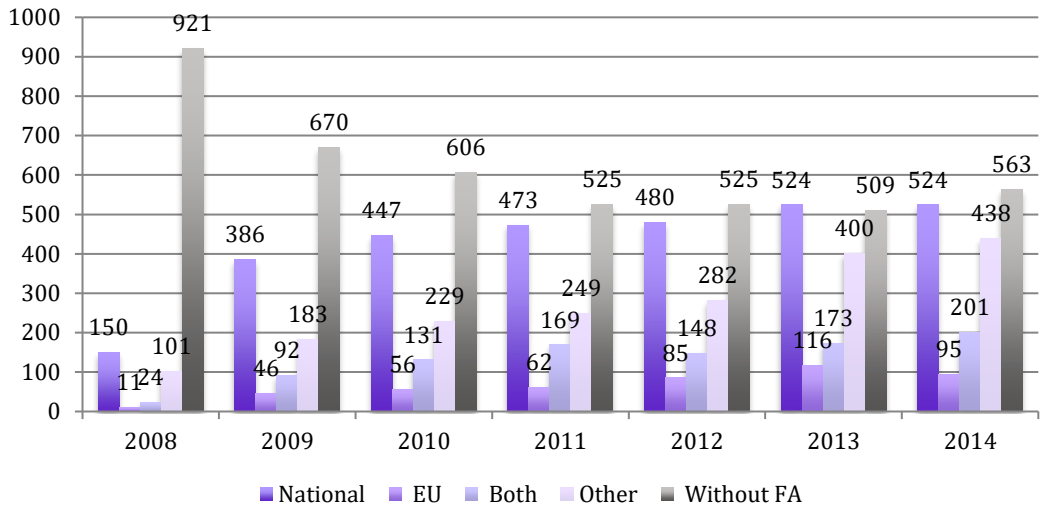


Figure 8. Number of articles by funding source in 2009-2014. Source: Authors' calculations

There are substantial differences among research areas concerning funding recognition. Natural Sciences have the most significant percentages of articles with FA and Social Sciences the smallest fraction. As the coverage of Social Sciences is lowest in WoS, we drop these science fields from our study here.

Table 15. Sample description by fields of science in 2009-2014

Field of Science	Indicator	No FA	National	FP	Both	Other	Total
Technology & Engineering	N	268	294	27	53	151	793
	% of the funding type	33.80	37.07	3.40	6.68	19.04	100.0
Natural Sciences	N	1102	493	96	215	354	2260
	% of the funding type	48.76	21.81	4.25	9.51	15.66	100.0
Health	N	1044	1993	319	639	1164	5159
	% of the funding type	20.24	38.63	6.18	12.39	22.56	100.0
Total	N	2414	2780	442	907	1669	8212
	% of the sample	29.40	33.85	5.38	11.04	20.32	100.0

Source: Authors' calculation based on WoS

Overall, the sample has 8212 articles, where 29.4% did not have any FA, which is similar to other countries (e.g. Spain 33%, see Morillo 2016). After the exclusion of Social Sciences, the sample is divided into research areas in the following way: 62.8% Natural Sciences; 27.5% Health; and 9.7% Engineering and Technology. The most abundant groups of articles have national FA, are without or other funding FA. 5.38% recognize funding from FP, and 11.04% from both national and FP sources.

5.3. Difference in Visibility of Articles by Sources of Funding

Remarkable differences (as tested by the Welch test using 0.05 significance level) exist in the visibility of the articles with different funding acknowledgments. In all research areas, the least visible articles are without FA, but those with FP acknowledgment only yield the highest visibility. FP-funded articles rank on average twelve percentiles higher in citations compared to nationally funded items. Articles with both (national and FP) acknowledgements are more similar to nationally financed ones regarding visibility. At the same time, the number of first-quartile articles is highest.

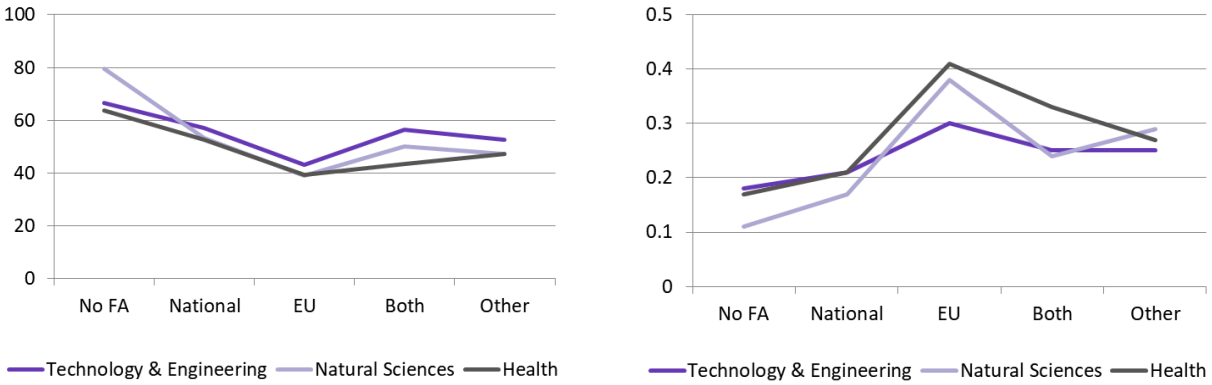


Figure 9. Mean values of percentile ranks of cited articles (left) and first-quartile article shares based on citation (right). Source: Authors' calculations

Articles with FP acknowledgment are generally compiled in international collaboration, but it is interesting to note that only in Natural Sciences, this has the highest share, but in Medicine and Engineering & Technology fields, other funding sources (private sector, other international etc.) support similarly or even to a higher degree international co-publications. Domestic cooperation seems quite different – in the case of Medicine, FP funding seems also to support domestic cooperation (in combination with national funding), but less so in Natural Science, where the combination of national and FP acknowledgment is highest and not at all in Engineering & Technology (still some support in combination with national funding).

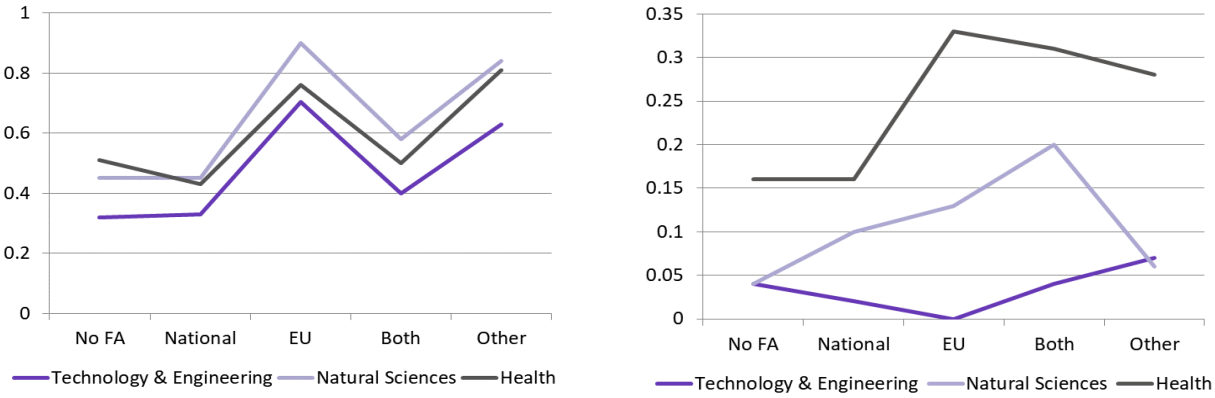


Figure 10. International (left) and national (right) collaboration proportion of total number of publications in the field. Source: Authors' calculations.

Articles funded by the FP tend to be published in journals with a greater impact factor, but they also tend to include a greater number of collaborators (the number of authors is enhanced especially in the case of Engineering & Technology).

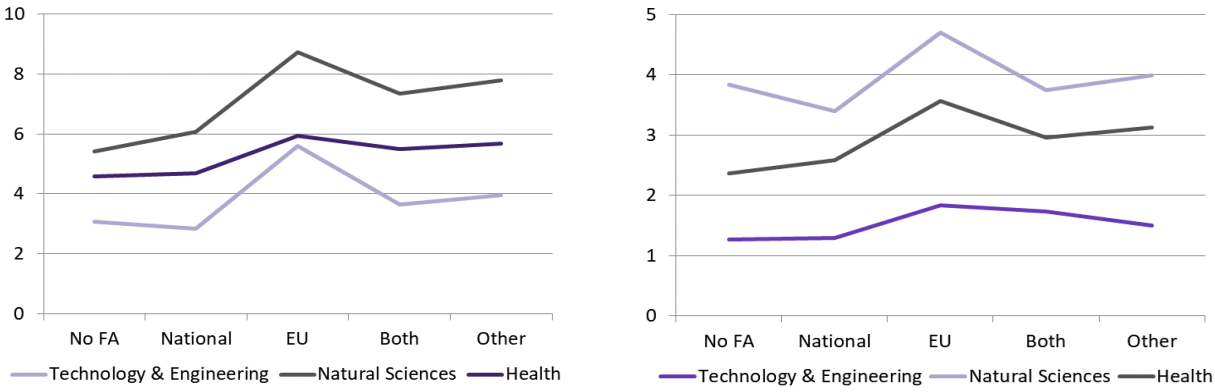


Figure 11. Mean number of authors (left) and mean journal impact factor (right). Source: Authors' calculations

For illustrating the research visibility across FA types, a decision tree was formed to explore which input variables affect the percentile in the science field (dependent variable). The categorical response variables we consider are funding type and international (as opposed to national) collaboration as explanatory variables. For generating the tree, we use CHAID technique[7] and a significance level of 0.05 for splitting and merging decisions. The presented

[7] Chi-square automatic interaction detection (CHAID) is a decision-tree technique that is based on adjusted significance testing (Bonferroni testing). It performs multi-level splits when computing classification trees.

decision tree is inclined towards Natural Sciences (which is also the largest research area in the sample).

As we can see from the decision tree (Figure 12), the best possible combination maximizing research visibility is to use FP funding with an international co-authorship network. FP-funded internationally collaborated articles (percentile in subject area 38.2) are eight percentiles higher in citations (reverse scale) than nationally funded international collaboration articles (46.5) and four percentiles higher than articles that got funding from both sources (42.7).

It suggests that the EU funding can help Estonia to receive substantially higher visibility of science in a collaborative international environment than otherwise possible. The FP effect is somewhat different when we look at articles with national co-authorship. Then visibility does not differ when comparing FP and national public funding, but a combination of both improves visibility significantly. A possible reason may be that there is a small number of FP funded articles without international collaboration. Still, FP-funded papers published in the national (co-)authorship[8] network are 20.6 percentiles lower compared to internationally co-authored papers.

[8] Only about 1/12 of all articles were written by single authors.

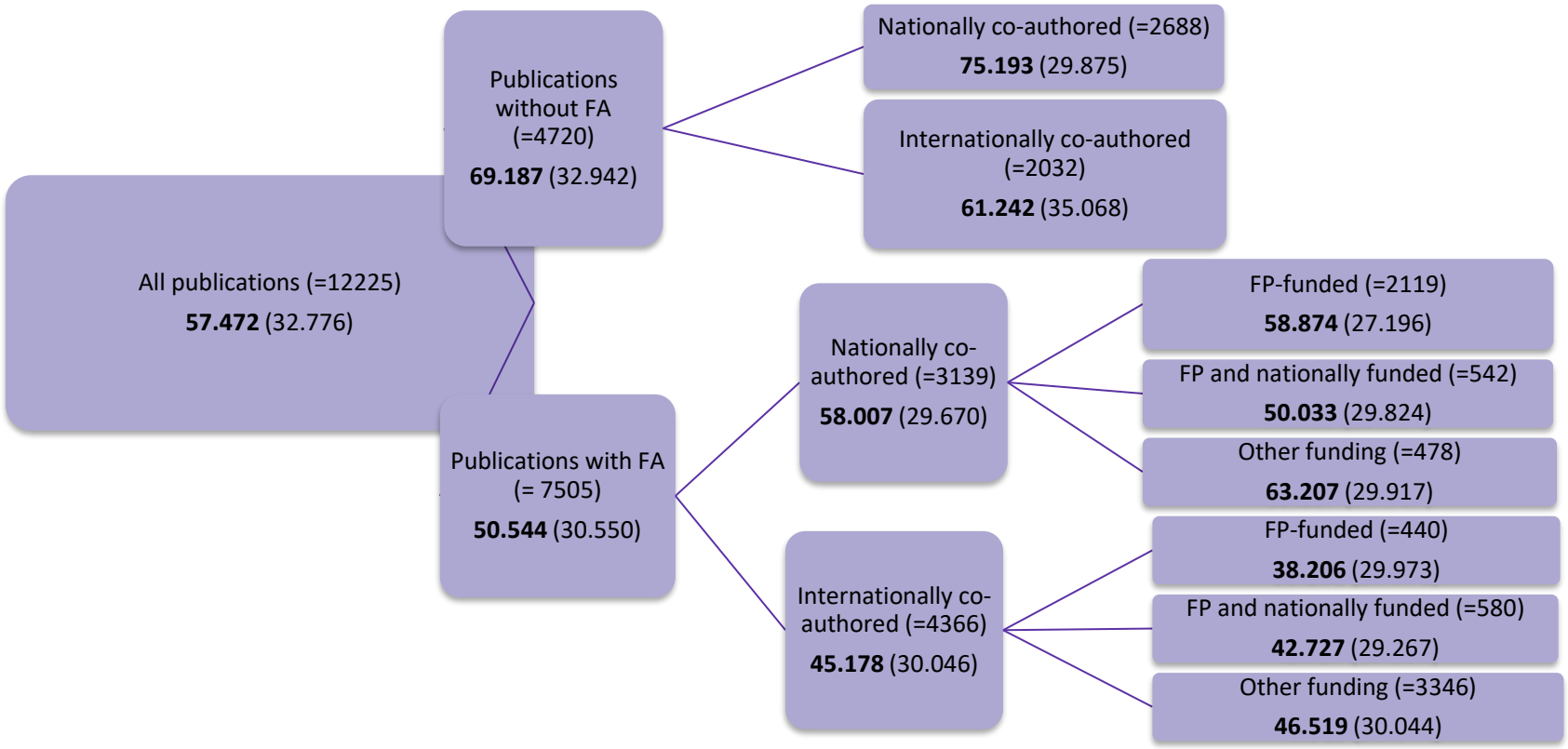


Figure 12. Decision tree (CRT) of the percentile in the subject area by funding types and international collaboration in 2009-2014
Source: Authors' calculation

However, the pretty large standard deviations show that funding sources alone are not the best predictors of research visibility because of a significant variance of percentiles in subject areas. However, the CRT analysis showed statistically significant differences in all models separating different publication types.

5.4. Main findings

- Funding sources alone are not the best predictors of research visibility because of a significant variance in results, but the average citations are still significantly higher.
- FP-funded publications are above the performance levels regarding citation compared to other publications, they even have higher citation impacts compared to the ones funded by the Estonian Research Council. This result is not unique but has also been shown in cases of other small countries (e.g. Denmark). Thus Estonian researchers benefit from FP participation regarding research impact.
- FP helps to create international research (publishing) networks for Estonian researchers; FP-linked articles have higher average numbers of international co-authors in all fields of science.
- In some science fields (Medicine and Natural Sciences), FP funding also supports larger numbers of domestic co-authors, in the latter case in combination with national public funding. The FP thus benefits researchers in setting up international and sometimes even local research networks.

6. Estimation of Estonian Potential in Participation of FP7 and H2020

6.1. Methodology

Previous analysis has shown the relative success of Estonia in comparison with other EU13 countries in both FP7 and H2020. The question how this is achieved in comparison to other countries is still not answered, as this success could be based on higher inputs (applications, investments, etc.), but also could be due to some other reason, such as a favorable position within the EU countries. It is claimed by some earlier studies that Estonia uses an "alibi" position among small member states (see Figure 13), implying "*Favourable position, either by their location (BE) or thanks to a alibi position project leaders believe that evaluators will have sympathy if they involve partners from small EU13 countries (MT, EE, LT, LV, SI).*" (MIRRIS 2014a, Part I: 7). This could be adequate, assuming that these countries do not invest enough into research and enjoy some advantage making them very efficient in acquiring EC contributions for R&D.

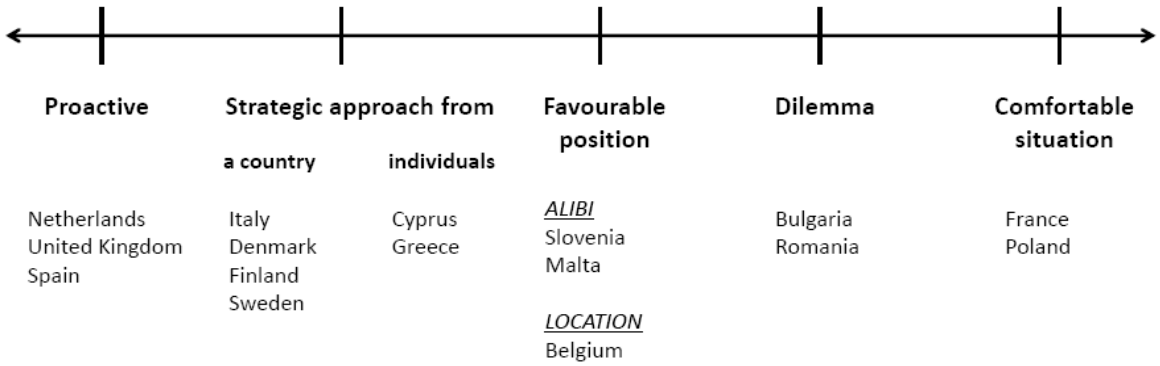


Figure 13. Strategic Positions of EU Countries in Obtaining H2020 Funding. Source: MIRRIS 2014a, 7.

As our analysis in previous sections points to relatively higher inputs (applications, R&D expenditure, etc.) of Estonia as compared to the other EU13 countries, in this chapter we elaborate on the analysis of the efficiency defined in general as a ratio of an amount of outputs over inputs. The empirical method initially was the suggestion of Farrell (1957) and called Data Envelopment Analysis (DEA), which allows us to combine multiple outputs with multiple inputs without requiring the precise specification of the functional relationships between them. In short, DEA is a method for measuring efficiency by using linear programming techniques to envelop observed input and output vectors as tightly as possible (see Figure 14). According to input and output values, DEA computes a frontier line (*F(y)*) with the best possible combination of inputs maximizing outputs. A dot on the frontier line (*a*) is considered to be an efficient

country, and dots further away from the line (*c, d*) are relatively inefficient. Furthermore, DEA also makes it possible to suggest to inefficient states what and how to improve in order to catch up with the countries on the efficient frontier line. For example, the reduction of both inputs can lead a country from c to *λc*c*; the distance from the efficiency score (*efficient = 1*) shows this inefficiency; but a further reduction in *X2* is possible on the best-practice frontier, thus reaching point *a* on the frontier. The latter distance (from *λc*c* to *a)* is denoted as "slack" of input *X2*. In input-oriented models, similar slacks in output(s) can be analyzed.

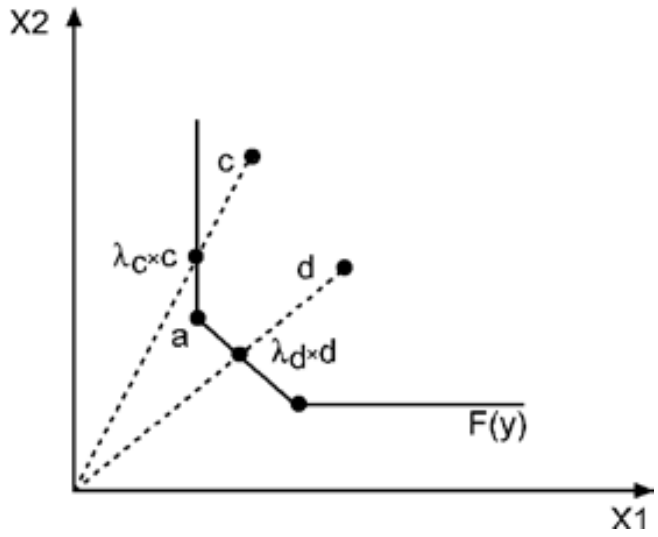


Figure 14. The efficiency determination by DEA. Source: Cunha Marques and Garzón Contreras 2007, 290

The more specific questions we can ask with DEA are two-fold:

Firstly, we need to determine a country's potential output given its inputs if it operated as efficiently as the best-practice frontier (output-oriented DEA). This would correspond to the maximizing behavior of different countries, which is perhaps not reasonable, but exists (EC noting that the participation should not be increased at any price; overly concentrating on the *juste retour* of finances should not be the goal (Council of European Union 2011)).

Secondly, as small countries do have scarce resources, the input minimization for achieving the (relatively) good performance would also be worth looking at for determining how much input a country could contract (e.g. number of applications) while behaving efficiently for using the same output level (input-oriented DEA).

It has been discussed that when input-oriented technical efficiency is higher than the output-oriented one, the country will need to increase its output scale to attain the most productive scale size, once input inefficiency is eliminated. If output efficiency is higher, then the country needs to scale down after eliminating output inefficiency (Ray 2008).

6.2. Inputs and Outputs

The empirical estimation of efficiency when participating in the FPs has some data limitations that hinder the comparison of EU28 countries across time. Therefore for a practical estimation, the data need to be somewhat manipulated. In general, a country is removed from the analysis if there are missing values of indicators described in Table 16. Therefore, each year has a different number of countries in the sample. In input-oriented instances, some years (2012, 2014, 2015) are calculated without the number of scientists and engineers (SE) as this variable had many gaps.

Table 16. Input and Output Indicators Used in DEA

Input /Output	Description and source	Short name
Output	Number of participations in FP7/H2020 by year (Total and themes); eCORDA	PROJECT
Output	EC contribution (meaning grant size received from EU); eCORDA	ECCONTR
Input	Number of applications; eCORDA	APPLIC
Input	Average share of application grade from maximum obtained score in specific theme; eCORDA	SCORE
Input	Persons with tertiary education (ISCED) and/or employed in science and technology; EUROSTAT	HRST
Input	Scientists and engineers; EUROSTAT	S&E
Input	Total intramural R&D expenditure (GERD) by sectors of performance; EUROSTAT	GERD
Input	National public funding to transnationally coordinated R&D; EUROSTAT	TNCOORD

Source: Authors

In general, the number of participations as well as EC contributions are considered outputs (Table 16). It has been discussed that the EC contribution itself would and should not be understood as a proper aim, but as our analysis in this report shows, the coordinating role is incorporated with higher EC contribution as well as participation in certain larger instruments (e.g. Teaming, Twinning etc.); thus this is an important measurable indicator that we can use here. As input indicators, several available ones are considered related to application activity (number of applications), quality of applications, but also human-capital indicators related to the persons with tertiary and higher education, but also more specifically scientists and

engineers. Additionally, the R&D expenditure (both in total and by sectors of performance) and funding to transnationally coordinated research are included where possible.
The dynamics of input indicators shows that the number of applications in H2020 has been higher compared to FP7, and the average grades from the maximum have dropped (Estonia here behaves quite similarly to the dynamics of the average of EU27 countries). The HRST (in thousands) and the number of scientists and engineers (in thousands) have increased faster in Estonia than in the average of the EU27 countries (Table 17 and Table 18).

Transnationally coordinated research expenditure has on average grown quite fast in the EU27 countries. In Estonia, these have been quite stable since 2011. It has to be noted that this indicator did not determine the backlog from the participation frontier.

Table 17. Dynamics of Input Indicators in Estonia

Year	APPLIC (FP7)	SCORE (FP7)	APPLIC (H2020)	SCORE (H2020)	HRST (th)	S&E (th)	GERD (mill eur)	TNCOORD (th eur)
2007	561	0.63	-	-	NA	NA	173.65	1,265
2008	319	0.69	-	-	287.3	30.7	208.04	1,362
2009	333	0.68	-	-	285.2	29.5	197.39	5,016
2010	330	0.67	-	-	273.6	34.5	232.76	1,345
2011	342	0.61	-	-	292	37.5	384.45	3,330
2012	443	0.70	-	-	304.5	37.2	380.70	3,389
2013	291	0.64	-	-	304.6	40.1	326.05	3,522
2014	2	0.54	655	0.58	306.2	39.7	286.74	3,114
2015	-	-	818	0.60	315.7	46	302.77	3,300
2016	-	-	567	0.62	317.2	47.7	n/a	n/a

Source: Authors' compilation by eCORDA and EUROSTAT

Table 18. Dynamics of Input Indicators in EU27 countries (average values)

Year	APPLIC (FP7)	SCORE (FP7)	APPLIC (H2020)	SCORE (H2020)	HRST (th)	S&E (th.)	GERD (mill eur)	TNCOORD (th eur)
2007	4,072	0.64	-	-	NA	NA	8,497	122,506
2008	2,430	0.68	-	-	3,219	429	8,879	137,119
2009	2,891	0.68	-	-	3,249	435	8,786	135,736
2010	2,416	0.68	-	-	3,275	441	9,139	173,060
2011	3,241	0.65	-	-	3,395	567	9,611	201,916
2012	3,595	0.70	-	-	3,476	573	9,998	249,234
2013	2,311	0.66	23.5	0.07	3,537	585	10,155	264,775
2014	21	0.47	4,220	0.59	3,634	596	10,586	284,954
2015	-	-	5,081	0.59	3,677	602	10,716	288,423
2016	-	-	3,812	0.62	3,831	635	n/a	n/a

Source: Authors' compilation by eCORDA and EUROSTAT

Estonian GERD (in million EUR) doubled during 2007-2015 (however, we know also that it has dropped since 2016), the average of EU27 countries grew at a more moderate speed. It has been brought out in earlier studies that the availability of national R&D investments constitutes a pre-requisite (at least as co-funding) for successful international cooperation, thus we can expect this indicator to play a relevant role in frontier estimations.

The output indicators behave quite differently. The number of Estonian participations peaked in 2015 but dropped later and is somewhat similar to the years 2012-2013 as measured by EC contribution. Similar dynamics characterize the average numbers of EU27 countries, however based on that alone we can predict that there are fewer countries on the frontier in H2020 compared to FP7.

Table 19. Dynamics of Output Indicators in Estonia

Year	PROJECT (FP7)	ECCONTR (FP7)	PROJECT (H2020)	ECCONTR (H2020)
2007	18	2,033,602.90	-	-
2008	100	15,910,855.28	-	-
2009	79	13,540,764.43	-	-
2010	81	11,354,594.94	-	-
2011	72	10,694,255.50	-	-
2012	92	16,011,260.44	-	-
2013	93	16,083,230.62	-	-
2014	21	10,606,659.25	38	5,887,930.61
2015	-	-	127	43,125,227.70
2016	-	-	76	17,055,503.95
2017	-	-	6	179,025.00

Source: Authors' compilation by eCORDA and EUROSTAT

Table 20. Dynamics of Output Indicators in EU27 countries (average values)

Year	PROJECT (FP7)	ECCONTR (FP7)	PROJECT (H2020)	ECCONTR (H2020)
2007	155	59,993,470.72	-	-
2008	579	167,171,015.60	-	-
2009	586	175,957,290.80	-	-
2010	650	201,500,954.25	-	-
2011	711	235,968,749.27	-	-
2012	734	259,250,258.85	-	-
2013	803	296,099,377.75	0	-
2014	193	95,930,598.09	246	93,257,678.90
2015	5	2,759,085.24	727	322,832,974.25
2016	-	-	693	294,920,864.57
2017	-	-	32	15,659,305.98

Source: Authors' compilation by eCORDA and EUROSTAT

Based on all the indicator trends above, we could predict the efficiency drop in many countries in 2016, as inputs seem to have increased and outputs ceased. Still for a small country with extremely limited human and financial resources it is important to know if the system is operating efficiently enough given the resources it invests into R&D and internationalization in general. If the "alibi" hypothesis persists, Estonia will be in a position among efficient countries throughout H2020 – it will participate relatively more compared to the inputs into its innovation system.

6.3. Estonian Potential in EU-wide Comparison by Thematic Calls in 2007-2017

Output-oriented DEA estimation showed that generally, Estonia has been effective in acquiring FP grants in 2008-2014. In 2007, the efficiency was 77.6% of the frontier (efficient level), but in 2015 and 2016 it dropped again, and in 2016 even to a lower level of 62.6% in participation compared to efficient countries (Figure 15). The efficiency levels of Estonia are twice as high in some years compared to the lowest performers (e.g. Croatia, Lithuania in different years), but the pattern or dynamics is quite similar to them pointing to the similarities of adaptation important for EU13 countries – Estonia is doing relatively better, but is impacted by the same broader factors.

The drop in efficiency was visible not only in Estonia, but was generally evidenced in many smaller EU15 countries like Denmark, Finland, Sweden and Portugal (
Table 21). In 2016, the output drop can be associated with the fact that many successful countries (the Netherlands, the UK, Spain) were not in the sample in 2015 (because of missing data) and re-emerged in 2016.

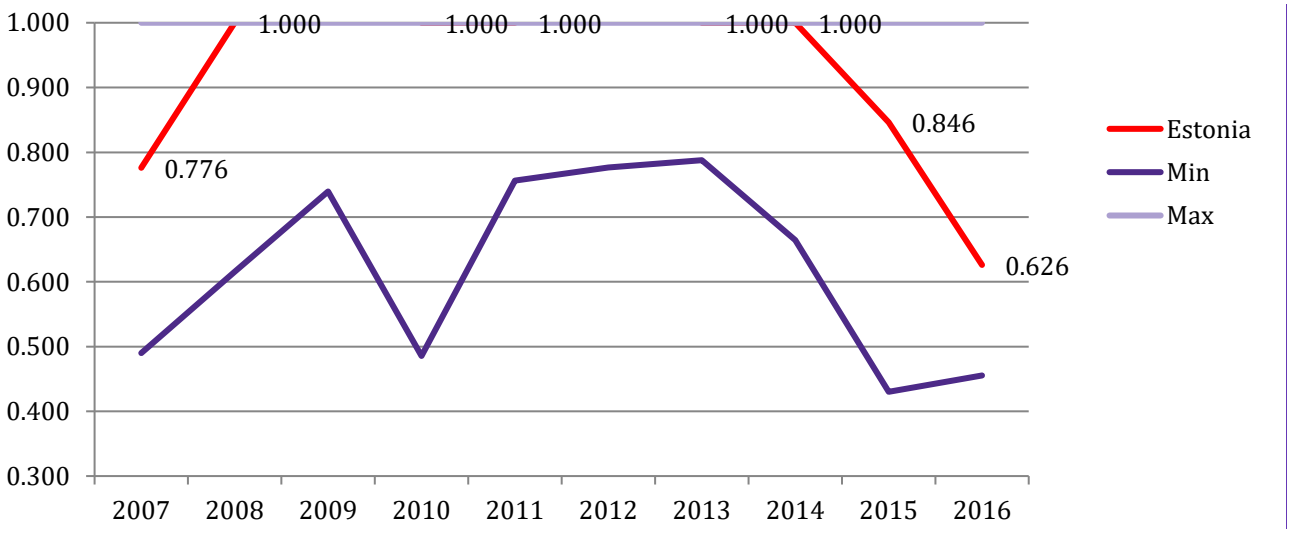


Figure 15. Estonia in comparison to the most (=1.000) and least efficient countries. Source: Authors' calculation.

In the case of input-oriented models, FP7 models did not differentiate Estonia very well, and therefore we present only the H2020 models here (years 2014-2016). The reason is technical, it is something called super-efficiency, which happens if most of the countries show efficiency levels around 1 (almost all are efficient); it is not possible then to rank which one is efficient and not efficient, and "super-efficiency" is used to avoid this problem (Andersen and Petersen 1993). The method is to find the maximum input changes while keeping the efficiency level at 1 and then to find efficiency score again for efficient countries.

Table 21. Output-Oriented Model Estimates

COUNTRY	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
AT	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.960	0.889	1.000
BE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.896	1.000
BG	1.000	1.000	1.000	1.000	1.000	1.000	1.000		0.565	0.607
CY	1.000	1.000		1.000	1.000		0.933		0.783	1.000
CZ	0.951	1.000	1.000	0.822	0.941	0.918		0.970	0.887	0.717
DE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DK	0.734	0.896	1.000	1.000	0.987	1.000	0.950	0.898	0.881	0.876
EE	0.776	1.000		1.000	1.000		1.000	1.000	0.846	0.626
EL					1.000	1.000	1.000	1.000	0.651	1.000
ES										1.000
FI	1.000	1.000	0.995	0.955	0.985	0.911	0.930	0.920	0.718	0.855
FR						1.000	0.949	1.000	1.000	1.000
HR	0.570	0.615	0.739	0.485	1.000		0.976		0.598	0.588
HU	0.986	1.000	1.000	1.000	1.000	0.991	0.996	0.664		0.611
IE						0.986	0.894	1.000	0.758	0.962
IT	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LT	0.490	0.674	1.000	0.895	0.903	1.000	1.000		0.547	0.722
LU	0.847	1.000		0.833	0.987				1.000	0.989
LV	1.000	1.000		1.000	1.000				1.000	0.455
MT	0.851	1.000		0.904	1.000				0.430	1.000
NL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000
PL	0.886	0.988	0.957	0.879	0.856	0.777	0.788	0.960	0.522	0.626
PT					0.956	1.000	1.000	1.000	0.676	0.770
RO	1.000	0.931	1.000	0.996	0.902	1.000	1.000	1.000	0.599	0.694
SE					1.000	1.000	1.000	1.000	0.841	0.949
SI	0.952	1.000	1.000	0.982	0.756		0.886		0.571	0.868
SK							0.795		0.594	1.000
UK				1.000	1.000	1.000	1.000	1.000		1.000

Source: Authors' calculation

Still, in 2015 Estonia could use inputs 84.4% less and in 2016 62.6% less inputs to achieve similar outputs that it did in H2020 programs compared to efficient countries. This result does not show that the overall innovation system was performing inefficiently; the resources that Estonia actually invested could be relatively more engaged with other activities and not H2020. As our interviews showed, some of the researchers who had FP projects before, no longer applied because of the local projects they performed (which were funded from ESIF).

Table 22. Input-Oriented Model Estimates 2014-2016

COUNTRY	2014	2015	2016
AT	0.933	0.889	1.000
BE	1.000	0.955	1.000
BG	0.578	0.566	0.607
CY	1.000	0.783	1.000
CZ	0.864	0.908	0.717
DE	1.000	1.000	1.000
DK	0.883	0.881	0.876
EE	1.000	0.844	0.626
EL	1.000	0.660	1.000
ES			1.000
FI	0.914	0.718	0.855
FR	1.000	1.000	1.000
HR	0.645	0.598	0.588
HU	0.551		0.611
IE	1.000	0.757	0.962
IT	1.000	1.000	1.000
LT		0.548	0.722
LU	1.000	1.000	0.989
LV			0.455
MT		0.430	1.000
NL	1.000		1.000
PL	0.877	0.522	0.626
PT	1.000	0.677	0.770
RO	0.732		0.694
SE	1.000	0.843	0.949
SI	1.000	0.571	0.868
SK		0.594	1.000
UK	1.000		1.000

Source: Authors' calculation

Regarding the years when Estonia was not efficient, it can be asked what it should have done differently or where the largest slacks (lags) were that kept back participation? For answering that question, the slacks from Estonia compared to the efficiency frontier are calculated, which gives us policy conclusions for the following issue: how much we should increase disproportionally the individual inputs to arrive at the frontier (input slack), or how much the frontier would shift if we used existing resources more efficiently (output slack).

In 2007, efficiency could have been achieved in the case of Estonia by simultaneously increasing the average score of applications, investments into R&D and also EC contribution by EUR 265,000 (as output slack). This reflects well the relatively efficient participation of other EU13 countries with a similarly low level of R&D investments and higher success rates (average score from the highest score was 0.63% in 2007 and 0.62% in 2016 in Estonia).

Table 23. Slacks in Output- and Input-Oriented Models

Year	Input slacks					Output slacks
	APPLIC (FP7 / H2020)	SCORE (FP7 / H2020)	HRST	S&E	GERD	ECCONTR
2007	-	0.106	-	-	21.13	265,075
2015	-	0.351	158.51	25.19	206	19,400,000
2016	18.496	-	-	-	-	10,400,000

Source: Authors' calculation

The results of the analysis of the H2020 years are quite well in line with our interview results showing that the application activity was not the factor causing inefficiency until 2016, where we see many researchers discouraged from applying for H2020 grants due to low success rates and also other reasons (e.g. if risks on non-performing partners were realized in earlier FP projects, ESIF-funded projects etc.). In 2015, the low scores seemed to play a role in inefficiency along with small human-capital inputs and R&D investments from the input side. In terms of output, increasing the EC contribution by EUR 19.4 million would bring Estonia to the efficiency frontier. In 2016, the application activity should also be increased to reach a total of 18 applications more along with increasing EC contribution by EUR 10.4 million – this would close the gap in efficiency. It can be discussed that small number of participations in horizontal types of instruments (e.g. SME, RIA etc.) would not fill the gap of EC contribution.

6.4. Thematic Potential of Estonia in 2007-2017

It is very common to discuss which science fields perform best internationally and which are lagging behind. As in H2020, the fields do not reflect fields of science, but rather the field of thematic application; we also perform an analysis according to thematic pillars or instrument groups. Thematic analysis of efficiencies shows that the drops are also visible in 2015 and 2016 in many thematic areas or instrument groups (Figure 16 and Figure 17). However as in many cases, the data are missing (even for Estonia), and not all years are covered, limiting the systematic comparison.

By our conclusion, it can be said that in 2016, the drop occurred in all fields except for Societal Challenges and Innovation in SMEs. In 2015, the LEIT, SEWP (which could not be measured in 2016), Secure Societies, and Transport fields were also efficient, other areas also dropped in efficiencies in 2015.

The drop in efficiency was largest in Transport (probably due to the shallow application grade results discussed in sub-chapter 2.2). This result was the weakest among all countries. Also, in Health, demographic change and wellbeing, the drop over the years has been substantial (to 0.52 in 2015 and further to 0.21 in 2016 (it was still not the lowest score). Only two countries scored lower than Estonia – Cyprus and Hungary (Annex 16).

Smaller drops (losses in terms of efficiency) have been visible in the Excellent Science and Secure Energy fields, in other fields, the reductions in efficiency have been substantial. As the Excellent Science pillar is mainly related to the research institutions' core functions, we can conclude that Estonia is coping relatively well in basic science cooperation in H2020 and mostly less so in applied projects (except for the Secure Energy field).

Considering the need for policy suggestions, the analysis of slacks has been conducted here, as well (**Table 24**), which shows that the HRST and SCORE indicators need an overall increase to improve efficiency (as in the case of general models), but also some theme-specific slacks become visible:

- The application activity needs to be enhanced substantially in the Health, demographic change and wellbeing field, and to a small degree in Food security, sustainable agriculture and forestry, marine and maritime and inland water research and SME Innovation.
- S&E personnel requires an increase for Secure societies as well as in the field of Smart, green and integrated transport.

- A small increase in transnationally coordinated research activities would improve the efficiency in Excellent Science.
- In GERD small slacks are visible in Excellent Science (government sector expenditure) and LEIT (higher-education expenditure).
- A substantial increase is needed in business, higher education, and private non-profit sector R&D expenditure to improve efficiency in the Health, demographic change and wellbeing and Excellent Science fields.
- The only field where Estonia could perform better regarding projects received given today's resource possibilities, is Climate action, environment, resource efficiency and raw materials.

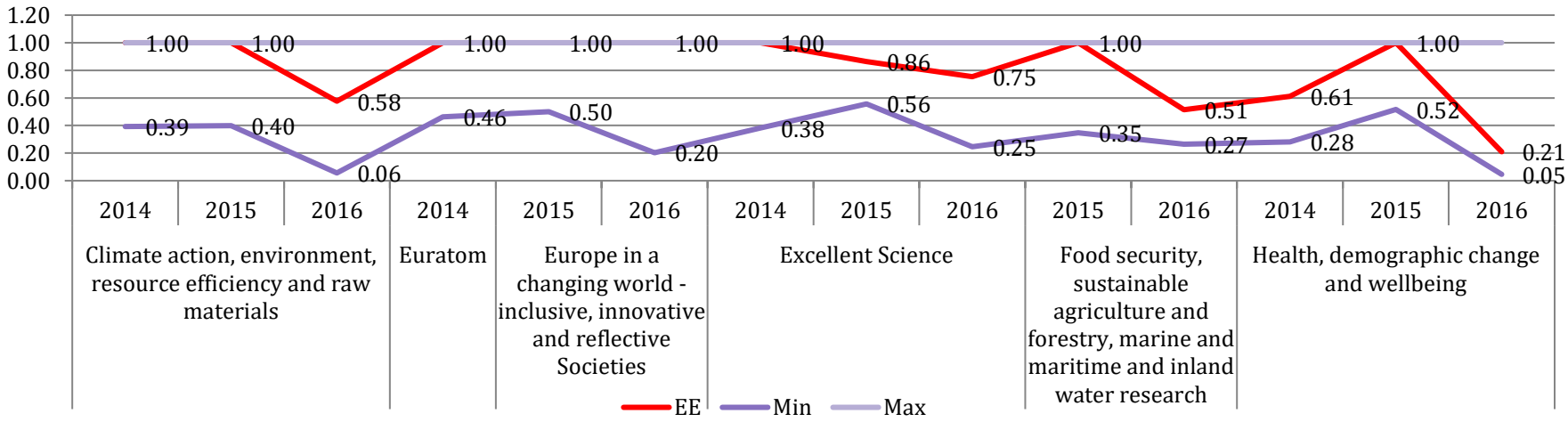


Figure 16. Thematic Efficiency Scores

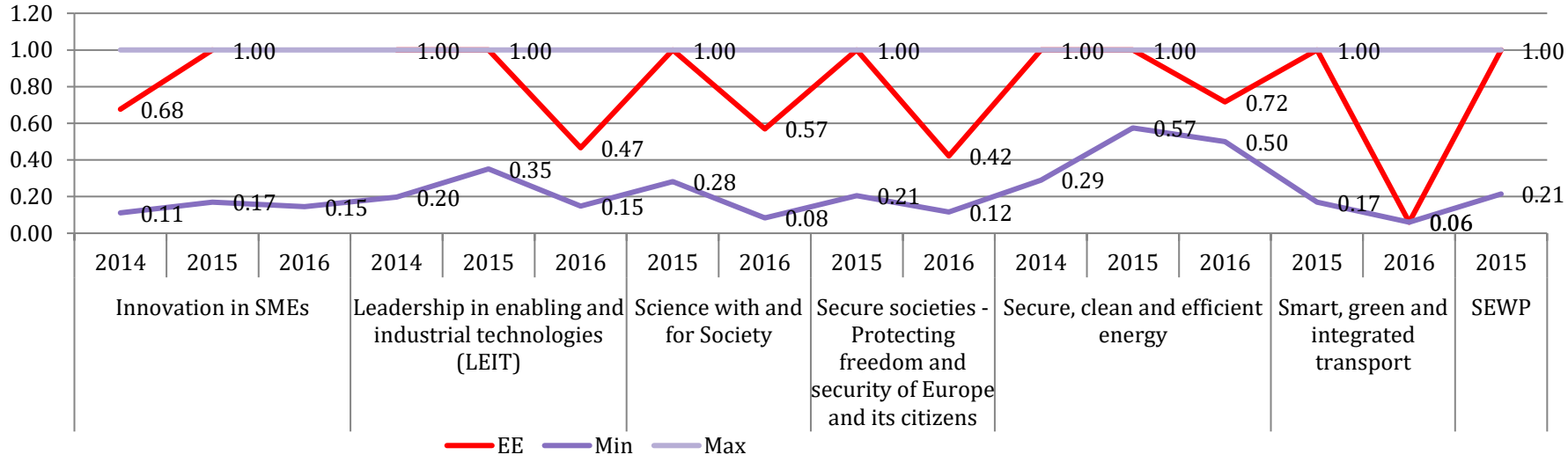


Figure 17. Thematic Efficiency Scores

Table 24. Slacks in Inputs and Outputs

Action	Input slacks										Output slacks	
	Year	APPLIC	SCORE	HRST	S&E	TN-CO-ORD	GERD (government sector)	GERD (business sector)	GERD (higher-education sector)	GERD (non-profit sector)	ECCONTR	PROJECTS
Climate action, environment, resource efficiency and raw materials	2016			19.199								1.86
Excellent Science	2014						0.00000009					
	2015		0.185	32.945		2,510.75		228,097	4,104,390	2,925,250	335,850	
	2016		0.351								7,645,751	
Food security, sustainable agriculture and forestry, marine and maritime and inland water research	2016	0.807		24.888							820,244	
Health, demographic change and wellbeing	2014	25.469	0.114	6.497				1,154,212	21,200,000	1,785,161	67,608	
	2016		0.045	9.421							502,953	
Innovation in SMEs	2014	2.306	0.462	115.246								
Leadership in enabling and industrial technologies (LEIT)	2014								0.0000000009			
	2015								0.0000000298			
	2016		0.347	29.93							660,852	
Science with and for Society	2016		0.087	6.10							87,256	
Secure societies – Protecting freedom and security of Europe and its citizens	2016		0.080	82.52	12.281						597,236	
Secure, clean and efficient energy	2016		0.353								2,173,423	
Smart, green and integrated transport	2016				0.265						175,468	

Source: Authors' calculation

6.5. Main findings

- Estonia was fulfilling its potential in 2014, but the efficiency in H2020 applications dropped in 2015 and further in 2016, implying that given the resources, Estonia would have had a much larger level of participation in 2015, but especially in 2016. In 2016, it seems that compared to efficient countries the reasons are associated with lower application activity, but also with a lower quality of the proposals.
- The results point to the need to increase the application activity in 2016, but generally also other inputs (human capital and R&D investments) which are related to FPs.
- Estonia also needs to encourage high levels of applications and increase the EC contribution (by, e.g., advocating the balancing of the remuneration from H2020 funds or encouraging applications where EC contribution is more substantial, such as SEWP).
- Thematic efficiency drops have occurred in many fields, some fields still have remained efficient in 2015-2016: Innovation in SMEs, Societal Challenges and SEWP (2015).
- In most cases the efficiency drops have been severe, especially in the fields of Transport and Health.
- In the Health and Excellent Science fields, substantially higher R&D expenditure in higher education, business, and private non-profit sectors are needed to improve the efficiency in H2020.
- **A policy-oriented conclusion from the analysis of the Estonian potential in H2020 is that the limited investments into R&D and human capital more broadly in recent years are holding back the participation in H2020.**
- **Additionally, the structure of participation needs to be shifted towards larger projects.**

7. Case Studies of Participation and the Perceived Impact of FP7 and H2020: Actors' Perceptions

7.1. Overview of the methodology

For the detailed analysis of actor experiences of FP participation and perceived impacts, we carried out interviews and focus groups with the most active researchers and research groups (regarding both applying for and receiving FP funding) from different disciplines (see also Annex 17). In addition, we carried out secondary interviews with industry representatives from small and large enterprises, as well as focus groups with policy makers (ministries, national contact points, NCP) and university administrators. In Table 25 we have summarized the cases covered by our analysis.

The interviews with researchers covered three broad topics:

- Personal motivations, incentives and main barriers to joining transnational cooperation projects;
- Main differences between how projects and consortia have been formed in FP7 vs. H2020;
- Main impacts on the functioning of actors in the innovation system (changes in the orientation of (research) activity, higher visibility but also complementarity between national and EU research areas, increased cooperation between different stakeholders at the domestic as well as the international levels).

It was noted at the policy-making level that Estonia's participation in several instruments (in particular EU partnerships) still remains in the early "piloting" phase, and the impacts (both substantive and procedural) are not yet fully visible (see also Table 14).

Table 25. Description of the sample for the in-depth exploration in the section of R&D performers

Characteristics for individual level at the research groups and enterprises	Participation experience from FP7 and/or H2020[9]	Number of participations in FP7 & H2020	Experience as coordinator in FP7 vs. H2020	Number of application in FP7 & H2020	Success rate (no of applications per one participation)	Participation in Estonian centers of excellence
Case 1	2	6	1 (H2020)	44	7.3	Yes, in 2016-2023

[9] Participation experience ("0" not at all, "1" in one or the other, "2" in both)

Case 2	2	4	1 (FP7) + 2 (H2020)	11	2,75	Yes, in 2016-2023
Case 3	2	3	2 (H2020)	15	5	Yes, 2008-2015; 2016-2023
Case 4	2	3	-	3	1	
Case 5	2	2	-	5	2.5	Yes, in 2015-2020
Case 6	2	2	-	13	6.5	
Case 7	2	2	-	16	8	Yes, in 2008-2015; 2016-2023
Case 8	1 (applied in both)	2 (FP7)	-	6	3	
Case 9	1 (applied in both)	2 (FP7)	-	16	8	
Case 10	1 (FP7 only)	2	-	3	1.5	
Case 11	1 (FP7 only)	1	-	1	1	Yes, in 2008-2011
Case 12	1 (H2020 only)	1	-	2	2	
Case 13	1 (H2020 only)	1	-	4	4	
Case 14	1 (applied in both)	1 (FP7)	-	12	12	
Case 15	1 (applied in both)	1 (H2020)	-	12	12	Yes, in 2015-2023
Case 16	Applied in H2020 only	-	-	1	-1	
Case 17	Applied in FP7 only	-	-	2	-2	
Case 18	Applied both in FP and H2020	-	-	2	-2	
Case 19	Applied in H2020 only	-	-	5	-5	Yes, in 2015-2023
Case 20	Applied both in FP7 and H 2020	-	-	7	-7	Yes, in 2004-2007; 2011-2015
Case 21	Applied both in FP7 and H 2020	-	-	11	-11	Yes, in 2008-2011; 2015-2020

Source: based on the eCORDA database as of 28 February 2017.

7.2. Motivations to participate and perceived impacts

In general, one can say that the cognitive view of the R&D performers is highly dependent on the field of research activity and previous experiences. Still, and not surprisingly, it was almost unanimously argued that for the EU13 researchers, FP projects are needed predominantly for *financial sustainability*; however, the model of achieving this sustainability may be perceived differently: for some, the EU grants themselves provide the main financing, for others, EU grants act as a quality seal leading to future research grants and funding also from other sources. Notably, the former group is more likely to act opportunistically and tries to maximize the number of research projects submitted under different calls to increase the probabilities of receiving FP funding.

On the other hand, there are research groups that are rather well funded locally (i.e. belong to the national priority areas of teaching and research) and whose motivation to participate is not so much driven by the budgetary constraints and overwhelming reliance on the external funding, but by somewhat pragmatic motives:

- Even if it is considered unlikely to gain funding for specific projects (e.g. due to the discrepancies between the research focus of the group and the EU priorities), some research groups participate in FP calls to *maintain their networks and visibility* in the research area, as active involvement in FP networks is deemed necessary for maintaining the existing status and role also in broader substantive research networks;
- Researchers even consider FP projects to function as *an indicator of quality or excellence* when applying for national funds or for advancing personal careers.

In these cases, FP projects are also seen as a fertile basis for the *further advancement of the research field or topic* (especially in comparison to the limited support by national R&D measures). Here the coordination of FP consortia is considered mainly to be an excellent opportunity for steering the research foci of the field in Europe. See also Example 1: Successfully coordinating FP7 and/or H2020.

Among *industrial partners* from Estonia, it seems that the participation patterns in FPs are somewhat more varied. Still, one can claim that the reasons for most active enterprises to participate in H2020 projects are more related to personal incentives and interests (e.g. movement of personnel from university to industry) than broader organizational strategies (e.g. finding targeted support for developing prototypes, etc.). See also Example 2: The experience of a company in FPs. The SME support instrument of H2020 has been very attractive and highly appreciated, mainly because of the single beneficiary logic of the instrument, but also because of the size of funding and the limited administrative burden attached to it, which are not

comparable to the national support measures. At the same time, it was claimed by consultants and NCPs that almost no SME has managed to receive EU funding without external help in project preparation.

While the SME participation in FP projects seems to be more related to the financial and more tangible incentives, the willingness of larger enterprises to join FP projects remains more limited due to the interests of keeping internal developments secret. In the case of Estonia, the main large firms participating in FPs are state-owned enterprises, and it was revealed in interviews that the main driver of their participation is the requirement for the owner (the state) to invest 1% of its turnover into R&D activities, which can be achieved much more easily through participation in large-scale EU projects rather than through domestic R&D projects.

Overall, the reported perceived impacts of FP participation cover different tangible and non-tangible aspects, as especially for active FP participants, the global research networks and projects are the primary drivers of their development:

- Research group sustainability (funding)
- International visibility and ability to define research directions in the EU (esp. as coordinator)
- Technology watch and information effects regarding the directions of R&D
- Domestic and international quality signaling
- Co-publications and co-development (of platforms, prototypes, etc.)
- Cultural change of organizations (esp. for universities etc.)

We exemplify these impacts in more detail also in the illustrative cases (Examples 1-5).

Overall, most of these impacts are difficult to measure in isolation (and beyond self-reporting) and appear with significant time-lag, i.e. given the fact that FP projects are focused on quick-access project deliverables (reports, policy briefs, inputs for piloting during the project duration), the scientific impact regarding, e.g., co-publications appears with a significant time lag. In some cases, researchers claimed that there were still papers being published that were the result of FP5 projects.

What this also means, and what we will elaborate on more below, is that depending on the priorities of different research groups – emphasis on financial sustainability vs. focus on excellence, signaling etc. effects – various parts of the FP instruments and their impacts are perceived differently. For example, well-funded and internationally networked research groups perceive the SEWP instruments as activities with limited impact on their research groups as they look for more tangible and substantive effects from FP.

As a critical observation regarding the context of H2020, one can note a growing dissatisfaction with the FPs among academia and active industrial partners due to the high rates of competition in H2020 and the perceived "lottery" element in the selection of project(s) to be funded from the final shortlist, i.e. actors often can predict what the projects are that will receive 90% and more of the evaluation points, but the selection of the final few projects to be funded often seems to have little logic behind. This may have a negative effect on the stakeholder motivation to keep applying for funds and to invest into relatively time-consuming attempts to coordinate such projects. In fact, the perceived high level of randomness regarding success has already made some of the research groups rather vocal about the situation. As stated by one of the interviewees: "*It is not the EU's task to provide and maintain the funding at the nation-state level. The respective incentives must change and the EU funding has to become an additional bonus!*"

Example 1. Successful coordination of FP7 and/or H2020 projects

A small number of research groups in one ICT-focused department of a university have coordinated three H2020 and one FP7 projects altogether. The share of such external funding in their budget is estimated to be around 30%. The experiences of this department with FP projects go back to the time of FP3.

These facts imply that successful coordination of FP projects is also based on secure and stable national funding of research groups, as the development of necessary research and project-management capabilities and international networks is a long-term process, often encompassing several generations of researchers, learning and mentoring.

The strongly horizontal nature of the research field and the long-term experience with FPs explain why the research groups have not felt significant differences between FP7 and H2020 regarding the greater focus on innovation and societal challenges.

In general, and as is the case with joining projects as a partner, consortia building is also primarily driven by previous personal relationships and projects: common past and existing information regarding the trustworthiness of partners and their capabilities are the main selection criteria for including members of the consortia. It was further confirmed that the prior assumptions that projects need to be geographically representative do not hold anymore. In addition, it was argued that while the EU policy rhetoric emphasized the importance of including SMEs and the most dynamic industry actors, the evaluations look at the ability of the industry actors to actually finance and carry out their roles, and this speaks in favor of (also) including established large firms whose name would provide credibility to the proposal.

Importantly, this research group did not differ from other cases in its preference to collaborate with foreign as opposed to domestic firms as the former tend to be larger and more reliable. The main exception seems to be the inclusion of SMEs that are closely related to the research groups (spin-offs etc.).

While research groups preparing proposals for the first time often feel that the administrative burdens of the FP are too big and central support by the host organizations too weak, such departments as highlighted here do not consider these administrative investments insurmountable (it was estimated that it takes about 1 week of work to prepare documents in order to act as the working-package leader and up to 4-5 weeks in case of coordinating a proposal). Instead, such groups seem to develop their internal support structures over time (from application to management of projects) and consider FP application rules and requirement, especially compared to ESIF, to be more sensible and to act as useful selection mechanisms to weed out weak applicants.

(Continued)

In the case of more complicated/technical projects, such groups are also willing to use the services of consulting and project-management companies (for call-specific know-how, preparation of sophisticated market analyses, coordination of a wide range of partners). Still, the overall assessment of the return from such collaborations remains ambivalent, as consulting firms are able to provide only universal/technical input. Further, the leading Estonian consulting firm confirmed that for the H2020 application the domestic academic market has mostly disappeared, as (presumably) R&D actors need to control and coordinate theory work with other actors more closely in innovation-focused projects.

Overall, while the shifts from FP7 to H2020 seem not to have changed the internal strategies and routines of the research groups, the considerable oversubscription and fierce competition for actual funding – which is now described as a lottery – has reduced the motivation of some of the leading scholars to keep applying for and coordinating FP projects

Perceived impact from participating in FPs

The FP projects tend to entail the additionality and scope for collaboration that cannot be achieved by other means (e.g. by working alone or solely with the national support measures). Often the format of a specific project is a relevant supporting factor to pursue the interests of a research group in practice, referring in turn to the actions taken in compliance with the general strategic aims.

The main perceived impact from the coordination of FP7 projects is the ability to set the direction of research in the EU and carry out research without the need to adapt the research activity for the general framework of the project. Thus, while the costs of coordination of FP projects are rather high, the choice to lead such projects is largely dependent on the research ambitions at the personal and/or research-group level.

The critical respondents also claimed that given the fact that research groups need to mostly plan, apply and administer their application and projects with internal resources – as most active research groups keep double management systems next to central university administration – it may not be financially rational any more to apply and especially coordinate H2020 applications.

In the current circumstances, where the processes of deciding whether to apply for and participate in H2020 projects are rather strongly related to the individual-level motivations, it seems that the readiness to lead the EU projects has become “a sink or swim phase” in the career of researchers: given the high competition rates combined with ex-ante administrative burdens, it is certain types of researchers in a critical phase of their career who are willing to invest in such endeavors. Once the research becomes more established in the local or international arena and gains alternative, more stable funding instruments, the motivations to pro-actively apply for H2020 projects may diminish. In other words, especially the motives of a

researcher to ask for FPs may be strongly influenced by their position in and the overall structure and incentives of the national RDI system.

Example 2: The experience of a research-intensive company in FPs

The R&D-focused company of the ICT sector has participated altogether in eleven FP7 and H2020 projects and coordinated two of them. Over the last three years, the share of external funding in the company's RDI budget has been around 70-75%. It is the most active (non-consultancy-oriented) Estonian company in FPs.

While in the EU projects, the company is defined as a regular SME, according to its self-perception, its heavy focus on R&D and its historical background (including public funding of the basic R&D, the role of public procurement in its technology development), the company could also be defined as a research organization, at least in the Estonian discourse, where such research-intensive firms are rather rare.

Given its strategic aim to develop its own cutting-edge products, which requires heavy investments often not available in Estonia (which is also the reason why many R&D-focused companies leave Estonia or shift their strategies), the key driving factors for participating in FP projects are financial and strategic "*survival*": i.e. FPs are attractive not so much for their "technology-watch" function, but for searching for ways to scale up the diffusion and usage of the technology platforms that the company is known for (through new references and new collaboration projects and partners).

The primary basis for receiving invitations to join different FP projects is related to the company's comparative advantage in certain technological platforms and the formal status as an SME. Just as in academia, the participation in different projects tends to follow a specific accumulation effect, and there are some overlaps between partners of FP7 and H2020 projects. Overall, it was also admitted that personal contacts (the existing networks, participation in conferences, previous cooperation projects, etc.) play a significant role next to the technological capabilities that the company has to offer.

Respectively, the critical changes between FP7 and H2020 concern the increased level of competition that has become tighter than ever before and the limited size of funding per calls. As a result, the company has grown more selective regarding whether and with whom to participate or not and how to best invest its time and effort. Similarly to the assessments of the academic research groups discussed in Example 1, the preparation of a project application is claimed to take a few weeks in case of joining some consortia, while the coordination of proposals usually requires at least a month (e.g. FET II phase). The company has had only limited experience using external help for preparing the applications, as their self-assessment is that their primary weaknesses are not so much technical/bureaucratic (which a consultant could help with), but rather the capabilities to write the sections of project applications on scientific excellence and impacts.

(Continued)

Perceived impact from participating in FPs
The most essential perceived positive effect from participating in FP instruments (the company has no experience in EU partnerships, etc.) is the ability to bring together and leverage different competencies from all over Europe, which would be impossible on one's own or within the national-level R&D support measures.

The other vital aspects concern the potential for scaling effects, as new projects create new references and increase the reputation and visibility of the company globally. The company already has projects going beyond the initial H2020 projects and have grown into independent cooperation projects together with public authorities from the other EU countries.

One can even say that FP projects, especially in the context of enterprises, should be taken as a way to gain more publicity for the technologies etc. to be picked up by the new customers/enterprises.

7.3. The participation processes: consortium building and success criteria

The majority of interviewees confirmed that compared to FP7, H2020 indeed has a stronger focus on close-to-market developments and/or societal challenges. The main exception seems to be the area of ICT, where researchers claimed that they experienced this change of focus already in previous FPs.

Nevertheless, research excellence (publications in the top journals and of high impact factor) is also still perceived to matter in all research areas. Thus, an exciting paradox has emerged, whereby, as argued by one interviewee: "*H2020 is not primarily oriented to funding fundamental research, but the excellence in it remains the key foundation for the evaluation of proposals*." This also makes changing the focus and specialization of research activities a risky challenge, as both socio-economic relevance and academic excellence seem to matter in FPs.

Further, the geographical representativeness aspect is seen to play a decreasing role in forming consortia, and if at all, then mostly applicable for the involvement of Southern European partners. Some interviewees also mentioned that the re-introduction of some geographical quotas (for the inclusion of EU13 partners) could work as a short-term remedy for increasing funding allocations to EU13, but this will not help significantly to remedy the structural weaknesses of EU13 participation in FPs.

A critical aspect affecting the success rates of FP participation concerns the logic of putting together or entering transnational research consortia that may succeed in the context of high competition. For a small country like Estonia, there are two crucial questions:

1. How to enter or put together competitive research consortia
2. How to engage industrial partners and the public sector as end-users

How to enter or put together competitive research consortia

Researchers and businesses representatives from different research fields recognize that the success of H2020 applications is increasingly dependent on the capacities and reputation of the coordinator, who should be "*the best in the field*". The excellence here refers in particular to the strength of one's network ties and one's capacity to define the research problems novel for the area.

Further, R&D performers argued unanimously that the key for entering and being accepted in FP projects has to do with the previous (personal) contacts, previous common projects, and networks. On several occasions, also participation in professional associations was highlighted as a relevant platform for consortia building. At the same time, only one interviewee mentioned the practice of searching for project partners based on their publication activity. In other words, existing networks matter more than existing capabilities developed in isolation.

Regarding potential remedies to cope with the high level of competition and the oversubscription in H2020 calls, researchers seem to fall into two camps. On the one hand, there are research groups that argue for changes at the system level, i.e. to eliminate the source of the problem (too much openness in the H2020 calls) via setting higher (quality) entry barriers (e.g. in FET). On the other hand, there are those who game within the current rules. One way how R&D actors have tried to tackle the issue, especially in the context of a more limited budget for projects (usually 2-3 mln EUR), is to cooperate within the university to set up more interdisciplinary research groups combining researchers from different disciplines and making themselves more valuable for the high-level consortia. The other way has been to prioritize the entrance or initiation of consortia with partners from certain countries usually represented in successful projects (e.g. Germany, Belgium, the Netherlands, Spain). More critically, many researchers from social sciences to ICT claim to know situations where already more or less finalized project proposals are "traded" between different types of actors from different countries to increase the probabilities of funding success. It is relatively obvious that such gaming will be detrimental to functional cooperation as well as to substantive research progress.

The same kind of logic for designing projects/consortia seems to be the case for enterprises, as well. The success of single-beneficiary instruments depends on the composition of a highly capable team and supporting network (including partnerships with R&D institutions and critical lead users, implementing bodies, etc.) and the presentation of novelty and a certain level of readiness of the prototype and/or platform technology (preferably together with positive earlier references). In the case of regular collaborative FP projects, the inclusion of crucial industrial players was highlighted as necessary both for improving the quality of proposals and for providing some kind of guarantee for project performance and sustainability, especially for solutions not yet marketable. Overall, the respondents were rather critical regarding the capacities (e.g. the designated staff with direct tasks related to innovation activities; basic language skills to join international projects) and financial readiness (e.g. the existence of buffer money to start with development activities) of SMEs to fit into the prototype-exploitation framework.

This overall context of how FP consortia emerge and function may be necessary for understanding the prevalence of "old boys" networks and the Matthew effect also discussed above. It seems that the research groups in which the participation in FP projects has remained limited are also those that suffer the most due to the lack of previous administrative capacities and learning effects related to the application processes. As today, these are the barriers that cannot be lowered by the central administrative units, neither at universities nor at the NCP level, the entry barriers for these groups remain high, if not rising.

How to engage industrial partners and the public sector as end-users

One of the most important aspects of the H2020 innovation/diffusion logic is that potential end users – companies or public-sector organizations – should be included in the H2020 project consortia to prototype or scale possible project deliverables. At the same time, it was argued by several interviewees that H2020 does not provide a proper format for facilitating university-industry cooperation as SMEs lack financial resources and large firms are not interested in publishing their business secrets. The previous explains, in turn, the popularity of the Single Beneficiary Scheme among industrial partners; or why research groups prefer Research Actions over Innovation Actions.

As was revealed from the interviews, the primary drivers for involving local enterprises in consortia are often personal contacts in university spin-offs and other cooperation partners from the industry. In the latter case, however, the understanding of possible broader benefits from transnational cooperation and H2020 projects tends to remain limited and requires extra explanation and persuasion from R&D institutions. The EU13 research groups seem to face an

additional challenge in finding appropriate industry/market partners not only locally, but increasingly transnationally, as well. Many active research groups argued that next to including their own spin-off firms in project applications, it is often easier to find suitable business partners with incentives to join projects from aboard. At the same time, there are also R&D-intensive Estonian SMEs, which have become well-known at the transnational level and hence desirable partners in consortia. Overall, there seems to be a lot of unused potential in bridging R&D institutions and domestic firms to jointly apply for or join FP projects focusing on new/novel research and innovation avenues.

On the other hand, the public sector also seems to be reluctant to act as a committed end-user in H2020 proposals. There are only a few ministries and local municipalities that actively participate in H2020 proposals together with research groups. And even in these cases, there have been situations where local administrative rules and reforms inhibit the full participation of these organizations (i.e. political agreements not to increase the number of civil servants have become obstacles for public-sector organizations to recruit staff who could work with specific projects). At the same time, in many areas (e.g. maritime issues, metrology, energy production, and transmission, etc.), the national institutions providing specific services, but also having internal R&D capacities, could have a considerable advantage in H2020 projects as leaders of national consortia. While Estonia has emphasized innovative public procurements as a potential tool for supporting innovation, the government could also provide symbolic leadership regarding participation in FPs by demanding specific agencies to participate in certain numbers of FP applications as the leader or a participant of national “consortia” (or to create innovation support units which have to self-finance some parts of their activities via joint research projects and FP grants, like Forum Virum in Helsinki).

In this broader context of structural barriers between different types of actors, institutionalization of EIT-KIC related activities has also taken a particular form in Estonia: some initiatives have converged into the hand of the private sector with little emphasis on RDI activities, and others are solely organized and coordinated by the R&D organizations. Thus, EIT-KICs seem to have difficulties in achieving their main goal of fostering synergy between education, science and business-related functions at the innovation-system level. See also Example 3: Participation in EIT-KIC. The higher attention to the activities across different EIT-KIC schemes is also something EIT on its own is expected to take a more vocal position about (see also European Court of Auditors 2016).

Example 3. Participation in RDI-focused activities of EIT-KIC

For the past three years the university has been involved in EIT-KIC as an associated partner. As an associate partner, the university research groups interested in EIT-KIC need to pay an annual membership fee amounting to a total of EUR 30,000 (during the initial years, the costs were covered by the Estonian Research Council and by the university centrally; now participating research groups need to find their own sources), which gives them limited voting rights and no right to initiate their own projects, but the right to join projects initiated by others. Full membership would cost EUR 100,000.

In the first years of participation (2015), the university research groups managed to join four successful applications, but in 2018 they will participate in the implementation of 19 projects, and the financing from EIT-KIC has increased from EUR 31,000 to EUR 534,000. This is also the EIT-KIC with the highest RDI returns in Estonia. The size of the average project is EUR 20,000-35,000 for a partner and EUR 100,000 for a lead partner. The focus of activities is very strongly related to societal impacts and applied research-related activities (starting from building entrepreneurship-related knowledge and skills, but also awareness-raising activities via information days and information exchange and cooperation in high-education programmes at the level of M.A. and Ph.D., primarily).

The chance to be involved in this particular EIT-KIC came through personal contacts, when well-acquainted foreign colleagues invited the institute currently leading the initiative to join the consortium. The members of the institute that were invited to join the initiative were not overly aware of the EIT-KIC instrument. In other words, this was not so much a strategic choice, but a chance event that the research groups opted to explore with the support of the university administration. The efforts of the institute were strongly supported and influenced by the government-financed mobility grant for a secondment to Brussels that enabled the eventual coordinator of the university to become familiar with EIT-related topics and the administration of FPs, to build research contacts, etc.

Perceived impact from participating in EIT-KIC

Even though participation in the instrument has enabled the Coordinator to become part of a strong Nordic industrial consortium in the field and expand the range of current collaboration partners, the effects at the national level remain more limited. Currently, the coordinator is pro-actively searching and pushing for different research groups to join the EIT-KIC initiative. There are no university-level strategic plans or support to enhance the scope of actors participating in the program. Thus, participation is to a large extent limited to the original institute who was invited to the EIT-KIC. Further, more central and strategic leadership across different EIT-KIC activities at the national level could be an avenue to expand the positive experience of the current case (especially inspired by the EIT+ example in Poland).

7.4. The perceptions on EU Partnerships and SEWP instruments

Based on the interviews with research groups, there is a consensus that the SEWP measures are not a sufficient substitute to compensate for the low participation of EU13 in FPs. On the one hand, the explanations can be related to still overly limited experience with Widening instruments. In many cases the true impact is expected to be seen in a few years (often also due to the delay in starting projects). On the other hand, the overall attitude remains rather negative. Most successful researchers seem to read these measures as political tools that partly contradict the "normal" ways of transnational cooperation that are predominantly based on scientific excellence, international reputation, and long-term network building. For the more successful and capable groups (that have participated in or coordinated different projects), many Widening measures are too focused on too soft activities, primarily oriented towards mobility, network building, etc. Even though these kinds of measures are relevant for building and sustaining ERA, they are not considered sufficient for meeting the primary needs of EU13 countries that would first need to invest in their own basic RDI capabilities and allow the RDI systems to mature. In this context, due to its high level of politicization, the reactions on the Teaming instrument, which probably requires the most efforts in the stage of application, also seem to be particularly harmful.

Of the Widening instruments, the instrument of ERA-Chairs (altogether six currently in Estonia) seems to be most highly appreciated by both researchers and university administrators due to the eligible costs (creation of a research group and coverage of their salaries) and the size and length of the financial support. According to several interviewees, "*These [ERA-Chairs] should be seen as Centres of Excellence inside the university, possibly paving a way to H2020 as well."* Most importantly, the instrument presumes the readiness to cope with the cultural changes at the organizational and research-group levels, as new research group leaders are likely to shake up existing organizational and research routines. See also Example 4: The experience of a university with Widening instruments.

Overall, the criticism of the leading researchers regarding the soft impact of the SEWP instruments partly overshadows their potential of building networking and research capabilities in groups with limited prior experience and track records in FPs. In other words, they could work as instruments of widening the participation within different EU13 countries, given that the positive experiences of more successful groups in applying and managing FP projects are also transferred to them.

Example 4: The experience of a university with the SEWP instruments

The university has been involved in two Teaming proposals, two ERA-Chair projects, and one Twinning project. Both central university staff and involved researchers showed skepticism regarding the functioning of these measures. It was highlighted that the application and successful functioning of SEWP measures are feasible only if these work in combination with other national measures and capabilities and/or function as supplementary to other EU projects, i.e. soft network-building and cooperation activities need a sustainable basis of research activities to have any meaningful impact.

While most of these instruments, especially Teaming and Twinning, intend to support cooperation oriented towards structural changes (i.e. more developed entities bring their knowledge to EU13 countries), the applicants' scientific capabilities should be adequately evaluated in combination with the EU15 partners. The complementarity between the partners is essential for fully benefiting from the instrument and for building RDI capabilities and institutional networks (e.g. via staff exchanges, expert advice, and assistance). The ERA-Chair instrument is considered not to be very complicated, rather the problems are cognitive in nature and are related to the local context: how to align the traditional functioning of the organization to the new competences, new ways of working, etc. To achieve meaningful impacts, the instrument also presumes a good set of complementarity between the local and external research capabilities: an excellent research team to be run at the local level and the academic reputation of the expert invited here as the holder of the ERA-Chair.

Perceived impacts from participating in SEWP instruments

The ERA-Chair instrument has been influential in changing the research directions and cultures of two institutes where the chairs are located. At the same time, the primary challenge has been to integrate the foreign researchers into the Estonian research culture and incentivize them to also turn the research groups on a sustainable funding path once the instruments end.

The assessment of the Twinning project is somewhat conservative, on the part of both the university administration and the coordinating group: probably the team does not need such a soft networking and collaboration-building instrument, given its relatively strong performance in FPs over the years.

Attempts to apply for the Teaming measure have been unsuccessful, but at least one of the groups involved in one of the Teaming proposals has had two years of close collaboration with the key EU15 partners of the application in applying for new H2020 projects (of which one has started). Besides, as a result of the drafted proposal, the research group has started to develop a new research stream, which has resulted in two Ph.D. theses soon to be defended, 2 follow-up Interreg projects and other collaborations with the national and regional-level partners involved in the initial proposal.

The perceptions of the EU partnership instruments remain rather varied. The ERA-Nets are perceived as "*a possible way how to grow bigger, but as the funding is non-existent, not worth of the related burden.*" The shared view by the different stakeholders is that the range of ERA-Nets should be more restricted (merged) but potentially more influential. The experience with JPIs remains overly limited.

It was also discussed to which extent these partnership instruments could be seen as platforms for providing access to the "*old boys'"* networks. Today, the aspect concerning natural network building is not felt to be strong enough, especially if the countries' participation is dependent on top-down invitations in certain themes (JPIs in particular; the latter can also be related to the lack of systemic flow of information on different initiatives between the relevant stakeholders). Based on the interviews one can claim that the majority of these partnership schemes seems to resemble fictional networks, especially in contrast to the professional networks that bring together member organizations and key players in certain specific areas and seem to have a higher effect today. These professional networks provide strong embeddedness into certain transnational networks and often act as a platform to boost up the project proposals/consortia among relevant contacts/partners. Here, however, the country's status as a full member or associated member is the issue that needs more in-depth consideration.

One has to highlight that the effectiveness of EU partnership instruments for EU13 seems to depend to a large extent on the strategic choices and commitments by policy makers: researchers are likely to follow but not lead such choices, as the entrance to existing networks requires a significant policy level and financial commitments. See also Example 5: The experience of a ministry from participating in the EU Partnership instruments.

Many interviewed researchers claimed that the national priorities regarding the participation in EU partnership instruments remain both poorly communicated on the national level and poorly defended on the EU level. Researchers do not fully understand the processes of domestic coordination of participation activities, priority setting and how different delegates are selected to represent Estonia at the EU meetings (and who has the right to make commitments; this related primarily to the role of professional/academic representatives). As a result, several interviewed researchers indicated cases (also in the otherwise well-received Bonus program) where the lack of national financial commitments came as a surprise to researchers, and project ideas that had already been discussed between researchers and partners transnationally had to be canceled. Or, as stated by one researcher: "*Facilitating participation in the networks/initiatives not backed-up by the necessary political and financial commitment makes no sense!*"

The establishment of the network of scientific councilors in different ministries is considered a step in the right direction, but it may need further investments (by respective ministries) regarding capacity building, as the tasks to be fulfilled by the position are arguably far more extensive than one person can tackle and may require a larger R&D system at the ministry.

Example 5. The experience of a ministry from participating in the EU Partnership instruments

The Ministry is among the two more active ministries, participating in different participation instruments from JPIs to ERA-Net and Bonus and representing its specific policy domain. The Ministry also has its R&D policy, staff, and budget.

The primary mission of the Ministry in participating in the EU-level initiatives is to align its strategic policies and initiatives with the developments at the EU level and thereby link Estonian research groups partly funded by the Ministry with the cutting-edge research themes and topics pursued across Europe. For this, the active involvement in field-specific R&D standing committees of the EU is crucial as it provides key insights regarding the emerging R&D developments of the field in general. Comparing FP7 and H2020 practices, the more active involvement of ministerial representatives in the H2020 program committees also provides a deeper understanding of the decision-making processes at the EU level. At the same time, there is a constant challenge to find an appropriate balance between representatives from among civil servants (who have the authority to make commitments) and scientific experts (who have the substantive expertise) and the pressure to keep up with the complex webs of policy initiatives pushed by larger member states and the EU as a whole.

On the national policy-coordination level, there still seem to be unresolved questions regarding the appropriate roles of specific ministries and the Estonian Research Council (ETAg) as the central coordinator, especially regarding the areas with overlapping responsibilities between different ministries. The current system is implicitly built on the attempts to turn the ETAg into the central policy coordinator, but it lacks the domain-specific capabilities to select and prioritize some fields over others. As a result, Estonia is involved in many different EU initiatives with limited funding (as associate partner, observer, etc.) and this seems to create general dissatisfaction on the research-group level. At the same time, much of the domain-specific policy knowledge resides in specific ministries whose R&D advisors and other specialists could be empowered to take responsibility for running the R&D-related activities (incl. having direct access to the financial resources currently foreseen for co-financing on the part of ETAg).

This shift would probably also require a redesign and participation and consultation processes across the RDI system. On the one hand, the R&D performers need to be informed and trained to support their active involvement in different EU Partnerships. On the other hand, these relevant stakeholders of the field (from research groups to industry) should be

7.5. Administrative and project-management capacities

Even though one aspect in the transition from FP7 to H2020 concerned the simplification and reduction of administrative burden in different stages of project application and administration, finding information, preparing applications and the management of projects are still perceived as challenging, especially by the newcomers (see also the interim evaluation of H2020 in general; European Commission 2017c, 41). According to interviewees, the navigation of the H2020 landscape of different calls is rather confusing (in some cases the interviewed scientists were not able to link their ongoing H2020 projects to particular instruments). Further, the horizontal nature of calls not only seems to be challenging for applicants but also creates tensions and confusion at the level of H2020 program committees (e.g. in some cases ca. 40% of program funding has been allocated to "other activities").

Overall, the stronger the cumulative experience of research groups in previous FP rounds, the less criticism one can find regarding the administrative rules and routines. In other words, the variety and complexity of H2020 may be an initial entry barrier as new research groups entering the field may be overwhelmed by the information. At the same time, once these groups gain first experiences and tacit knowledge, it is often found that the H2020 administrative rules and designs are in fact more flexible and more comfortable to administer than especially ESIF, but also other national instruments.

The performance-based bonuses of the ETAg for above the threshold grants are appreciated highly by the R&D performers, though, some would also like to see more emphasis given to *ex-ante* support of the more complicated applications (for the overview of policy instruments facilitating participation in FP/ESIF, see Ruttas-Küttim 2015). Especially the representatives of enterprises raised the issue whether and under which conditions it would be reasonable for the state to invest in preparing proposals *ex-ante*, i.e. the provision of a special support measure to mitigate the risk and costs (approx. a couple of weeks to 4 months when applying for the first time) related to preparing the proposals. Arguably, none of the successful SMEs in phase 2 of the SME instrument have written the project proposal on their own and have relied on external support by consultants.

Probably more importantly, considerable systemic problems in both applying for and managing FP projects can be found at the organizational level of R&D performers. The general perception of researchers from universities is that the support functions from the central R&D to accountancy departments of universities seem to lack the relevant capacities to be involved in drafting and implementing these projects beyond formal control functions. The division of tasks in the accountancy department of Tallinn University to have a more focused approach to

different EU support measures could be a crucial success story to learn from. The greater support regarding more transferable/universal issues such as ethics, privacy, data management, open data were also mentioned several times.

Finally, as Estonia relied heavily on ESIF funding in RDI, the complexities and mismatches arising from using two funding streams with distinctly different rules and regulations in parallel (co-financing some instruments etc.) were raised both by university administrators and researchers regarding the possibility of using lump sum funding, coverage of infrastructure usage (which in many other countries is covered by the state if it is not eligible under H2020), etc.

7.6. Main findings

- Financial sustainability is also cognitively felt like one of the most important motivators behind participation in H2020. Still, it is less dominant for the research groups with significant national funding (e.g. in prioritized fields, etc.).
- On the industry level, the instruments of sole beneficiaries are appreciated more highly than other more collective instruments, which potentially points to the failures in domestic networks (interaction failures) or also a lack of shared visions etc. within the systems (transformation failures).
- The actors perceived the change from FP7 to H2020 as not shifting away from "excellence" towards "innovation", but rather "innovation" emerged besides "excellence" with both being important.
- The coordination success of Estonia described in Chapter 2 may have been overestimated, as the actors have revealed the trading/gaming of the roles in different projects.
- There seems to be unused potential in bridging R&D institutions and domestic firms to jointly apply for or join FP projects focusing on new/novel research and innovation avenues.
- While Estonia has emphasized innovative public procurements as a potential tool for supporting innovation, the government could also provide symbolic leadership regarding participation in FPs.
- In instruments requiring more and diverse partnerships, the success is visible when research groups, the university level, and the public-sector intermediaries work together, but it demands change both in organizational routines but also in public RDI consultation and the priority-setting process.
- The experienced researchers do not perceive H2020 bureaucracy and administrative rules as difficult; it is difficult for newcomers (the limitation here seems to be at the

university level). The confusion is felt rather on the program level of H2020 and its logic, structure, and variety of instruments, which seems to be challenging to understand for actors.

- The number of instruments in H2020 resting on top-down proposals of participation has shifted out of the reach of researchers and needs increased action on behalf of science managers in the public sector (ministries and intermediary organizations).

8. Policy recommendations

We use the failures approach to innovation systems (Bach et al. 2014; Weber and Rohracher 2012) to present the policy recommendations, where we can separate the capabilities of individual actors (and sectors, e.g. business, higher education and public sectors) and institutions of different kinds and levels shaping the networks and links between the actors. Resulting from the relevance of failures found in the analysis of Chapters 4-9, we divide the policy recommendations into two categories: a) how to improve the general framework conditions of applying for FP grants; b) how to enable the public-sector organizations to lead the way in entering new and so far under-utilized FP instruments and domains. The first section concerns the main challenges faced by the different actors of the national system, in particular capability building and cooperation problems prevalent at the domestic level. The second section is built upon the issue of transformation and change management, where the governmental level is expected to engage actively and behave as a so-called "role model".

Improving framework conditions

1. Given the indications of declining efficiencies and also the feedback from interviews and case studies regarding the potential fatigue effect, policy-makers needs to both **encourage a broader pool of research performers to apply for FP projects** and negotiate for **increasing the actual EC contributions per project** (to balance the remuneration rates between EU15 and EU13), or encourage applications where EC contributions are more substantial. In addition, Estonian policy discourse should also emphasize and incentivize the applications in Excellence pillar and support ambitious scholars in applying for ERC grants and disseminating the best-practice lessons. This could be achieved by more selective and extensive nation-level motivation packages (bonuses for passing thresholds, selective ex-ante funding of preparing key strategic applications or application in areas where Estonia has been less active).
2. The criticism of the leading researcher groups regarding the soft impact of the SEWP instruments partly overshadows the **potential of SEWP instruments to support building networking and research capabilities in groups whose prior experience and track record in FPs is limited so far**. In other words, SEWP-type instruments could work as instruments of widening the participation within different EU13 countries, given that the positive experiences of more successful groups in applying and managing FP projects are also transferred to them. **More emphasis should be put on informing, training and incentivizing groups with limited experience in FPs to try to enter SEWP measures and other soft networking tools (COST, etc.)**.

3. Given that Estonia is coping relatively well in research-oriented segments of H2020, but less so in applied R&D projects, policy should also focus more on **increasing the R&D capabilities of the business sector**. In other words, industrial and innovation policy should not only focus on networking, demand and export-oriented support activities, but should also tackle the challenges of basic-capabilities development in R&D.
4. On the national policy-coordination level, there still seem to be **unresolved coordination issues regarding the roles of specific ministries and ETAg as the central coordinator of research activities**. In the current system ETAg acts as the central policy coordinator, but it lacks the domain-specific capabilities to select and prioritize research fields and issues to be tackled. Estonia is involved in many different EU initiatives with limited funding (as associate partner, observer, etc.), and this seems to create general dissatisfaction on the research-group level. At the same time, much of the domain-specific policy knowledge resides in particular ministries whose R&D advisors and other specialists could be empowered to make more policy-level decisions regarding priorities and funding allocations. One option would be to **pilot with new forms of deliberative decision-making tools in specific policy/priority areas**, i.e. specific mini-conferences where leading researchers and representatives from the industry debate the priorities of Estonian national participation in EU partnership instruments and vote on the priority of topics where Estonia should be a full vs. associate member, into which to invest national resources etc.

Improving policy leadership

1. As FP is no longer about research as such, but about steering the processes of research and innovation towards tackling societal challenges and pursuing specific missions, **public-sector organizations need to become more proactive in FPs as project leaders and partners**. So far, the participation of ministries, intermediary organizations, local municipalities etc. has remained limited and concentrated in a few proactive pockets. Yet, especially Innovation Actions of H2020 need these organizations as end-users to participate in the co-creation and piloting actions. If public organizations understand FP projects as tools for investing in innovation and development and become proactive partners, this could, in addition to bringing investment and development funds to these organization, also increase the possibilities for research performers to join innovation-oriented project in FP.
2. While Estonia has emphasized innovative public procurements as a potential tool for supporting innovation, **the government could also provide symbolic leadership** by demanding (as a first pilot) specific agencies to participate in certain numbers of FP applications per year as the leader or partner of a national mini-consortium; or to create

innovation-support units within government which have to self-finance some parts of their activities via joint research projects and FP grants (like Forum Virum in Helsinki).

3. There is also a significant **unused potential in bridging Estonian R&D institutions and firms to apply for FP projects that focus on new/novel research and innovation avenues**. Public policies could again lead the way by creating bridging/matching events and financing *ex ante* the preparation of FP proposals between new partners (who have not collaborated before and lack trust) in selected priority areas.

For a detailed overview of the remedies on the EU, national, organizational (ministries, universities), and individual levels (including also entrepreneurs), see **Table 24**. In the case of Estonia, many potential options still exist to improve the participation in H2020 that seemed to decline in recent years (2015-2016).

Table 26. Failures and RDI policy responses relevant for Estonia

	Transformation failures	Institutional Failures	Capabilities failures	Interaction failures	Market failures
Overall objective of policy instrument to tackle the failure	**Shared vision and coherence and coordination of the respective policies and policy-making processes**	**Change in institutional mechanisms (regulations, standards, legislation) and in political and socio-economic cultures, norms, values**	**Support for exploration activities and/or increasing absorptive capacity via R&D cooperation, subsidies, training and networking**	**Development of new and existing networks and conditions for stable partnerships in a long-term perspective**	**Better circulation of information and knowledge, sharing of risks and uncertainty (e.g. subsidies to cope with under-investment in R&D, to reach a critical mass of resources, avoid duplication)**
European level	Reconsider the development of research excellence and catching-up in the same framework (the EU13-specific problems need to be tackled by their problem-specific measures)	Alignment and harmonization of principles, rules, and regulations for ESIF and FP co-funding	More attention to developing basic RDI capabilities of EU13 countries	More attention to developing networks between academia and industry across Europe (e.g. organizing events, improving information sharing)	The oversubscription needs a reaction either via setting higher barriers and/or meeting the increasing demand; Align the unit prices between EU13 and EU15

National level	National priorities and the respective processes (both vertical and horizontal, but also inclusion of relevant stakeholders) need to be developed and set up	Develop strategic aims together with higher prioritization and commitments (both political and financial)	Empower the ministerial level for coordinating participation, especially in joint initiatives via more active engagement in advisory bodies of H2020 as well as facilitating building stronger feedback mechanisms with stakeholders at the national level	Support participation of R&D performers as full members in professional associations, EIT schemes, JPIs, etc., and guarantee coverage of the membership fee for a certain period of time	Support professionalization of NCP system at the national level to provide not only information, consultation, etc. but also idenfitying and coordinating actions (especially if involving different stakeholders) of high potential for Estonia
	Develop R&D funding system (incl. baseline funding) providing stronger complementarity at the national level for R&D performers to compete transnationally	Harmonization of cost reimbursement rules between the EU and national regulations (e.g. lump-sum issue still incompatible with national regulations)			Stronger emphasis on training support units (R&D support centers, accountancy, legal advice, etc.) at organizational level, especially at universities
	Develop incentive system for organizations/research groups to actively participate in different EU research instruments			Raise awareness and capabilities of local industry to be a more active partner in RDI collaboration networks	Consider provision of also ex ante support (including financial) to overcome initial sunk costs (while applying for the first time) and cover the project costs from national sources if over the threshold
Organizational level: Ministries	Develop strategic plans for participating in different EU instruments	Develop internal capacities and processes to acommodate different funding principles, rules and regulations (e.g via	Empower the public agencies to be more active partners in FP projects as an end-user, coordinator,	Empower R&D advisory system at the ministerial level – especially capabilities and resources to be able to design and implement R&D	

		supporting specialization on different funding instruments and their specifities)	etc.	strategies in the field of responsibility	
Organizational level: Universities	Develop complementarity to the other RDI activities and funding mechanism	Develop internal processes for interaction between central R&D units and research groups while applying but also managing EU projects, incl. the flow of information in real-time about submissions and their proceedings	Support research groups whose participation in FP has remained limited so far to help them surpass the initial sunk costs	Improve capabilities by vision-sharing, mentoring, information about priorities, support structures and internationalization benefits in general	Develop incentive-system for support structures to increase their motivation in relation to application and project-management processes
Individual level (incl entrepreneurs)	Develop incentive systems for researchers (e.g. career advancement, but also flexibility in relation to working conditions)	Develop a balance between the workload vs. bringing in more projects to be motivatived in financial terms for single researchers	Develop capabilities of individual actors (language skills, networking benefits etc.)	Develop attractive networking events to motivate participation of passive actors	

Source: Synthesis by the authors based on data analysis and interviews.

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Annexes

Annex 1. Explaining Action Types in H2020

Type of Action	Code	Number of Applicants	Types of Applicants	EU Funding Rate	Description
ERA-Net Cofund[10]	ERA-NET-Cofund	Min. 2 legal entities from different MS/AC	Research Funders	33%	Instrument for supporting public-public cooperation in joint calls and joint activities across all H2020 priority areas with national funding and H2020 top-up funding
Pre-Commercial Procurement	PCP	Min. 3 independent legal entities from different MS/AC	Public procurers	70%	
Pre-Commercial Procurement Cofund Action[11]	PCP COFUND	Min. 2 independent legal entities (public procurers) from two different MS/AC	Public procurers	70%	Instrument for procuring innovative goods and services, group of public buyers with one lead procurer, joint call for tender, joint evaluation of offers, awarding in the name of the group
Public Procurement of Innovative Solutions	PPI	Min. 3 independent legal entities from different MS/AC	Public procurers	20%	
Public Procurement of Innovative Solutions (PPI) Cofund actions[12]	COFUND-PPI	Min. 2 independent legal entities (public procurers) from two different MS/AC	Public procurers	20%	Instrument for procuring innovative solutions – joint tender, joint evaluation but awarding can be individual (as well as through lead procurer)

[10] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-d-eranet-cofund_en.pdf.
[11] HORIZON 2020 – WORK PROGRAMME 2016-2017 General Annexes, D. Types of action: specific provisions and funding rates: Pre-Commercial Procurement (PCP) Cofund actions https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-d-cofund-pcp_en.pdf.
[12] Public Procurement of Innovative Solutions (PPI) Cofund actions http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-d-cofund-ppi_en.pdf.

European Joint Programme[13]	EJP COFUND	Min. 5 from MS/AC	Including research funders is obligatory (ministries/regional authorities, research councils, funding agencies)+others	70%	Joint programming instrument for coordinated national research activities designed for research funding bodies
Coordination and Support Action[14]	CSA	1 legal entity		100%	Research and co-ordination support services (standardization, strategic planning, awareness-rising, networking, policy dialogs, etc.
ERC Grants	ERC	1 legal entity		100%	Frontier research of the highest quality
Research and Innovation Action	RIA	Min. 3 legal entities from 3 MS/ACs		100%	Basic and applied research
Innovation Action	IA	Min. 3 legal entities from 3 MS/ACs		70%	Planning and design of new or improved products, processes and services
MSCA Cofund	MSCA COFUND	1 legal entity		50%	Co-funding of national and international doctoral and fellowship programs

Source: Ukrainski et al. 2017, 85-86 (Adopted from: http://www.sfi.ie/international/european-research-area-era/h2020/horizon-2020-calls-explained.html).

[13] HORIZON 2020 – WORK PROGRAMME 2016-2017 General Annexes, D. Types of action: specific provisions and funding rates: European Joint Programme (EJP) Cofund actions http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016_2017/annexes/h2020-wp1617-annex-d-ejpcofund_en.pdf.

[14] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-d-csa_en.pdf.

Annex 2. Cooperation Matrix of FP7

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	EU	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	706	744	160	86	333	1715	422	141	449	1047	110	458	1170	91	325	283	1132	92	63	73	49	939	420	319	225	623	216	133	1340
BE		1175	188	120	406	2383	626	154	716	1703	146	589	1939	96	438	399	1774	116	105	99	62	1644	570	527	314	1022	265	146	2164
BG			98	55	68	805	1273	116	137	1208	186	97	932	154	69	160	648	188	22	25	38	62	721	296	209	269	229	71	248
CY				54	68	214	71	47	207	202	17	73	178	35	58	80	199	42	23	41	47	140	91	90	74	92	61	35	239
CZ					199	805	215	78	276	604	74	223	637	52	197	145	626	74	33	55	40	503	283	173	152	346	122	108	707
DE						4416	1273	302	1508	3434	289	1232	4050	194	794	827	3809	217	148	160	97	3072	1153	1005	560	2020	505	275	4697
DK							513	116	358	894	97	402	945	67	222	265	876	85	39	66	33	879	314	295	156	623	151	86	1231
EE								70	137	240	19	146	232	44	97	78	244	64	30	63	39	201	124	100	89	184	71	48	276
EL									831	1208	98	400	1235	117	281	312	1283	109	67	77	76	844	441	457	273	559	196	119	1417
ES										2613	186	890	2793	159	596	675	2883	181	102	141	97	2010	856	936	499	1353	373	211	3311
EU											0	97	254	18	51	36	226	22	3	11	6	200	67	54	54	121	48	27	248
FI												639	932	60	246	252	860	92	50	67	32	783	362	284	194	643	166	93	1100
FR													2754	154	605	661	3061	174	121	130	90	2349	911	837	475	1579	371	212	3650
HR														54	69	47	163	27	19	36	26	129	86	70	78	99	77	36	188
HU															266	160	626	81	35	69	39	520	274	217	187	350	132	111	714
IE																348	648	57	34	50	44	550	232	262	120	369	130	74	875
IT																	2816	188	114	135	105	2157	947	855	516	1422	424	222	3500
LT																		45	22	54	24	137	109	69	84	111	59	46	215
LU																			29	25	18	87	53	52	35	72	28	21	136
LV																				36	38	113	87	65	73	95	50	38	145
MT																					24	62	59	53	53	52	27	30	91
NL																						1860	721	619	349	1307	317	173	2943
PL																							314	296	230	489	174	114	1058
PT																								484	209	414	142	81	956
RO																									151	269	116	96	508
SE																										931	229	123	1876
SI																											163	71	455
SK																												73	248
UK																													3924

Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the numbers of cooperations (participants) within home country.

Annex 3. Cooperation Matrix of H2020

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	283	386	79	56	175	734	203	57	235	527	185	501	83	135	139	511	74	50	64	26	417	201	198	118	284	124	105	558
BE		536	104	72	228	1040	290	85	365	849	300	844	100	180	242	853	85	71	80	30	738	288	309	179	406	146	115	954
BG			35	34	35	339	511	54	65	599	396	380	108	49	80	312	90	22	19	20	38	301	176	130	109	100	46	124
CY				33	35	112	39	31	116	120	36	95	28	32	48	125	23	21	28	20	72	57	65	55	53	46	29	123
CZ					90	339	111	42	125	287	109	276	51	92	91	291	57	27	46	16	222	143	109	76	162	59	87	292
DE						1615	511	114	677	1494	468	1518	132	257	374	1543	114	114	99	38	1241	447	477	244	751	221	135	1817
DK							201	54	170	400	173	389	67	100	153	389	51	32	52	25	375	160	174	77	248	85	58	491
EE								29	65	96	67	84	32	38	40	103	30	20	37	16	93	56	60	49	60	35	34	107
EL									370	599	176	524	70	120	169	638	54	63	55	31	380	201	256	143	239	101	70	658
ES										1245	396	1217	124	230	334	1315	87	86	84	41	884	366	462	232	573	199	129	1396
FI											204	380	42	78	123	389	48	34	48	19	332	140	168	88	240	82	53	440
FR												1082	108	208	288	1232	91	92	78	42	895	376	423	195	569	180	126	1398
HR													33	49	63	127	40	21	28	15	100	76	69	40	59	41	48	112
HU														68	80	221	47	29	37	16	181	114	99	80	123	57	62	244
IE															156	312	48	25	40	21	254	127	146	91	169	67	57	378
IT																1219	90	77	91	42	923	397	427	234	550	203	140	1439
LT																	20	22	35	14	89	67	50	44	61	33	52	102
LU																		20	19	14	68	34	44	25	41	24	22	103
LV																			18	20	86	68	64	58	64	49	40	90
MT																				10	38	20	25	25	20	21	14	45
NL																					746	301	310	169	486	147	107	1136
PL																						141	176	124	196	87	88	402
PT																							242	130	189	97	69	474
RO																								88	109	79	55	215
SE																									307	100	73	691
SI																										79	46	205
SK																											39	124
UK																												1418

Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the number of cooperations (participants) within home country.

Annex 4. Cooperation Matrix of H2020 in SEWP

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	2	0	1	3	4	5	2	0	0	0	0	3	0	3	0	3	0	1	1	0	2	2	2	2	1	1	1	4
BE		0	1	0	0	4	0	1	0	3	0	3	0	2	0	6	0	1	0	2	4	0	2	2	0	1	1	5
BG			3	0	1	3	3	2	1	2	1	0	1	1	0	2	0	0	1	0	1	4	2	2	2	2	0	1
CY				2	1	6	1	1	2	3	0	2	1	1	0	5	0	1	2	0	2	2	2	2	1	1	0	4
CZ					1	3	0	1	2	1	0	3	1	1	0	3	0	2	1	0	0	1	1	1	1	0	0	4
DE						10	3	3	5	8	3	9	2	8	0	13	0	6	3	0	4	7	5	10	3	6	3	8
DK							0	2	0	0	0	1	1	0	0	1	0	0	0	0	1	2	1	0	0	0	0	2
EE								3	1	1	2	0	1	1	0	2	0	1	1	0	1	1	1	1	2	0	0	5
EL									0	2	0	0	1	1	0	2	0	1	2	0	0	1	1	2	1	0	0	0
ES										0	1	3	2	1	1	9	0	1	1	1	0	1	4	2	1	1	2	4
FI											2	0	0	0	0	1	1	1	0	0	0	0	3	0	1	0	2	2
FR												2	1	0	0	8	0	1	1	0	3	4	3	4	2	3	1	7
HR													1	1	1	5	0	1	1	0	1	1	1	1	0	0	0	2
HU														5	0	2	0	2	1	0	1	1	1	1	0	0	0	1
IE															0	2	0	0	0	0	0	0	1	0	0	0	0	1
IT																2	0	3	2	1	7	5	5	7	2	3	2	8
LT																	1	0	0	0	0	0	0	0	1	0	0	0
LU																		0	1	0	0	1	1	3	0	0	0	2
LV																			1	0	2	3	2	2	4	1	0	2
MT																				2	1	0	0	0	0	0	0	2
NL																					3	4	4	3	1	1	0	6
PL																						3	2	2	2	1	0	5
PT																							8	2	1	1	0	11
RO																								2	2	2	0	4
SE																									2	2	0	4
SI																										2	0	1
SK																											2	1
UK																												3

Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the number of cooperations (participants) within home country.

Annex 5. Cooperation Matrix of H2020 in Science with and for Society

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	7	17	6	10	11	19	9	4	13	23	5	12	5	9	5	16	5	4	2	5	16	10	7	6	5	7	5	20
BE		5	4	9	7	13	7	5	7	17	4	10	6	8	8	15	4	2	2	2	12	9	8	5	6	6	4	15
BG			0	2	6	8	10	3	2	13	7	6	3	3	4	10	5	2	1	2	3	8	5	4	2	2	3	4
CY				2	6	6	3	5	5	9	2	5	3	5	4	7	3	3	2	3	5	4	4	6	5	4	4	7
CZ					1	8	5	4	7	11	3	6	4	3	4	9	1	2	2	4	4	6	4	2	5	4	3	6
DE						15	10	5	14	22	11	15	4	7	6	21	8	5	1	4	21	11	9	5	9	4	3	24
DK							1	3	4	11	4	8	4	4	4	9	2	2	2	2	8	5	5	3	2	2	2	6
EE								0	2	5	3	4	2	1	3	5	1	0	1	1	3	2	3	2	3	1	1	3
EL									6	13	10	10	4	2	6	13	4	3	2	6	10	8	8	4	4	4	4	10
ES										15	7	18	6	10	8	22	3	4	2	4	17	10	9	7	8	7	4	21
FI											0	6	2	1	4	6	4	2	1	2	5	2	5	2	3	1	2	5
FR												7	3	5	9	20	2	2	2	4	15	8	7	6	4	3	2	16
HR													0	3	4	4	1	1	2	2	3	4	4	2	2	1	2	3
HU														1	4	7	4	3	2	2	8	3	2	4	3	3	3	9
IE															1	10	2	2	2	3	6	3	6	4	2	1	2	6
IT																12	5	2	2	3	17	9	11	7	5	5	2	18
LT																	0	2	1	1	6	2	2	3	3	1	2	4
LU																		0	1	2	3	2	2	3	1	1	3	2
LV																			0	2	2	2	2	2	1	1	2	2
MT																				1	3	2	2	2	2	2	3	5
NL																					10	8	6	6	3	3	3	22
PL																						3	5	4	4	4	3	9
PT																							2	4	2	2	2	8
RO																								0	2	2	3	5
SE																									0	2	1	7
SI																										1	3	7
SK																											0	4
UK																												15

Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the number of cooperations (participants) within home country.

Annex 6. Cooperation Matrix of H2020 in Industrial Leadership

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	76	71	5	9	25	179	31	7	40	114	31	103	5	16	28	107	9	6	8	1	72	26	31	12	47	19	13	100
BE		127	11	10	40	248	40	12	82	200	61	201	3	18	48	199	13	17	13	2	157	48	59	21	58	21	15	202
BG			5	4	3	64	89	4	10	161	93	84	4	2	10	71	13	6	2	1	2	44	30	17	10	15	4	16
CY				4	3	26	2	5	25	20	5	14	1	2	6	23	3	3	4	2	7	11	13	5	10	7	3	26
CZ					29	64	15	4	22	48	13	50	2	6	13	55	5	4	7	0	38	19	11	9	16	2	6	50
DE						494	89	17	197	423	111	417	8	32	112	413	18	29	15	2	267	90	112	36	151	49	19	452
DK							44	4	30	76	23	59	2	6	17	62	4	4	2	2	54	17	24	7	30	13	6	74
EE								7	10	12	8	14	4	3	4	13	8	3	6	2	13	7	9	7	3	5	5	16
EL									122	161	30	136	4	18	43	175	9	18	7	4	80	44	59	24	58	15	9	170
ES										390	93	323	7	32	86	361	16	23	11	1	179	72	110	38	113	45	20	347
FI											60	84	1	11	30	79	8	6	6	2	63	21	29	7	46	12	6	91
FR												329	4	26	74	312	15	30	10	2	171	68	93	29	105	35	19	325
HR													6	2	0	6	2	2	1	0	4	2	5	1	1	1	2	6
HU														13	10	33	3	4	2	0	17	7	11	4	15	5	3	25
IE															42	71	6	4	9	1	56	21	25	9	28	12	6	78
IT																336	13	19	13	5	174	75	86	36	111	40	21	358
LT																	4	6	6	1	15	5	9	5	5	4	4	17
LU																		6	2	1	14	4	9	5	4	2	4	26
LV																			3	1	12	6	8	7	4	5	4	9
MT																				4	2	1	1	1	1	1	0	5
NL																					139	44	56	22	74	25	15	200
PL																						37	30	14	24	16	7	70
PT																							66	17	29	16	9	97
RO																								25	10	9	6	27
SE																									69	15	5	121
SI																										22	4	38
SK																											12	16
UK																												303

Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the number of cooperations (participants) within home country.

Annex 7. Cooperation Matrix of H2020 in Excellent Science

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	52	60	17	8	41	142	40	9	57	97	34	103	10	25	24	99	12	7	12	6	78	39	36	19	54	24	19	126
BE		62	24	13	46	180	47	14	62	123	52	145	13	35	45	137	10	9	14	8	129	50	62	26	77	28	19	177
BG			6	11	9	81	125	10	17	117	71	83	17	8	18	65	13	4	4	6	10	63	46	26	17	21	13	28
CY				7	9	22	9	7	27	21	7	20	6	10	13	25	6	4	5	5	13	12	12	11	8	9	7	25
CZ					16	81	29	11	39	65	32	67	9	32	25	73	10	5	11	4	62	42	44	20	39	18	21	76
DE						362	125	18	141	302	97	363	17	53	79	322	18	15	18	9	285	100	102	35	184	37	27	470
DK							48	10	39	75	42	88	5	23	37	79	7	5	9	6	88	37	40	14	60	19	13	135
EE								6	17	15	13	17	7	8	15	19	4	4	6	5	19	11	11	10	12	6	5	18
EL									68	117	47	136	10	37	43	127	12	8	11	6	90	49	56	31	59	23	20	154
ES										197	71	263	13	49	65	240	10	9	14	7	193	79	91	31	133	34	23	319
FI											40	83	4	20	28	83	2	1	10	4	82	30	45	17	48	15	10	103
FR												238	17	49	55	276	13	15	16	8	226	87	91	30	133	37	26	372
HR													6	8	11	17	6	4	5	5	14	12	14	9	6	8	8	18
HU														10	18	52	9	5	11	5	48	30	32	22	29	18	20	57
IE															34	65	5	5	7	6	50	30	35	17	42	15	10	91
IT																235	13	9	14	10	212	85	88	32	116	39	30	348
LT																	1	4	8	4	12	12	11	8	6	7	7	18
LU																		4	4	4	7	6	5	4	4	5	5	13
LV																			0	6	15	14	14	12	10	11	10	17
MT																				2	10	6	7	7	4	6	5	8
NL																					170	63	78	26	112	24	23	308
PL																						33	46	23	42	23	21	97
PT																							51	26	48	23	20	113
RO																								10	17	14	12	32
SE																									63	21	16	185
SI																										7	13	46
SK																											9	28
UK																												414

Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the number of cooperations (participants) within home country.

Annex 8. Cooperation Matrix of H2020 in Societal Challenges

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	145	234	48	25	91	378	119	35	122	287	111	273	60	80	80	280	45	32	39	14	242	120	119	76	173	70	64	301
BE		316	59	39	109	556	193	51	209	475	159	450	75	110	138	473	48	42	48	16	414	171	172	115	243	81	68	519
BG			20	16	14	154	281	34	32	295	202	181	79	33	47	161	55	10	11	11	22	175	89	79	73	52	22	69
CY				18	14	50	23	12	55	66	20	52	16	13	24	63	10	10	14	10	44	27	33	30	27	23	14	58
CZ					30	154	60	19	51	141	41	121	32	40	48	136	32	14	23	8	106	64	46	36	83	26	47	134
DE						695	281	69	312	700	221	667	97	147	171	741	59	59	59	23	629	226	244	147	376	112	76	818
DK							108	34	95	234	101	230	53	65	94	233	35	21	38	15	222	98	102	51	153	50	35	271
EE								13	32	61	39	47	16	23	17	61	14	12	20	8	55	31	33	27	37	21	20	63
EL									172	295	86	237	48	59	74	314	25	33	31	15	194	95	127	79	112	57	34	311
ES										614	202	576	93	130	171	658	51	49	53	28	476	197	239	145	299	102	75	664
FI											96	181	31	40	60	206	24	24	29	11	169	78	83	53	123	45	26	210
FR												462	79	117	147	588	50	44	46	28	456	196	222	114	299	87	70	637
HR													20	33	46	90	28	13	17	8	75	53	43	25	47	28	34	77
HU														34	47	122	26	15	19	9	102	69	51	46	70	27	31	144
IE															78	161	34	14	21	11	137	71	77	59	95	38	38	194
IT																611	55	44	57	23	494	211	230	143	298	104	80	681
LT																	13	10	17	8	50	43	25	25	38	19	33	53
LU																		10	11	7	44	21	27	10	32	16	10	60
LV																			14	11	53	40	36	33	41	29	22	57
MT																				1	22	11	15	15	13	12	6	25
NL																					410	175	160	107	280	87	62	574
PL																						62	89	77	116	40	52	210
PT																							112	79	105	52	35	238
RO																								50	73	46	30	135
SE																									162	52	45	350
SI																										43	22	103
SK																											14	69
UK																												627

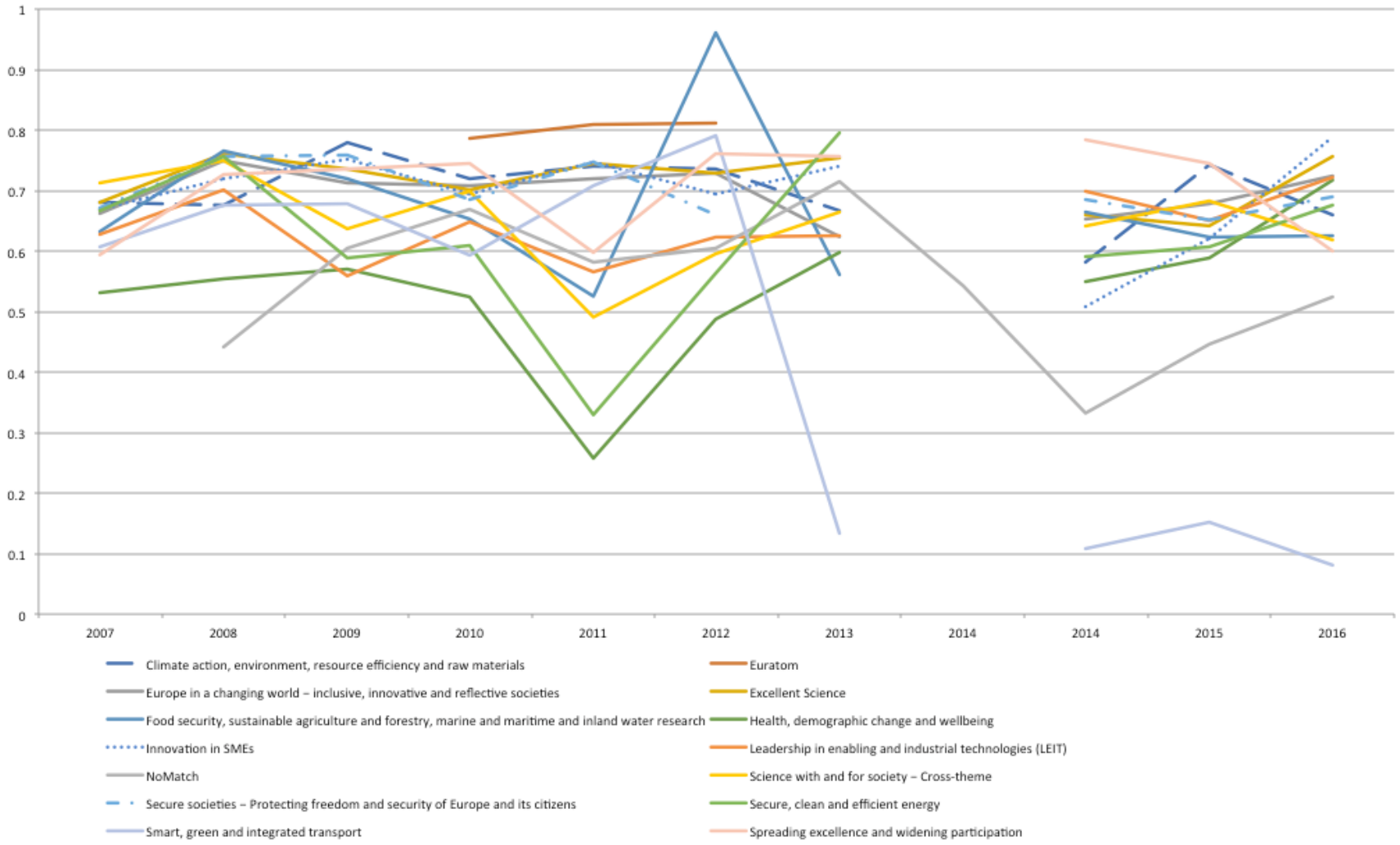
Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the number of cooperations (participants) within home country.

Annex 9. Cooperation Matrix of H2020 by Public Sector Institutions (PUB)

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	9	18	12	1	5	26	18	3	5	35	19	34	12	9	15	29	9	5	16	4	13	25	31	9	29	20	6	14
BE		16	11	3	3	23	21	9	3	48	18	33	10	9	12	39	14	5	11	5	26	24	36	14	24	18	6	30
BG			3	5	6	6	26	9	2	19	34	34	16	7	8	18	14	7	8	4	6	18	32	24	13	16	6	4
CY				0	6	5	6	3	3	7	1	5	6	3	5	7	5	4	7	5	4	1	5	4	4	4	4	3
CZ					3	6	7	4	2	9	5	7	5	4	6	6	4	3	6	4	9	3	5	4	6	5	3	4
DE						30	26	8	9	47	23	46	9	12	19	47	18	8	20	8	26	29	32	16	34	16	4	41
DK							6	9	4	41	21	30	9	7	16	34	11	7	16	6	28	22	26	10	31	15	7	28
EE								0	2	11	10	9	3	3	5	10	6	3	6	2	10	5	4	4	9	5	4	9
EL									5	19	6	12	2	6	4	21	3	0	6	1	6	8	13	6	5	4	0	12
ES										67	34	88	18	16	27	90	16	7	20	11	49	37	61	26	68	17	13	74
FI											4	34	8	4	15	25	11	6	13	2	24	21	25	7	28	14	4	18
FR												34	16	22	26	62	16	9	23	7	33	38	49	18	64	26	9	36
HR													3	7	8	11	6	4	8	4	9	7	16	8	9	6	8	6
HU														4	8	16	6	3	10	4	6	10	17	8	11	9	6	12
IE															4	18	11	9	12	7	15	14	22	10	20	11	6	14
IT																57	14	4	24	5	43	36	60	28	33	25	6	61
LT																	4	7	13	5	10	14	18	8	16	13	6	12
LU																		2	8	5	4	4	5	4	9	7	3	2
LV																			4	4	10	21	23	9	17	19	6	11
MT																				6	6	3	8	4	7	6	3	3
NL																					14	18	26	10	32	14	8	40
PL																						3	32	13	28	18	3	24
PT																							16	24	26	25	12	32
RO																								11	13	6	5	19
SE																									12	16	7	34
SI																										2	6	9
SK																											1	4
UK																												30

Source: Authors' calculations based on eCORDA. Note: on the main diagonal are the number of cooperations (participants) within home country.

Annex 10. Proportion of average scores of Estonian applications from maximum score obtained



Source: Authors' calculations based on eCORDA

Annex 11. Success rates by action types

	COFUND-EJP	COFUND-PCP	COFUND-PPI	CSA	CSA-LS	ERA-NET-Cofund	ERC-ADG	ERC-COG	ERC-LVG	ERC-POC	ERC-STG	IA
BG	2.00			0.19	0.60	2.00	0.00	0.00		0.00	0.00	0.08
CY	1.00			0.19		1.00	0.00	0.06		0.70	0.00	0.09
CZ	0.27	0.25		0.23	1.00	1.25	0.05	0.14		0.00	0.08	0.13
EE	2.00			0.21	0.50	0.94	0.00	0.17		0.00	0.04	0.15
HR	0.75	0.00		0.22	0.50	0.75	0.00	0.06			0.00	0.04
HU	1.50			0.17	0.71	1.00	0.00	0.14		0.11	0.15	0.07
LT	0.80	0.00		0.15	0.50	1.22	0.00	0.00			0.00	0.09
LV	1.33	0.00		0.18		1.22	0.00	0.00			0.00	0.07
MT				0.31	0.33	1.00		0.00			0.13	0.08
PL	1.50	0.50		0.21	0.60	1.03	0.01	0.03		0.50	0.04	0.09
RO	0.20			0.19	1.00	1.06	0.00	0.03			0.03	0.13
SI	1.00	1.00		0.16	1.00	1.06	0.04	0.00		0.00	0.00	0.12
SK	0.80			0.22		1.17	0.00	0.14			0.00	0.07
EU13 Total	0.72	0.25		0.20	0.67	1.08	0.01	0.07		0.29	0.05	0.10
AT	0.38	0.00	1.00	0.23	0.75	0.95	0.18	0.18		0.44	0.18	0.15
BE	0.50	0.75	0.00	0.28	0.56	1.01	0.15	0.17		0.32	0.13	0.17
DE	0.30	0.57	1.00	0.26	1.00	0.94	0.17	0.21	1.00	0.35	0.18	0.17
DK	0.63	0.60	0.00	0.22	1.00	1.00	0.15	0.14		0.36	0.10	0.15
EL	0.80	0.00		0.20	0.71	0.87	0.03	0.03		0.36	0.02	0.13
ES	0.50	0.70	0.40	0.21	1.00	0.88	0.08	0.09		0.45	0.08	0.14
FI	1.67	0.25	0.00	0.27	0.75	1.03	0.08	0.08		0.35	0.06	0.13
FR	0.47	0.83		0.32	0.70	0.97	0.11	0.18		0.27	0.19	0.16
IE	2.00	1.00		0.24	0.60	0.96	0.04	0.12		0.27	0.14	0.12
IT	0.55	0.38		0.20	0.87	0.93	0.08	0.08		0.30	0.05	0.13
LU		1.00		0.39	1.00	1.17	0.33	0.20			0.13	0.13
NL	0.43	0.29	1.00	0.28	1.00	0.97	0.15	0.23	1.00	0.37	0.19	0.16
PT	0.63	0.00		0.19	1.00	0.92	0.10	0.11		0.36	0.08	0.13
SE	0.50	0.50		0.22	1.00	1.02	0.08	0.14		0.33	0.10	0.18
UK	0.60	0.67		0.24	0.63	0.81	0.15	0.18		0.32	0.13	0.15
EU15 Total	0.53	0.51	0.46	0.24	0.80	0.95	0.12	0.15	1.00	0.34	0.12	0.15
Grand Total	0.58	0.49	0.46	0.23	0.76	0.97	0.11	0.15	1.00	0.34	0.12	0.14

Annex 11 Continued

	JTI-BBI-CSA	JTI-BBI-IA-DEMO	JTI-BBI-IA-FLAG	JTI-BBI-RIA	JTI-CS2-IA	JTI-CS2-RIA	JTI-ECSEL-IA	JTI-ECSEL-RIA	JTI-FCH2-CSA	JTI-FCH2-IA	JTI-FCH2-RIA Total	JTI-IMI2-CSA	JTI-IMI2-RIA	JTI-SESAR-CSA	JTI-SESAR-IA	JTI-SESAR-RIA	JTI-Shift2Rail-CSA	JTI-Shift2Rail-IA
BG	0.00	0.00		0.00	1.00	0.00	0.00	0.00	0.67		0.00		0.00			0.00		
CY		0.00		0.14							0.00		0.00					
CZ		0.00	0.00	0.00	0.54	0.60	0.50	0.15	0.00		0.18	0.00	0.12	1.00	1.00	0.60	1.00	
EE	1.00	0.00		0.00						0.00	0.17		0.00			0.00		
HR		0.55		0.14					0.00	0.00	0.67		0.00	1.00	1.00	0.93		
HU		0.43	0.50	0.00			0.57	0.22	1.00			1.00	0.00	1.00		0.56		
LT		0.00		0.17				0.80			0.17		0.00	1.00	1.00	0.93		
LV		0.00	0.00	0.05	0.17	0.00	0.00	0.19	1.00	0.50	0.33		0.00			0.00		
MT			0.00	0.00						1.00	0.00		0.00			0.10		
PL	1.00	0.50	0.00	0.15	0.11	0.00	0.44	0.02	0.17	0.00	0.00	0.00	0.07	1.00	1.00	0.36		
RO		0.20	0.00	0.13	0.00	0.00	0.33	0.25	0.33		0.00		0.00			0.00		
SI	0.00	0.17	0.00	0.00		0.00		0.33	0.33		0.13		0.21			1.00		
SK	1.00	1.00	1.00	0.14	0.00		0.80	0.20	0.00		0.00			1.00	1.00	0.52	1.00	
EU13 Total	0.43	0.36	0.27	0.09	0.31	0.19	0.51	0.15	0.30	0.18	0.12	0.33	0.08	1.00	1.00	0.49	1.00	
AT	0.00	0.17	0.18	0.28	0.46	0.17	0.63	0.18	0.50	0.88	0.21	0.00	0.25	1.00	1.00	0.64		
BE	0.50	0.33	0.42	0.43	0.33	0.35	0.50	0.22	0.17	0.35	0.22	0.13	0.27	0.80	0.67	0.55	1.00	
DE	0.47	0.27	0.24	0.38	0.46	0.41	0.52	0.19	0.43	0.45	0.30	0.08	0.26	1.00	1.00	0.38		1.00
DK	0.00	0.13	0.15	0.27		0.00	0.50	0.24	0.38	0.71	0.32	0.00	0.23	1.00	1.00	0.68		
EL	1.00	0.07	0.20	0.10	0.26	0.27	0.31	0.10	0.33	0.11	0.11		0.06			0.08		
ES	0.20	0.44	0.00	0.32	0.29	0.26	0.37	0.15	0.29	0.29	0.27	0.00	0.24	0.83	0.78	0.43	1.00	1.00
FI	1.00	0.19	0.25	0.48		0.00	0.29	0.15	0.50	0.67	0.37	0.00	0.28			0.33	1.00	
FR		0.38	0.30	0.42	0.35	0.59	0.36	0.23	0.58	0.47	0.27	0.27	0.23	1.00	0.93	0.55	1.00	1.00
IE		0.30	0.75	0.16	0.00	0.00	0.47	0.31			0.00		0.18	1.00	1.00	0.81		
IT	0.67	0.33	0.35	0.18	0.34	0.24	0.29	0.22	0.36	0.28	0.25	0.17	0.25	1.00	0.67	0.36	1.00	1.00
LU							1.00	0.00				1.00	0.42			1.00		
NL	0.55	0.55	0.25	0.37	0.90	0.86	0.47	0.18	0.11	0.33	0.33	0.67	0.46	1.00	1.00	0.39		
PT	1.00	0.10		0.15	0.33	0.40	0.27	0.10	1.00	0.00	0.13	0.00	0.08			0.13		1.00
SE	1.00	0.44	0.40	0.47	0.29	0.41	0.41	0.22	0.33	0.38	0.29	0.14	0.25	1.00	1.00	0.58		
UK	0.44	0.24	0.25	0.22	0.37	0.40	0.15	0.12	0.36	0.46	0.27	0.32	0.31	1.00	1.00	0.33	0.50	1.00
EU15 Total	0.52	0.32	0.24	0.31	0.36	0.37	0.43	0.19	0.35	0.43	0.27	0.19	0.28	0.96	0.91	0.46	0.87	1.00
Grand Total	0.51	0.32	0.24	0.29	0.36	0.36	0.43	0.18	0.35	0.42	0.25	0.20	0.27	0.97	0.92	0.46	0.89	1.00

Annex 11 continued

	JTI-Shift2Rail-RIA	MSCA-COFUND-DP	MSCA-COFUND-FP	MSCA-IF-EF	MSCA-IF-GF	MSCA-ITN-EID	MSCA-ITN-EJD	MSCA-ITN-ETN	MSCA-RISE	PCP	PPI	RIA	SGA-CSA	SGA-RIA	SME-1	SME-2	H2020-EEN-SGA
BG	1.00		0.00	0.06	0.00	0.00	0.00	0.04	0.15	1.00		0.09	0.37	1.25	0.01	0.00	
CY	0.00			0.10	0.25	0.00	0.40	0.04	0.27	0.00		0.09	0.22	1.50	0.05	0.03	6.00
CZ	0.62	0.00	0.11	0.08	0.05	0.00	0.13	0.10	0.25	0.00		0.11	0.21	1.33	0.03	0.05	6.00
EE			0.00	0.09	0.22	0.50	0.09	0.05	0.22			0.08	0.20	1.33	0.11	0.05	2.00
HR	0.43		0.00	0.06	0.00	0.17	0.14	0.04	0.16	0.00		0.09	0.00	1.50	0.02	0.00	2.00
HU			0.00	0.10	0.04	0.00	0.25	0.06	0.18	0.33		0.11	0.42	1.20	0.03	0.04	1.89
LT	0.00			0.19	0.00	0.00	0.00	0.11	0.06	0.00		0.07	0.30	1.50	0.08	0.03	8.00
LV				0.07	0.00		0.00	0.09	0.07			0.10	0.13	3.00	0.04	0.03	2.00
MT		0.00		0.00	0.00		0.25	0.00	0.17			0.08	0.15	1.50	0.08	0.04	2.00
PL	1.00	0.38	0.25	0.08	0.08	0.50	0.07	0.07	0.18	0.00		0.10	0.09	1.25	0.05	0.03	2.00
RO	0.50			0.05	0.00	0.00	0.12	0.02	0.16	0.00		0.09	0.02	1.50	0.01	0.00	1.97
SI	2.00			0.05	0.17	0.10	0.13	0.06	0.21	0.00		0.10	0.34	1.33	0.05	0.06	2.80
SK	0.20			0.04		0.20	0.14	0.08	0.26			0.10	0.26	1.50	0.04	0.00	8.00
EU13 Total	0.53	0.27	0.11	0.08	0.10	0.13	0.10	0.07	0.18	0.18		0.10	0.20	1.40	0.04	0.03	2.40
AT	0.87	0.14	0.14	0.16	0.07	0.11	0.17	0.11	0.41	0.00	0.00	0.12	0.22	1.25	0.15	0.07	2.00
BE	0.26	0.50	0.10	0.16	0.13	0.11	0.22	0.11	0.30	0.80	0.00	0.14	0.09	1.10	0.09	0.01	1.75
DE	0.72	0.17	0.16	0.16	0.17	0.18	0.11	0.10	0.36	0.38	1.00	0.14	0.19	1.00	0.09	0.06	2.38
DK	0.00	1.00	0.40	0.19	0.15	0.14	0.07	0.10	0.36	0.17		0.14	0.00	1.20	0.16	0.08	2.50
EL	0.00	0.00	0.00	0.11	0.09	0.14	0.00	0.07	0.33	0.33		0.12	0.00	1.25	0.04	0.02	4.00
ES	0.62	0.28	0.23	0.14	0.11	0.14	0.17	0.08	0.31	0.52	0.80	0.12	0.03	0.95	0.10	0.07	2.76
FI	0.20	0.33	0.00	0.12	0.11	0.33	0.04	0.08	0.34	0.50		0.12	0.29	1.60	0.09	0.07	2.33
FR	0.68	0.42	0.06	0.15	0.12	0.09	0.10	0.09	0.34	0.80	1.00	0.16	0.02	0.93	0.11	0.04	2.44
IE	1.00		0.53	0.14	0.21	0.20	0.07	0.11	0.35	0.00		0.12	0.00	1.25	0.13	0.11	5.00
IT	0.51	0.15	0.06	0.11	0.11	0.10	0.11	0.08	0.31	0.15	0.75	0.10	0.07	1.00	0.07	0.04	2.38
LU		0.00		0.14		0.00	0.29	0.08	0.55			0.13	0.13	1.50	0.08	0.05	2.00
NL	0.42	0.44	0.17	0.19	0.20	0.23	0.18	0.10	0.35	0.50	1.00	0.14	0.17	1.06	0.10	0.06	2.25
PT	0.75	0.00	0.20	0.11	0.08	0.00	0.10	0.07	0.27	0.57		0.11	0.37	1.00	0.11	0.03	6.00
SE	0.67	0.33	0.25	0.12	0.11	0.19	0.14	0.10	0.32	1.00		0.13	0.23	1.00	0.16	0.06	2.00
UK	0.27	0.18	0.13	0.20	0.21	0.14	0.11	0.10	0.36	0.05	1.00	0.13	0.12	1.04	0.12	0.06	2.33
EU15 Total	0.55	0.27	0.18	0.16	0.14	0.15	0.12	0.09	0.33	0.33	0.74	0.13	0.15	1.04	0.10	0.06	2.45
Grand Total	0.55	0.27	0.17	0.16	0.14	0.15	0.12	0.09	0.31	0.31	0.74	0.13	0.17	1.08	0.08	0.05	2.44

Source: Authors' calculations based on eCORDA. Note: Blank cells indicate no applications in the respective action types, and success rates 1 or above throughout specific action types indicate non-application-based funding allocation, including ones, which require substantial financial commitment on behalf of partners.

Annex 12. Number of projects in different Action Types of H2020 in Estonia

Pillar	Action type	Action type	Number of Participations
Excellent Science	**CSA**	Coordination and support action	13
	ERC-COG	Consolidator Grant	1
	ERC-STG	Starting Grant	1
	MSCA-IF-EF-RI	Reintegration panel	1
	MSCA-IF-EF-ST	Standard EF	2
	MSCA-IF-GF	Global Fellowships	4
	MSCA-ITN-EID	European Industrial Doctorates	2
	MSCA-ITN-EJD	European Joint Doctorates	1
	MSCA-ITN-ETN	European Training Networks	5
	MSCA-RISE	RISE	8
	RIA	Research and Innovation action	7
	SGA-RIA	SGA-RIA	4
Excellent Science Total			**49**
Industrial Leadership	**CSA**	Coordination and support action	8
	CSA-LS	CSA Lump sum	1
	ERA-NET-Cofund	ERA-NET Cofund	3
	H2020-EEN-SGA	Specific Grant Agreement Enterprise Europe Network (EEN)	10
	IA	Innovation action	7
	RIA	Research and Innovation action	9
	SME-1	SME instrument phase 1	14
	SME-2	SME instrument phase 2	5
Industrial Leadership Total			**57**
Science with and for Society	**CSA**	Coordination and support action	7
	ERA-NET-Cofund	ERA-NET Cofund	1
	RIA	Research and Innovation action	1

Pillar	Action type	Action type	Number of Participations
Science with and for Society Total			**9**
Societal Challenges	**CSA**	Coordination and support action	33
	ERA-NET-Cofund	ERA-NET Cofund	11
	IA	Innovation action	27
	JTI-BBI-CSA	Bio-based Industries Coordination and Support action	1
	JTI-FCH2-RIA	Research and Innovation action	1
	RIA	Research and Innovation action	39
	SME-1	SME instrument phase 1	16
	SME-2	SME instrument phase 2	2
Societal Challenges Total			**130**
Spreading excellence and widening participation	**CSA**	Coordination and support action	13
	SGA-CSA	Specific Grant agreement and Coordination and Support Action	5
Spreading excellence and widening participation Total			**18**
Grand Total			**263**

Source: Authors' calculations based on eCORDA

Annex 13. Cooperation patterns in different Action Types of H2020, comparisons of EU28 and Estonia

Action Type	EU28							Estonia						
	Projects	Coordi-nator	Participants					Projects	Coordi-nator	Participants				
			HES	REC	PUB	PRC	OTH			HES	REC	PUB	PRC	OTH
COFUND-EJP	2	REC	2	2	2		1							
	1	PUB	1	1	1	1	1							
								2	Not EE	2				
COFUND-PCP	3	REC	2	3	1	2	1							
	2	PUB	1	2	2	2	2							
	1	PRC	1		1	1								
	1	OTH		1	1	1								
COFUND-PPI	1	HES		1	1		1							
CSA	237	HES	181	139	60	125	87	12	HES	1			1	1
	296	REC	176	221	111	148	134							
	107	PUB	30	51	51	37	45							
	263	PRC	99	112	46	130	113	1	PRC					
	149	OTH	65	81	58	88	89	4	OTH	1	1		2	1
								48	Not EE	17	2	6	6	19
ERA-NET	1	HES		1	1									
	21	REC	2	21	21	3	13							
	22	PUB	5	18	22	5	9							
	2	PRC		2	2	1	2							
	1	OTH	1	1	1	1	1							
								14	Not EE	1		5		9
ERC	1980	HES	122	60	3	19	2	1	HES					

Action Type	EU28							Estonia						
	Projects	Coordi-nator	Participants					Projects	Coordi-nator	Participants				
			HES	REC	PUB	PRC	OTH			HES	REC	PUB	PRC	OTH
	671	REC	37	20	2	2		1	REC					
	2	PUB												
	19	PRC	2											
	3	OTH	2			1								
H2020-EEN-SGA	6	HES	2	4	2	2	4							
	19	REC	10	8	14	13	15							
	79	PUB	12	19	61	37	43							
	30	PRC	6	2	20	22	15	2	PRC				2	2
	29	OTH	9	11	17	12	24							
IA	121	HES	99	85	27	120	47	1	HES			1		
	189	REC	142	158	53	185	77							
	16	PUB	14	16	13	15	12							
	308	PRC	224	204	72	306	84							
	16	OTH	6	14	4	15	13							
								18	Not EE	5	3	2	10	3
JTI	91	HES	56	54	11	66	14							
	153	REC	72	87	20	112	14							
	6	PUB	1	5	3	5	2							
	209	PRC	101	115	31	162	25							
	11	OTH	9	7	2	9	5							
	2	N/A	1	1	1									
								2	Not EE				2	
MSCA	3413	HES	485	284	37	367	37	9	HES				1	
	928	REC	67	54		61	2	1	REC					
	22	PUB												

Action Type	EU28							Estonia						
	Projects	Coordi-nator	Participants					Projects	Coordi-nator	Participants				
			HES	REC	PUB	PRC	OTH			HES	REC	PUB	PRC	OTH
	79	PRC	17	6		7		1	PRC	1	1		1	
	8	OTH												
								6	Not EE	5			1	
MSCAcofund	25	HES	12	9	1	16	4							
	48	REC	44	30	1	34	5							
	2	PUB	2	1			1							
	13	PRC	13	9		11	2							
	1	OTH	1	1			1							
PCP	2	HES	2	2	2	1	1							
	1	REC		1	1									
	2	PUB	2	1	2	1	1							
	1	OTH	1	1	1	1	1							
PPI	2	REC		2	1	1	2							
RIA	676	HES	646	545	175	572	194	3	HES				2	
	612	REC	563	525	151	546	181							
	21	PUB	21	15	9	20	8							
	306	PRC	279	259	68	291	79							
	24	OTH	22	22	14	22	14							
								47	Not EE	29	6	4	9	1
SGA-CSA	20	HES	17	14	2	2	4	1	HES			1		
	6	REC	4	6	2	1								
	14	PUB	12	14	2	3	1							
	2	OTH	1					1	OTH	1				
SGA-RIA	2	HES	2	2	1	1	1							
	3	OTH	3	3	3	3	3							

Action Type	EU28							Estonia						
	Projects	Coordi-nator	Participants					Projects	Coordi-nator	Participants				
			HES	REC	PUB	PRC	OTH			HES	REC	PUB	PRC	OTH
								4	Not EE	1				3
SME-1	1	HES				1								
	1856	PRC				130		28	PRC				2	
	1	OTH												
SME-2	479	PRC				76		6	PRC					
								1	Not EE				1	
FPA	16	HES	182	75	3	56	4	1	HES			1		
	5	REC	3	9	4	1								
	12	PUB	18	17	2	5	1							
	2	OTH	9	11	9	4	1	1	OTH	2				
								2	Not EE	1				1

Source: Authors' calculations based on eCORDA

Annex 14. Estonian Participation in Partnership Initiatives

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
Joint Technology Initiatives (with industry under Article 187):			
Innovative Medicines Initiative	Founding members are: European Commission and the European Federation for Pharmaceutical Industries and Associations (EFPIA); States Representatives Group includes all EU Member States and the countries associated with the EU's research programs	Estonian Research Council	EMIF 2013-2018, European Medical Information Framework, University of Tartu[15]
Clean Sky (Aeronautics)	Members: BE, CH, DE, EL, ES, FR, IL, IT, LT, MT, NL, PL, RO, SE, UK Partners: AT, BE, BG, CH, CY, CZ, DE, DK, EL, ES, FI, FR, HU, IE, IL, IT, LT, MT, NL, NO, PL, PT, RO, SE, TR, UK		No projects found through programming initiative web-page[16]
Fuel Cell and Hydrogen	Members: the European Union, represented by the European Commission, the Industry Grouping "Hydrogen Europe" and the Research Grouping "N.ERGHY", States Representatives Group includes all EU Member States and the countries associated with the EU's research	Estonian Research Council	2017-2020, Automated mass-manufacturing and quality assurance of Solid Oxide Fuel Cell stacks, AS ELCOGEN[17]
Biobased industries	Members: EU and the Bio-based Industries Consortium, States Representatives Group includes all EU Member States and the countries associated to the EU's research	Estonian Research Council	2016-2018, Increase public awareness of bio-based products and applications supporting the growth of the

[15] http://www.imi.europa.eu/projects-results/maps-statistics
[16] http://www.cleansky.eu/sites/default/files/inline-files/Clean%2520Sky%2520at%2520a%2520Glance%2520FINAL.pdf
[17] http://www.fch.europa.eu/fchju-projects

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			European bioeconomy, CIVITTA EESTI AS[18]
Electronic components and systems	Members: EPoSS, AENEAS and ARTEMIS Industry Association, the European Union, Member States and Associated Countries to the Framework Programme Horizon 2020 on a voluntary basis	Entreprise Estonia, Estonian Research Council[19]	No recipients of ECSEL JU Grants for Research Actions, Calls 2014-2016[20]
Joint programs (with Member States, under Article 185)			
European and Developing Countries Clinical Trials Partnership (EDCTP)	AT, DE, DK, FI, FR, ES, IE, IT, LU, NL, NO, PT, SW, UK		No projects found through programming initiative web-page[21]
European Metrology Research Programme (EMPIR)[22]	AT, BA, BE, BG, HR, CH, CZ, DE, DK, EE, ES, FI, FR, GR, HU, IE, IT, NL, NO, PL, PT, RO, RS, SE, SI, SK, TR, UK	AS Metrosert	2017-2020, Pavement surface characterization for smart and efficient road lighting, AS Metrosert; 2017-2020, Further metrology for earth observation and climate, Tartu Observatory – Estonian Ministry of Education and Research (Estonia)

[18] https://www.bbi-europe.eu/projects
[19] http://www.ecsel.eu/sites/default/files/2017-09/members_pab_january_2016_v1.pdf
[20] http://www.ecsel.eu/transparency-reporting
[21] http://www.edctp.org/projects-2/edctp2-projects/
[22] European Metrology Research Programme, https://www.euramet.org/research-innovation/research-empir/about-empir/

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			2016-2019, Traceability routes for electrical power quality measurements, AS Metrosert 2016-2019, Future photometry based on solid-state lighting products, AS Metrosert 2015-2018, Optical metrology for quantum enhanced secure telecommunication, AS Metrosert 2015-2018, Metrology for the photonics industry – optical fibres, waveguides and applications, AS Metrosert, University of Tartu 2015-2018, Traceable calibration of automatic weighing instruments operating in the dynamic mode, AS Metrosert
Eurostars (for SMEs)	Countries with public support: AT, BE, BG, CA, CH, CY, CZ, DK, ES, FI, FR, HR, HU, IE, IL, IS, IT, KR, LT, LU, LV, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR, UK, ZA	Enterprise Estonia	No ongoing projects found through programming initiative web-page, 13

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
	Countries without public support: EE, GR		completed projects before or incl. in 2015[23]
Active and Assisted Living Programme (AAL 2)	AT, BE, CA, CH, CY, DE, DK, ES, FI, FR, GR, HU, IE, IL, IT, LU, NL, NO, PL, PT, RO, SE, SI, UK		No projects found through programming initiative web-page[24]
BONUS: Joint Baltic Sea Research Programme	DE, DK, EE, FI, LT, LV, PL, SE	Estonian Research Council	FP7: BONUS BAMBI 2014-2017, Baltic Sea marine biodiversity – addressing the potential of adaptation to climate change, University of Tartu[25] FP7: BONUS BIO – C3 2014-2017 Biodiversity changes – causes, consequences and management implications, University of Tartu H2020: BONUS MICROPOLL, 2017-2020: Multilevel assessment of microplastics and associated pollutants in the Baltic Sea, Tallinn University of Technology

[23] https://www.eurostars-eureka.eu/eurostars-projects?search_api_views_fulltext=Estonia&field_project_date_value=&field_project_date_value2=&field_shared_countries=&field_shared_technologies=&field_project_call_id=

[24] http://www.aal-europe.eu/our-projects/

[25] Ongoing Bonus projects as of October 2017, https://www.bonusportal.org/files/4526/2017_09_07_BONUS_projects_Oct_2017.pdf

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			FP7: BONUS BALTCOAST 2015-2018, A systems approach framework for coastal research and management in the Baltic, Tallinn University FP7: BONUS MICROALGAE 2014-2017, Cost efficient algal cultivation systems – a source of emission control and industrial development, Tallinn University of Technology (coordinating partner) FP7: BONUS SWERA 2014-2016, Sunken wreck environmental risk assessment, Tallinn University of Technology FP7: BONUS STORMWINDS 2015-2018, Strategic and operational risk management for wintertime maritime transportation system, Tartu University, Tallinn University of Technology

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			FP7: BONUS SHEBA 2015-2018, Sustainable shipping and environment of the Baltic Sea region, Tallinn University of Technology FP7: BONUS INSPIRE 2014-2018, Integrating SPatIal pRocesses into Ecosystem models for sustainable utilization of fish resources, University of Tartu (coordinator) FP7: BONUS GO4BALTIC 2015-2018, Coherent policies and governance of the Baltic Sea ecosystems, Stockholm Environment Institute Tallinn Centre FP7: BONUS BLUEPRINT, 2014-2017, Biological lenses using gene prints – Developing a genetic tool for environmental monitoring in the Baltic Sea, University of Tartu H2020: BONUS INTEGRAL 2017-2020, Integrated

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			carbon and trace gas monitoring for the Baltic Sea, Tallinn University of Technology FP7: GEOILWATCH 2014-2016, Geopositional early warning system for marine oil spill recognition in the Baltic Sea, Tallinn University of Technology (coordinator) FP7: FERRYSCOPE 2014-2016, Bridging the divide between satellite and shipborne sensing for Baltic Sea water quality assessment, University of Tartu FP7: FISHVIEW 2014-2017, Assessing fish passibility using a robotic fish sensor and enhanced digital imaging, Tallinn University of Technology (coordinator) FP7: HARDCORE 2014-2017, Harnessing Coastal Radars for Environmental Monitoring Purposes, Tallinn

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			University of Technology
ERA-Net Cofund			
BiodivERsA3 2015-2020: Consolidating the European Research Area on biodiversity and ecosystem services	AT, BE, BG, CH, DE, EE, ES, FR, HU, LT, NL, NO, PL, PT, RO, SE, TR, UK	Estonian Research Council	BIOVEINS – Connectivity of green and blue infrastructures: living veins for biodiverse and healthy cities, Estonian University of Life Sciences SoilMan – Ecosystem services driven by the diversity of soil biota – understanding and management, University of Tartu SOILCLIM – Managing soil biodiversity and ecosystem services in agroecosystems across Europe under climate change, University of Tartu IMAGINE – Integrative Management of Green Infrastructures Multifunctionality, Ecosystem integrity and Ecosystem Services: From assessment to regulation in socio-ecological systems,

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			Estonian University of Life Sciences
BiodivScen 2017-2022: Promoting and implementing joint programming at the international level to reinforce research on the development of scenarios of biodiversity and ecosystem services	AG, AT, BE, BG, BR, DE, EE, ES, FI, FR, HU, IE, LT, NL, NO, PL, RO, SE, SK, TR	Estonian Research Council	No funded projects yet[26]
CHIST-ERA III 2017-2022: European coordinated research on long-term ICT and ICT-based scientific challenges	AT, BE, BG, CH, CZ, EE, ES, FI, FR, IE, IT, LT, PL, RO, SK, TR	Estonian Research Council	No funded projects yet
CoBioTech 2016-2021 Cofund on Biotechnologies	AG, BE, CH, DE, EE, ES, FR, IL, IT, LV, NL, NO, PL, PT, RO, RU, SI, TR, UK	Estonian Research Council	SCALEAPP (suggested for funding in 2017) Investigating large-scale bioreactor effects in microbial application, Center of Food and Fermentation Technologies YOGURTDESIGN (suggested for funding in 2017)

[26] https://www.era-learn.eu/network-information/networks/biodivscen

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			Microbial community modeling for the production of "designer" yogurt, University of Tartu
CORE Organic Plus 2016-2021: Coordination of European Transnational Research in Organic Food and Farming Systems Cofund	AT, BE, CH, DE, DK, EE, ES, FI, FR, IT, LV, NL, NO, PL, RO, SE, SI, TR, UK	Ministry of Rural Affairs	No funded projects yet[27]
ERA-CVD 2015-2020, ERA-NET on cardiovascular diseases to implement joint transnational research projects and set up international cooperations.	AT, BE, DE, EE, ES, FR, IL, IT, LV, NL, NO, PL, PT, RO, SI, SK, TR, TW	Estonian Research Council	DETECTIN-HF (2016-?) Determining the role of clinical and epigenetic risk markers in dilated cardiomyopathies and heart failure, University of Tartu
ERA-PLANET 2016-2021, The European network for observing our changing planet	AT, CH, CZ, DE, DK, EE, ES, FI, FR, GR, IT, RO, SE, SI, UA	Estonian University of Life Sciences	iCUPE 2017-2020, Integrative and Comprehensive Understanding on Polar Environments, Estonian University Of Life Sciences[28]

[27] https://www.era-learn.eu/network-information/networks/core-organic-cofund/core-organic-call-2016
[28] http://www.era-planet.eu/index.php/calls/

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
EuroNanoMed III 2016-2021: 2016-2021, ERA-NET ON NANOMEDICINE	BE, CA, DE, EE, ES, FR, GR, IE, IL, IT, LT, LV, NL, NO, PL, PT, RO, SK, TR, TW	Estonian Research Council	No 2014-2017 projects found through programming initiative web-page[29]
FACCE SURPLUS 2015-2020: Sustainable and Resilient agriculture for food and non-food systems	BE, CY, DE, DK, EE, ES, FI, FR, IT, NL, NO, PL, RO, UK	Ministry of Rural Affairs	No projects found through programming initiative web-page[30]
FACCE SusCrop 2018-2022: ERA-NET Cofund on Sustainable Crop Production	AT, BE, DE, DK, EE, ES, FI, FR, IE, IT, LV, NL, NO, PL, TR, UK	Ministry of Rural Affairs	No calls yet
GENDER NET Plus 2017-2022: ERA-NET Cofund Promoting Gender Equality in H2020 and the ERA	AT, BE, CA, CY, CZ, EE, ES, FR, IE, IL, IT, NO, SE	Estonian Research Council	No funded projects yet
HERA JRP UP 2015-2019: HERA JOINT RESEARCH PROGRAMME USES OF THE PAST	AT, BE, HR, CH, CZ, DE, DK, EE, ES, FI, FR, IE, IS, IT, LT, LU, LV, NL, NO, PL, PT, SE, SI, UK	Estonian Research Council	MODSCAPES – Modernist reinventions of the rural landscapes, Estonian University of Life Sciences
HERA-JRP-PS 2015-2019: HERA Joint Research Programme European Public Space, Culture and	AT, BE, CH, CZ, DE, DK, EE, ES, FI, FR, HR, IE, IL, IT, LT, LU, LV, NL, NO, PL, SE, SI, SK, UK		No funded projects yet

[29] http://www.euronanomed.net/projects-funded/7th-joint-call-2016/
[30] http://faccesurplus.org/about-facce-surplus/

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
Integration			
M-ERA.NET 2 2016-2021, ERA-NET for materials research and innovation	AT, BE, BG, BR, CY, CZ, DE, EE, ES, FR, HU, IE, IL, IS, IT, LT, LU, LV, NL, NO, PL, PT, RO, RU, SE, SI, SK, TR, TW, ZA, Observers: FI, KR	Estonian Research Council	No projects found[31]
SusAn 2016-2021, European Research Area on Sustainable Animal Production Systems	AT, BE, CZ, DE, DK, EE, ES, FI, FR, GR, IE, IT, LT, LV, NL, NO, PL, PT, SE, SI, SK, TR, UK	Ministry of Rural Affairs	No projects found[32]
SUSFOOD2 2017-2021, ERA-Net Cofund on Sustainable Food production and consumption	BE, DE, DK, EE, ES, FI, FR, IE, IT, NL, NO, RO, SE, TR, UK	Ministry of Rural Affairs	No projects found
TRANSCAN-2: Aligning national/regional translational cancer research programs and activities	AT, BE, DE, EE, ES, FR, GR, HU, IL, IT, LV, NL, NO, PL, PT, SI, SK, TR, TW	Estonian Research Council	CEVIR Cancer evolution and identification of relapse-initiating cells, HANSABIOMED Ltd[33] PROMETOV Proteogenomic and targeted metabolomic analysis of ovarian cancer heterogeneity and its contribution to recurrence and therapy resistance, Tartu University Hospital

[31] https://www.era-learn.eu/network-information/networks/m-era-net-2/m-era-net-call-2016
[32] www.era-susan.eu/sites/default/files/SusAn_CofundedCall_results-list_published.pdf
[33] http://www.transcanfp7.eu/index.php/pages/funded-projects.html

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
Water Works 2014-2019 in Support of the Water JPI	BE, CY, DK, EE, ES, FI, FR, IE, IL, IT, MD, NL, NO, PT, RO, SE, TR, UK, ZA	Ministry of Environment, Estonian Research Council	IMDROFLOOD – Improving Drought and Flood Early Warning, Forecasting and Mitigation using real-time hydroclimatic indicators, University of Tartu
WaterWorks2017 2018-2022: Water Works 2018-2022 in Support of the Water JPI (WaterWorks2017) and of the EC Call SC5-33-2017: Closing the water cycle gap	BE, BR, CY, EE, EG, ES, FI, FR, IE, IL, IT, MD, NL, NO, PL, RO, SE, TN, ZA	Estonian Research Council	No funded projects yet
ERA-CAPS (self-sustained) 2015-…: ERA-Net for Coordinating Action in Plant Sciences	AT, BE, CH, DE, DK, FR, PL, PT, RS, UK, US, observers: EE, European Union, IL IT, LV, NL, NZ, NO	Estonian Research Council	No projects found through programming initiative web-page[34]
ERA-NET plus (Active)			
WSF 2014-2018 – Welfare State Futures	AT, DE, DK, EE, FI, FR, IE, IS, NL, NO, PL, PT, SE, SI, UK	Estonian Research Council	HEALTHDOX The Paradox of Health State Futures, university of Tartu[35]
FACCE Era Net Plus Food security, Agriculture, Climate Change ERA-NET	BE, CH, CY, CZ, DE, DK, EE, ES, FI, FR, IE, IL, IT, NL, NO, RO, SE, UK	Estonian Ministry of Rural Affairs	Climate-Smart Agriculture on Organic Soils, University of Tartu

[34] http://www.eracaps.org/joint-calls/era-caps-funded-projects
[35] https://www.era-learn.eu/network-information/@@overview-projects?cid=d3d273084e1c476ab4e0b7f03517d79f

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
plus			The WaterWorks2015 ERA-NET Cofund is a collaboration of Water JPI and FACCE JPI.
ERA.Net RUS plus 2013-2018: Further linking Russia to the ERA: Coordination of MS/ AC S&T programs towards and with Russia	AT, CH, DE, EE, ES, FI, FR, GR, IL, LV, MD, PL, RO, RU, SK, TR	Estonian Research Council	ACTICOAT (funding decision in 2017) Active Environmentally friendly coatings for light metals based on combination of nano- and micro-containers, University of Tartu HeDoCat (2017) Novel Heteroatom-doped Nanocarbon Catalysts for Fuel Cell and Metal-air Battery Applications, National Institute of Chemical Physics and Biophysic BalticLitter (2017) Litter rim of the Baltic Sea coast: monitoring, impact, and remediation, University of Tartu EAT Estates After Transition, Faculty of Science and Technology, Institute of

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			Ecology and Earth Sciences
CORE Organic Plus 2013-2018: Coordination of European Transnational Research in Organic Food and Farming Systems	AT, BE, DE, DK, EE, ES, FI, FR, IT, LT, LV, NL, NO, PL, RO, SE, SI, TR, UK	Estonian Ministry of Rural Affairs	FertilCrop – Fertility-building management measures in organic cropping systems, Estonian University of Life Sciences FaVOR-DeNonDe Drying, Juices and Jams of Organic Fruit and Vegetables: what happens to Desired and Non-Desired compounds?, Estonian University of Life sciences SoilVeg Improving soil conservation and resource use in organic cropping systems for vegetable production through introduction and management of Agro-ecological Service Crops (ASC), Estonian partner n/a[36]
Joint Programming Initiatives (JPIs)			

[36] https://www.era-learn.eu/network-information/networks/core-organic-plus/core-organic-plus-call/improving-soil-conservation-and-resource-use-in-organic-cropping-systems-for-vegetable-production-through-introduction-and-management-of-agro-ecological-service-crops-asc-soilveg

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
JPND Alzheimer and other Neurodegenerative Diseases	AL, AT, AU, BE, BG, CA, CH, CZ, DE, DK, ES, FI, FR, GR, HR, HU, IE, IL, IT, NO, PL, PT, RO, SE, SI, SK, TR, UK	-	No ongoing projects found through programming initiative web-page[37]
FACCE JPI 2010-2022: Agriculture, Food Security and Climate Change[38]	AT, BE, CH, CY, CZ, DE, DK, EE, ES, FI, FR, IE, IL, IT, NL, NO, NZ, PL, RO, SE, TR, UK	Ministry of Rural Affairs	Prowaste, Protein-fibre fibre biorefinery for scattered material streams, Center of Food and Fermentation Technologies, Estonia MACSUR is a knowledge hub within FACCE-JPI, Estonian University of Life Sciences The WaterWorks2015 ERA-NET Cofund is a collaboration of Water JPI and FACCE JPI.
JPI Cultural Heritage 2009-2022: Cultural Heritage and Global Change: A New Challenge for Europe	BE, BY, CY, CZ, DK, ES, FR, IE, IT, LT, LV, MD, NL, NO, PL, PT, RO, SE, SK, UK, observers: AT, BG, DE, EE, GR, IL	Ministry of Culture	No projects found through programming initiative web-page[39]
JPI Urban Europe – Global Urban Challenges, Joint European Solutions	AT, BE, CY, DE, DK, FI, FR, IT, LV, NL, NO, SE, SI, UK Observers: ES, PL, PT, RO, TR, more countries are involved in specific activities	-	No projects found through programming initiative web-page[40]
JPI Climate 2012-2022:	AT, BE, DE, ES, FI, FR, IE, IT, NL, NO, SE, UK	Estonian	No projects found through

[37] http://www.neurodegenerationresearch.eu/supported-projects/
[38] http://www.faccejpi.com/
[39] http://www.jpi-culturalheritage.eu/
[40] http://jpi-urbaneurope.eu/app/uploads/2017/06/JPI-UE-Projects-Catalogue-2017-2.0-170608.pdf

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
Connecting Climate Knowledge for Europe	Associated: DK, EE, RO, SI, TR Observer institutions: NordForsk European Environment Agency (EEA) European Space Agency (ESA) European Climate Research Alliance (ECRA)	Environment Agency, Marine Systems Institute Tallinn University of Technology, Ministry of Environment	programming initiative web-page[41]
More Years, Better Lives – The Potential and Challenges of Demographic Change	AT, BE, CA, CH, DE, DK, ES, FI, FR, IL, IT, NL, NO, PL, SE, SI, UK	-	No projects found through programming initiative web-page[42]
JPI AMR 2012-2022: Antimicrobial Resistance – The Microbial Challenge – An Emerging Threat to Human Health	AR, BE, CA, CH, CZ, DE, DK, EE (observer), EG, ES, FI, FR, GR, IE, IL, IN, IT, JP, NL, NO, PL, RO, SE, TR, UK, ZA	Ministry of Social Affairs	No projects found through programming initiative web-page[43]
Water JPI 2011-2022: Water Challenges for a Changing World	AT, CY, DE, DK, EE, ES, FI, FR, IE, IL, IT, MD, NL, NO, PL, PT, RO, SE, TR, UK Observers: BE, GR, HU, LV	Ministry of Environment	The WaterWorks2015 ERA-NET Cofund is a collaboration of Water JPI and FACCE JPI. No projects found through programming initiative web-page[44]

[41] http://www.jpi-climate.eu/joint-activities/joint-calls/2016finalresults
[42] http://www.jp-demographic.eu/calls/projects/#1513327277182-549982f0-7cfd
[43] https://www.jpiamr.eu/supportedprojects/

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
JPI Oceans 2011-2022: Healthy and Productive Seas and Oceans	BE, DE, DK, EE, ES, FR, GR, HR, IE, IS, IT, LT, NL, NO, PL, PT, RO, SE, TR, UK Observer: MT	Ministry of the Environment, Ministry of Rural Affairs, University of Tartu	No projects found through programming initiative web-page[45]
JPI HDHL 2010-2020: A Healthy Diet for a Healthy Life	AT, BE, CA, CH, DE, DK, ES, FI, FR, IE, IT, NL, NO, NZ, PL, RO, SK, TR, UK, observers: CY, CZ, EE, IL, LV, SE, SI	Ministry of Social Affairs	No projects were found[46]
cPPP			
5G Infrastructure Public Private Partnership	European Commission and European ICT industry		No participation found[47]
Big Data Value Public-Private Partnership	European Commission and the Big Data Value Association (BDVA)	No members from Estonia in BDVA	
EeB Energy-efficient Buildings	European Commission and the private sector as represented by the Energy Efficient Buildings Association (E2BA)		MORE-CONNECT, Development and advanced prefabrication of innovative, multifunctional building envelope elements for modular retrofitting and smart connections, Tallinn

[44] http://www.waterjpi.eu/index.php?option=com_content&view=article&id=229&Itemid=712
[45] http://www.jpi-oceans.eu/search-joint-actions-and-projects
[46] https://www.era-learn.eu/network-information/networks/era-hdhl/preliminary-announcement-biomarkers-in-nutrition-and-health
[47] https://5g-ppp.eu/wp-content/uploads/2017/11/5GPPP-brochure-phase2-final-web.pdf

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
			University of Technology, AS Matek, REF Ehitustööd[48]
EGVI The European Green Vehicles Initiative	European Commission and European Green Vehicles Initiative Association (EGVIA)	No members from Estonia were found[49]	No projects
FoF Factories of the Future	European Commission and the private sector as represented by the European Factories of the Future Research Association	No members from Estonia were found	No projects
HPC High Performance Computing Contractual Public-Private Partnership	European Commission, ETP4HPC European Centres of Excellence in Computing Applications[50]		No projects
Photonics	European Commission and Photonics 21 Association		
SPARC is a Public-Private Partnership in Robotics	European Commission and euRobotics AISB		
SPIRE Sustainable Process Industry PPP: efficient and smart processes meeting the needs of tomorrow	European Commission together with Sustainable Process Industry Association		1 Project
FETFLAGSHIP			
Graphene Flagship	List of Partners: https://graphene-flagship.eu/project/Pages/Consortium.aspx	University of Tartu	1 Project
Human Brain Project Flagship	www.humanbrainproject.eu/en/open-ethical-engaged/contributors/partners/		
Quantum Flagship			

[48] http://www.buildup.eu/sites/default/files/content/eeb_ppp_project_review_2017.pdf
[49] https://egvi.eu/about-egvia/members
[50] http://ec.europa.eu/programmes/horizon2020/en/news/overview-eu-funded-centres-excellence-computing-applications

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
KIC			
EIT Climate-KIC[51]: addressing climate change mitigation and adaptation	Mediterranean: France, Italy, Spain North-Eastern: Germany & Poland Benelux: the Netherlands & Belgium Alpine & Hungary: Austria, Switzerland Nordic: Denmark, Sweden & Finland UK & Ireland	Cleantech Forest (SME)	Pioneers into Practice program hosted in 2016[52] Climate Launchpad national finals hosted in August 2017 Estonia is part of the Climathon movement and is hosting the global 24-hour climate change hackaton in October 2017
EIT Digital[53]: addressing Information and Communication Technologies	Brussels Head Office Berlin Node Budapest Node Eindhoven Node Helsinki Node London Node Madrid Node Paris Node Stockholm Node Trento Node Silicon Valley hub		Startup Wise Guys serve as Innovation Centre for the ARISE Europe program MoU signed with Startup Estonia in May 2017 StartupNations Summit in November 2017

51 https://eit.europa.eu/eit-community/eit-climate-kic
52 www.etag.ee/wp-content/uploads/2017/08/2017-10-13_Presentation_EIT_MK_draft.pdf
53 http://eit.europa.eu/eit-community/eit-digital

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
EIT InnoEnergy[54]: addressing sustainable energy	Benelux Iberia Alps Valleys Sweden Poland Plus Germany	Skeleton Technology OÜ	Technopol has become an EIT Energy Hub in Estonia Estonia hosts a start-up competition PowerUp! during Autumn of 2017
EIT Health[55]: addressing healthy living and active aging	London (UK/Ireland) Stockholm (Scandinavia) Barcelona (Spain) Paris (France) Heidelberg (Germany) Rotterdam (Belgium-Netherlands)	University of Tartu (Estonian Genome Center)	
EIT Raw Materials[56]: addressing sustainable exploration, extraction, processing, recycling and substitution	Baltic Sea Co-location Centre (in Espoo, Finland) Central Co-location Centre (in Metz, France) Eastern Co-location Centre (in Wroclaw, Poland) Nordic Co-location Centre (in Luleå, Sweden) Southern Co-location Centre (in Rome, Italy) Western Co-location Centre (in Leuven, Belgium)	Tallinn University of Technology	
EIT Food[57]: putting Europe at the center of a global revolution in food innovation and production	Leuven – CLC West (Belgium, France, Switzerland) London – CLC North-West (UK, Ireland, Iceland) Madrid – CLC South (Spain, Italy, Israel) Munich – CLC Central (Germany, The Netherlands)		

54 https://eit.europa.eu/eit-community/eit-innoenergy

55 http://eit.europa.eu/eit-community/eit-health

56 http://eit.europa.eu/eit-community/eit-raw-materials

57 https://eit.europa.eu/eit-community/eit-food

Initiative	Participating countries/organizations	EE participation	Projects with EE participation (in H2020 or FP7, which are still active in 2015-2017)
	Warsaw – CLC North-East (Poland, Finland)		

Annex 15. The Methodology of Data Envelopment Analysis

The methodology is based on Choi et al. 2004, where the calculation of the DEA efficiency level is as follows:

$$\text{Max } h_0 = \sum_{i=1}^{m} v_i x_0$$

subject to

$$-\sum_{r=1}^{s} u_r y_{rj} + \sum_{i=1}^{m} v_i x_{ij} \leq 0$$

$$\sum_{r=1}^{s} u_r y_{r0} = 1$$

$$u_r, u_i \geq \epsilon, \forall_r, i$$

where m is the number of inputs, s is the number of outputs, u_r and v_i are weights on outputs and inputs of country$_j$ efficiencies; x_{ij} is i^{th} input of country$_j$. and y_{cj} is cth output of country$_j$. Here, x_{i0} and y_{r0} are inputs and outputs from one country$_0$ (this is one of the countries chosen for the evaluation).

Next is a linear programming technique transforming the function according to the duality principal as follows:

$$\text{Max} h_0 = \theta$$

subject to

$$-\sum_{i=1}^{n} \lambda_j y_{rj} + \sum_{r=1}^{s} \theta y_{r0} + s_r^+ = 0$$

$$\sum_{i=1}^{n} \lambda_i x_{ij} + s_i^- = x_{i0}$$

$$u_r, u_i \geq \epsilon, \forall_r, i$$

$$i = 1,2, \cdots n\,; r = 1,2, \cdots s\,, s_c^+, s_i^-, \geq 0, \forall_i, r, j$$

According to the characteristics of the research, the output-oriented model of DEA is a suitable one. It is to calculate the best possible combination of outputs with fixed inputs so that it finds out which group uses inputs the most efficiently and produces the most outputs among the groups.

$$\text{Max} h_0 = \frac{\sum_{i=1}^{m} v_i x_{i0} + v_0}{\sum_{r=1}^{s} u_r y_{r0}}$$

$$\text{subject to}$$

$$\frac{\sum_{i=1}^{m} v_i x_{ij} + v_0}{\sum_{r=1}^{s} u_r y_{rj}} \geq 1$$

$$u_r \geq \epsilon \geq 0, v_i \geq \epsilon \geq 0, r, i = 1,2, \cdots s, m$$

where, v_0 means whether a model assumes constant returns to scale or not. if v_0 is positive, negative and zero, the model assumes increasing returns to scale, decreasing returns to scale and constant returns to scale.

Lastly, the following is a calculation of the optimal level of efficiency with slacks on inputs and outputs values:

$$\text{Max } \theta + \epsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$$

$$\text{subject to}$$

$$\sum_{i=1}^{m} \lambda_i x_{ij} + s_i^- = x_{i0}$$

$$\sum_{r=1}^{s} \lambda_r y_{rj} - s_r^+ = \theta y_{r0}$$

$$\lambda_j > 0$$

$$s_c^+, s_r^-, \geq 0 \; ; m = 1,2, \cdots m \; ; s = 1,2, \cdots s; j = 1,2, \cdots n$$

where, s_c^+ and s_r^- are slacks on inputs and outputs.

Annex 16. Thematic Efficiency Scores

Country	Climate action, environment, resource efficiency and raw materials			Euratom	Europe in a changing world – inclusive, innovative and reflective societies		Excellent Science			Food security, sustainable agriculture and forestry, marine and maritime and inland water research		Health, demographic change and wellbeing		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2015	2016	2014	2015	2016
AT	0.694	0.774	0.740	0.946	0.578	1.000	0.516	1.000	0.958	0.512	0.560	0.487	0.897	0.449
BE	1.000	1.000	1.000	0.701	0.922	1.000	0.805	1.000	0.922	1.000	1.000	1.000	1.000	1.000
BG	0.872	1.000	0.056	1.000	1.000	0.203	1.000	1.000	1.000	1.000	0.395	0.280	0.599	0.756
CY	0.809	1.000	1.000	1.000	1.000	0.971	1.000	0.974	1.000	0.720	0.265	0.859	0.866	0.167
CZ	1.000	1.000	0.500	1.000	1.000	0.353	1.000	1.000	0.673	1.000	0.287	1.000	1.000	0.321
DE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DK	1.000	1.000	1.000		1.000	0.560	1.000	1.000	1.000	1.000	0.638	1.000	1.000	0.942
EE	1.000	1.000	0.576	1.000	1.000	1.000	1.000	0.864	0.755	1.000	0.514	0.612	1.000	0.210
EL	0.392	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.786	1.000	0.609	1.000	1.000	0.727
ES			1.000			1.000			0.801		1.000			1.000
FI	0.865	1.000	0.522	0.739	0.499	0.558	0.382	0.771	1.000	0.739	0.716	0.619	1.000	0.894
FR	0.833	1.000	0.947	0.463	0.972	0.645	0.763	1.000	0.892	1.000	0.922	1.000	1.000	0.873
HR	1.000	1.000	0.213	1.000	1.000	0.296	1.000	1.000	0.266	0.736	0.596	0.924	0.674	0.598
HU	1.000	1.000	0.567	0.792	1.000	0.477	1.000	1.000	0.630	1.000	0.474	1.000	1.000	0.046
IE	1.000	1.000	1.000	1.000	1.000	0.543	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
IT	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.966	1.000	1.000	1.000	1.000	0.947
LT		1.000	0.107	0.922	0.556	0.983	1.000	0.953	0.457	1.000	0.799			0.312
LU	0.919	1.000	0.750	1.000	1.000	1.000	1.000	1.000	0.710	1.000	1.000	1.000	1.000	1.000
LV	1.000		0.549		1.000	0.493	1.000	1.000	0.246		0.578	1.000	1.000	0.663
MT	1.000		1.000		1.000	0.362	1.000	0.556	1.000	0.771	1.000	1.000		0.857
NL	1.000		1.000	0.676	0.676	0.701	1.000		1.000	0.609	1.000	0.690		1.000
PL	0.845	0.606	0.539	0.805		0.575	0.965	0.703	0.708	1.000	0.554	1.000	0.640	0.467
PT	1.000	1.000	1.000	1.000	0.779	0.713	1.000	1.000	0.755	0.876	0.595		0.851	0.703
RO	1.000	1.000	0.994	1.000	0.731	0.474	1.000	0.847	0.702		0.515	1.000	0.685	0.401
SE	1.000	1.000	0.529	0.896	1.000	0.525	1.000	1.000	0.846	1.000	1.000	1.000	1.000	0.940

Country	Climate action, environment, resource efficiency and raw materials			Euratom	Europe in a changing world – inclusive, innovative and reflective societies		Excellent Science			Food security, sustainable agriculture and forestry, marine and maritime and inland water research		Health, demographic change and wellbeing		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2015	2016	2014	2015	2016
SI	1.000	1.000	0.793	1.000	1.000	0.579	1.000	1.000	0.675	1.000	0.345	1.000	0.640	0.697
SK	1.000	0.400	0.810	0.826	0.658	1.000	0.620	0.880	1.000	0.347	1.000	0.727	0.517	0.332
UK	1.000	1.000	1.000	0.618	1.000	1.000	1.000		1.000	1.000	0.881	1.000		1.000
Min	0.392	0.400	0.056	0.463	0.499	0.203	0.382	0.556	0.246	0.347	0.265	0.280	0.517	0.046
Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Annex 16 continues

Country	Innovation in SMEs			Leadership in enabling and industrial technologies (LEIT)			Science with and for Society		Secure societies – Protecting freedom and security of Europe and its citizens		Secure, clean and efficient energy			Smart, green and integrated transport		SEWP
	2014	2015	2016	2014	2015	2016	2015	2016	2015	2016	2014	2015	2016	2015	2016	2015
AT	1.000	0.563	0.549	1.000	1.000	0.904	1.000	1.000	0.796	0.842	1.000	1.000	1.000	1.000	1.000	0.617
BE	0.583	0.579	1.000	1.000	1.000	1.000	1.000	1.000	0.740	0.973	1.000	1.000	1.000	1.000	1.000	1.000
BG	1.000	1.000	1.000	1.000	0.742	0.185	1.000	0.488	1.000	0.195	1.000	1.000	0.709	0.726	0.472	1.000
CY	1.000	0.917		0.906	0.374	0.803	1.000	1.000	1.000	0.281	0.290	0.657	1.000	0.561	1.000	1.000
CZ	1.000	1.000		1.000	1.000	0.544	1.000	0.084	1.000	0.646	1.000	1.000	0.910	1.000	0.823	1.000
DE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DK	1.000	0.513	0.388	0.669	1.000	0.890	1.000	0.876	0.930	0.698	0.614	1.000	1.000	1.000	0.792	0.343
EE	0.676	1.000		1.000	1.000	0.467	1.000	0.570	1.000	0.422	1.000	1.000	0.716	1.000	0.060	1.000
EL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.682	0.214
ES			1.000			1.000		0.813		1.000			0.996		1.000	
FI	0.361	0.170	0.298	0.776	0.799	0.754	0.282	1.000	1.000	0.930	0.744	0.807	0.838	0.635	1.000	0.579
FR	1.000	1.000	0.635	1.000	1.000	1.000	1.000	0.415	1.000	0.755	0.595	1.000	0.974	1.000	1.000	0.755
HR	1.000	1.000		0.197	0.803	0.148	1.000		0.599	0.341	1.000	1.000	0.711	0.837	0.771	1.000
HU	0.982	1.000	0.406	0.886	1.000	0.400	1.000	0.413	0.454	0.215	0.775	0.832	0.515	1.000	0.671	1.000
IE	0.800	1.000	0.657	1.000	1.000	0.651	1.000	0.573	1.000	1.000	0.856	1.000	0.782	1.000	0.929	1.000
IT	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LT	1.000	1.000	0.236	0.758	1.000	0.429	1.000	0.745				0.588	0.517	0.390	0.955	0.562
LU	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.718	1.000	1.000	1.000	1.000	1.000	1.000	0.205	1.000
LV	1.000	1.000		1.000	1.000	0.249	1.000		1.000	0.115	1.000	1.000	0.630	1.000	0.290	1.000
MT	1.000	1.000		1.000	0.351	1.000	1.000		1.000	1.000	1.000	0.626	0.932	1.000	1.000	1.000
NL	0.467		0.602	1.000		0.917		0.857		0.699	1.000		1.000		0.826	
PL	0.112	1.000	0.578	0.822	0.668	0.388	0.680	0.591	0.494	0.466	1.000	0.776	0.500	0.959	0.346	0.903
PT	0.668	0.754	0.469	1.000	1.000	0.697	0.616	0.335	1.000	0.845	1.000	1.000	0.659	0.792	0.530	1.000
RO	1.000	1.000	0.145	1.000	0.913	0.466	0.967	0.094	1.000	0.426	1.000	0.925	1.000	1.000	0.509	1.000
SE	0.786	1.000	0.372	1.000	1.000	0.794	0.750	0.223	1.000	0.733	1.000	1.000	0.973	1.000	0.913	0.515
SI	1.000	0.955	1.000	1.000	1.000	0.637	0.959	1.000	1.000	0.384	1.000	1.000	1.000	1.000	0.556	1.000
SK	0.514	0.864		0.449	0.743	0.772	0.554	0.198	0.206	0.238	0.340	0.575	0.709	0.169	1.000	0.511

Country	Innovation in SMEs			Leadership in enabling and industrial technologies (LEIT)			Science with and for Society		Secure societies – Protecting freedom and security of Europe and its citizens		Secure, clean and efficient energy			Smart, green and integrated transport		SEWP
	2014	2015	2016	2014	2015	2016	2015	2016	2015	2016	2014	2015	2016	2015	2016	2015
UK	0.741		0.598	1.000		0.815		0.733		0.940	1.000		0.801		0.646	
Min	0.112	0.170	0.145	0.197	0.351	0.148	0.282	0.084	0.206	0.115	0.290	0.575	0.500	0.169	0.060	0.214
Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Annex 17. The List of Interviewees

Target Group	Date	The representative
NATIONAL LEVEL		
UNIVERSITIES	10 April 2017	A focus group with Dr. Malle Krunks (Director and Lead Researcher) and Dr. Maarja Grossberg (Senior Researcher), School of Engineering, Department of Materials and Environmental Technology, TTÜ
	12 April 2017	A focus group with Prof. Jüri Elken and Prof. Urmas Lips, School of Science, Department of Marine Systems, TTÜ
	21 April 2017	A focus group with Prof. Gert Jervan, Prof. Jaan Raik and Prof. Maarja Kruusmaa, School of Information Technologies, Department of Computer Systems / Department of Computer Engineering, TTÜ
	25 April 2017	Dr. Kai Pata, Senior Researcher, School of Digital Technologies, Centre for Educational Technology, Tallinn University
	25 April 2017	Prof. Ellu Saar, School of Governance, Law and Society/previously Institute of International and Social Studies, Tallinn University
	17 May 2017	Prof. Erkki Truve, School of Science, Department of Chemistry and Biotechnology, TTÜ
	19 May 2017	A focus group with Prof. Jarek Kurnitski and Prof. Targo Kalamees, School of Engineering, Department of Civil Engineering and Architecture, TTÜ
	2 June 2017	A focus group with Prof. Maaja Vadi and Prof. Urmas Varblane, School of Economics and Business Administration, University of Tartu
	20 June 2017	Dr. Marco Kirm, Vice-rector of Research, University of Tartu
	22 June 2017	Prof. Ülle Jaakma, Vice-Rector of Research, Estonian University of Life Sciences
	8 September 2017	Dr. Veiko Karu, School of Science, Department of Geology, TTÜ
	12 September 2017	A focus group with Aivar Auväärt, Liina Kotkas and Marika Lunden, Research Administration Office, TTÜ
ENTERPRISES		
	28 April 2017	Rene Jõeleht, CEO, Optofluid Technologies OÜ
	5 May 2017	Dr. Peeter Laud, Scientific Director, Cybernetica AS
	23 May	Silver Toomla, Managing Partner / Senior Consultant, Invent

	2017	Baltics OÜ
	13 June 2017	Dr. Jako Kilter, Power System Expert, Elering AS / Associate Professor, School of Engineering, Department of Electrical Power Engineering and Mechatronics, TTÜ
	29 May 2017	Dr. Peep Küngas, CEO of SOA Trader OÜ, Senior Research Fellow at University of Tartu, Institute of Computer Science
POLICY-MAKERS		
NCPs	30 May 2017	A focus group with Ülle Must (Chief Specialist, Joint Research Centre, other forms of International collaboration, incl. COST), Margit Ilves (Senior Advisor Financial Aspects, SMEs, EIT), Ülle Napa (Senior Advisor on Climate Action, Environment, Resource Efficiency and Raw Materials)
MINISTRIES	28 September 2017	Külli Kaare, the Head of Research and Development Department, the Ministry of Rural Affairs

