Evaluation of investments in Research and Technological Development (RTD) infrastructures and activities supported by the European Regional Development Funds (ERDF) in the period 2007-2013

Contract N° 2018CE16BAT111

Case study report

Estonia

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LIST OF ABBREVIATIONS

CS	Case study
CA	Contribution analysis
ESIF	European Structural and Investment Funds
ERDF	European regional development Fund
FP7	7th Framework Programme
GDP	Gross Domestic Product
GERD	Gross Expenditure on research and Development
H2020	Horizon 2020
HE	Higher Education
HEI	Higher Education Institution
IA	Implementing Agency
ICT	Information and Communication Technology
MA	Manging Authority
MS	Member State
NSRF	National Strategic Reference Framework
OP	Operational Programme
OP DEE	Operational Programme for Development of Economic Environment
R&D	Research and Development
R&DI	Research and Development and Innovation
RTD	Research, Technology and Development
SME	Small and Medium Size Enterprise
ToC	Theory of Change

EXECUTIVE SUMMARY

BACKGROUND AND GOAL OF THE CASE STUDY

Over the past decade, research and innovation have become a cornerstone of EU-level political and strategic goals. During the 2007-2013 programming period, over EUR 16 b of European Regional Development Fund (ERDF) resources (almost 5% of the total ERDF allocation) were invested through 212 OPs in projects supporting RTD infrastructure, competence centres and activities in the EU Member States and regions (codes 01 and 02).

This case study has been carried out in the framework of the Evaluation of Investments in Research and Technological Development (RTD) infrastructures and activities supported by the ERDF in the period 2007-2013. The evaluation's main objective is to identify the effectiveness of RTD infrastructures and activities, their coherence with other policies, their efficiency, relevance, and, Overall as part of the evaluation, a total of seven case studies (CS) have been carried out to illustrate the concrete effects of ERDF-supported RTD policy instruments. Case studies were designed to examine the use of funding for different policy instruments in the selected Member States and the specific context in which they were implemented, their rationale, their effectiveness and their long-term sustainability.

The case study looks into the ERDF support for RTD infrastructure investments in Estonia under the Operational Programme for the Development of the Economic Environment (OP DEE) 2007-2013. The OP DEE covers the sectors of entrepreneurship, R&D, transport and information society. The OP is a national one; it covers the whole territory of Estonia (there were no regional OPs in Estonia during this period). The case study analyses in detail three policy instruments implemented under the OP DEE:

1. **Infrastructure investments for research**, where investments into research equipment were conducted;
2. **Infrastructure investments for education in HEIs**, where HEIs' buildings were renovated or built;
3. **Collaborative R&D projects in Centres of Excellence**, where activities of Centres of Excellence were funded.

In addition to ERDF, the R&D system was also funded by the national government through baseline funding and research grants and other international programmes. In 2007 the share of government funding in total investments into R&D was 45.6% (while public sector R&D expenditures were at the level of 0.5% from GDP), making the public sector the main source of funding of R&D in Estonia. At the same time, the share of international programmes in Estonian R&D was 11.7% (about EUR 20 m), making Estonia's participation rate at FP7 27.6%.

OVERVIEW OF KEY FINDINGS AND CONCLUSIONS

The R&D policy context at the national level

ERDF support for RDI during 2007-2013 was delivered in the context of a broader national strategy implemented by the Estonian government. The Estonian RDI Strategy for the timeframe 2007-2013 called "Knowledge-Based Estonia" built up on the Baltic nation's potential while acknowledging as much as addressing some of the national RDI system's main shortcomings (e.g. chronic underfunding of infrastructure, lack of participation in international research networks, etc.). The three main objectives formulated in 2007 concern *i) "the competitive quality and increased intensity of research and development", ii) "innovative entrepreneurship creating new value in the global economy",* as well as *iii) "innovation-friendly society aimed at long-term development."* The R&DI strategy 2007-

2013 established a clear focus on developing R&D as a catalyst for wider innovation in the business sector.

These ambitions set by the RDI strategy were explicitly incorporated into the ERDF OPs, particularly Axis 2 of the DEE OP, focusing on developing the R&D system. As such, ERDF funding was from its very early stages, designed to support the achievement of overarching national ambitions. In particular, the OP DEE was built as the key instrument to fill the nation's R&D infrastructure gap. More globally, ERDF funds were designed to complement national RTD funding under the strategic objectives through the three OPs developed for 2007-2013. There are no links between the ERDF OPs and regional policies, given that all funding was managed at the national level, and the country was not equipped with regional innovation or research strategies or policies. As such, the regional dimension of ERDF support for RDI is limited.

The overarching contribution of cohesion funds represented approximately 3% of the country's GDP between 2007-2013. The OP 'Development of Economic Environment' funded 548 different projects thanks to a total ERDF contribution of EUR 328.5 m. Of this sum, 32.0% was dedicated to RTD activities, while 68.0% was geared towards RTD infrastructures and competence centres. In terms of the typology of institutions displaying the highest concentration of ERDF contribution channelled through the OP DEE, the vast majority (about 84.0%) were Higher Education Institutions. Research and Technology Organisations, on the other hand, only account for 6% of all contributions made through this OP (see Figure 4).

The rationale behind the OP DEE policy mix lies in the fundamental belief that R&D-based innovation is the main driver for economic growth. Such growth requires intensive R&D, which can be conducted only based on an attractive R&D environment. Concerning the R&D infrastructure, about 80% of the R&D infrastructure was in poor condition and outdated at the time. A large part of it was inherited from the Soviet period. Such infrastructure failed to contribute to top-level research and educational activities, thereby restricting the Estonian research community's participation in international research networks. Furthermore, the outdated research infrastructure and low attractiveness of Estonia for foreign researchers and companies set limits to increasing the volume of contractual R&D and collaboration with businesses.

The wider rationale behind the OP DEE was to develop a holistic approach to the development of the Estonian R&D and higher education system. This combined European Structural and Investment Funds investments into research infrastructure ('hard') and developing skills, mobility of researchers and internationalisation activities ('soft'). Investments into research infrastructure involved modernisation research equipment (laboratories and apparatus) and research and higher education environment (renovating or building new buildings) and developing the Centres of Excellence. This approach was expected to increase Estonian research and higher education quality, making it more visible and attractive for international students and researchers, leading to higher research quality and international collaboration.

Generally, the OP DEE was conceived as a catalyst to foster participation in FP7 as the key areas of Estonia's R&D competences (biotechnologies, ICT, materials technologies) are subsets of the themes of the Framework Programme. Also, infrastructure projects related to FP7 activities and human resources development in technology-related fields were prioritised by ERDF OPs.

Achievement of intended effects of the analysed policy instruments (i.e. effectiveness)

Overall, the three key policy instruments deployed under the ERDF in support of RDI during the period are considered very successful. There is widespread consensus among

interviewed stakeholders that these instruments have allowed moving the needle when it comes to the quality and the performance of the Estonian education and research system, and that these investments have been key in overhauling the system and reducing the gap with regard to the country's European neighbour. However, it is worth mentioning that the monitoring systems put in place as part of ERDF OP implementation were extremely weak (both in terms of the quality of indicators, availability of baseline data, and calculation of targets). As such, the body of available data – particularly quantitative data - enabling a full assessment of programme performance is extremely limited. This is particularly true of data relating to expected outcomes and impacts of the three tools.

As a result of ERDF 2007-2013 investments, all six Estonian public universities' research investment needs were addressed largely. To illustrate this, a total of 17 buildings were built or renovated for a total amount of EUR 111 m of ERDF funds. Furthermore, 293 projects were funded under a small-scale research infrastructure sub-programme, where research groups purchased small-scale research equipment. Research and Higher Education institutions received financing to conduct 100 investment projects for medium-scale research infrastructure (research equipment and laboratories). In addition, nine research objects of the Estonian research roadmap were funded, addressing the national interest needs. All in all, EUR 83 m of ERDF funds were invested in the modernisation of research equipment. Also, 12 Centres of Excellence were funded for a total ERDF amount of EUR 40 m.

In practice, demand for the ERDF RDI tools largely exceeded the supply of funding. This led in many cases to the reallocation of funding to the measures linked to the RDI instruments under consideration from other OP measures. In turn, this enabled to fund a higher number of projects compared to what was initially foreseen. As a result, many of the initially established KPIs and related goals were exceeded. For example, while it was expected the instruments would allow to renovate or build 12,000m2 of modernised space of research and Higher Education Institutions, the actual number was 40,634m2. Twelve Centres of Excellence were supported, rather than the seven which were originally foreseen.

These tools' success cannot be considered the result alone of the high level of demand that existed among target groups. It is also the result of well-executed instrument design, implementation and management. This is illustrated by the very limited adjustments introduced by the managing and implementing authorities during implementation and the high level of support granted by the implementing agencies to applicants and beneficiaries. The instruments were implemented based on a sound assessment of key needs and priorities, both at the level of the country as well as at the level of beneficiary institutions. Needs assessments were often established as pre-conditions to gain access to funding. In addition to this, support structures and measures were put in place to avoid negative impacts on instrument performance, stemming from procurement-related risks and hazards and the potential impacts of the 2008-2010 economic downturn on the selected projects. The continuity of government funding was also a key supporting factor. It allowed making long-term decisions and guaranteed the ability of beneficiary institutions to supply co-financing of ERDF investments. The average cofinancing rate was 15%, which institutions had to cover from their financial resources.

The existence of several supporting factors and the key role played by other RDI instruments (including other ERDF OPs) indicates that the ERDF policy instruments analysed as part of this case study were one of the leading contributors to the observed results. However, their existence alone would not have guaranteed the same level of observed change. Instead, such change also stems from a combination of factors that together enabled the emergence of successful causal pathways.

Evidence collected through document review and interviews confirm that the strategic decision to invest in the modernisation of research infrastructure was reasonable – the highest impact is seen in the increased level of quality and internationalisation of Estonian research, but also Estonia has become more attractive for both international students (i.e. PhDs) and researchers. Furthermore, the combination of both investments into 'bricks' and 'brains' has increased the sustainability of investments, institutions' capacity and competences, and collaboration between institutions. All interviewed higher education and research institutions confirmed that the modernisation of their research infrastructure (both buildings and equipment) created conditions for producing more high-level research, which in hand 'opened doors' into international scientific collaboration programmes. Even if the expected national level impacts were not, perhaps, fully visible at the end of the 2007-2013 period, they became and are becoming visible in subsequent years. For example, the participation of Estonian scientists in H2020 programmes and the number of high-level publications has increased significantly during 2014-2020. This shift would not have been possible without ERDF investments during 2007-2013.

This said, one major blind spot of the instruments lies in their capacity (or lack of) to drive cooperation between the beneficiary research organisation and the private sector. As a result, as the research infrastructure policy instruments were targeted towards HE and research institutions, companies' participation in these projects was extremely limited.

Drivers and barriers to success

A combination of various factors can be seen as the main drivers for the successful implementation of ERDF investments during 2007-2013. There was one implementing agency in charge of implementing all ERDF funds in support of R&D. Overall, the **management system** ran smoothly. It was able to mitigate all disputes arising from the interpretation of ERDF and public procurement rules. The implementing agency and beneficiaries recognised the challenge of applying ERDF and procurement rules on research infrastructure projects. This sometimes led to delays in procurement procedures, the need to review project design and, in some cases, reimbursements (mainly due to non-eligible costs forming 2% of the OP DEE Priority Axis 2 total budget).

The **holistic approach to R&D investments** can be seen as one of the main drivers for long-term results. This approach enhanced, on the one hand, investing into research environment (renovating or building new buildings) and research equipment (labs and apparatus); while at the same time investing into human resources through policy instruments of Centres of Excellence, researchers' mobility, doctoral studies and internationalisation, educating teachers, collaboration and innovation between higher education institutions as well as having system-level approach in modernizing financing system of higher education institutions. Investments made during 2007-2013 gave way to the preconditions for investments and further developments during 2014-2020. Furthermore, **stable funding sources** play a crucial role in the sustainability of R&D – government baseline funding for research and Higher Education institutions have been increasing since 2014, being on the level of 16% from government R&D funding in 2007, reaching 50% in 2020.

Another driving aspect observed is related to clear **prioritisation of investment needs** and joint goals to be achieved. In order to apply for ERDF support, research institutions had to map and prioritise their research infrastructure investment needs. This, in hand, forced institutions to analyse their research potential and identify the most relevant infrastructure needs for high-level research. This self-assessment process became part of further modernisation of research and Higher Education institutions structures and management systems and enabled financing the most important and relevant research infrastructure. Similarly, one of the main driving forces of the Centres of Excellence was the adoption of joint goals among involved research groups. The Centres of Excellence

were good examples of boosting collaboration between research groups and institutions – even when, in practice, they were competitors for limited government funding.

Relevance

The present case study's findings clearly show that ERDF support addressed the highest demands of the Estonian RTD system. There was a considerable gap in investments into research infrastructure during previous decades – the existing infrastructure was outdated and didn't meet modern research needs. The ERDF policy instruments for investments into research infrastructure were designed through a bottom-up and top-down approach. While the R&D and innovation policy was planned, implemented, and monitored at the national level, evidence showed that the policy instruments' planning involved wide consultation with target groups combined with a mapping of investment needs from a national perspective (research roadmap). Geographically, activities under Priority Axis 2 were mainly carried out in two of the county's largest cities - Tallinn and Tartu, which hosted the highest R&D potential in Estonia. The ERDF strategy decided to support leading institutions/regions rather than lagging ones. This said, strengthening Tartu as an R&D centre had a positive impact on Southern Estonia's development. Approaching the matter from yet another angle, namely, from the perspective of science, Engineering and Technology, were clear prime beneficiaries of ERDF funding. This, in turn, is clearly in line with the three priority areas of the 2007-2013 national RDI strategy of ICT, biotechnologies and material technologies.

Efficiency

The ERDF investments into research infrastructure were mainly targeted to support public and private R&D institutions involved in conducting, implementing and/or funding and organising research and development; including R&D institutions, Centres of Excellence, universities and institutions of professional higher education. Having said this, a limited number of companies benefitted from investments into research infrastructure.

The CS found that ERDF investments were significant enough to enable a major shift and bring Estonian research and HE institutions into a new performance level. Even if the number of high-level scientific publications and Estonian researchers' participation in international research and cooperation programmes remained stable during 2007-2013, a clear increase could be observed during 2014-2020. This clearly shows that investments into generating systemic change take time to materialise.

Sustainability and replicability

The case study did not identify any evidence pointing to serious challenges or threats to ERDF investments' sustainability. As ERDF investments were mainly used to support the development of research infrastructure, the main elements for sustainability are stable funding for maintenance of the equipment and buildings and a constant added value of the infrastructure. As the government's baseline funding has increased during 2014-2020 up to 50% of research organisations' total budgets (as compared to only 16% during 2007-2013), it is likely that financial sustainability will not be an issue in the short term. However, interviews still indicated that companies' access to new research infrastructure is limited due to strict ERDF rules (ERDF investments cannot be used for profit-making for more than 20.0% of the total time used of the equipment). If organisations hosting new infrastructure are not able to diversify their sources of revenue, this may put them at risk of being unable to cover operational and maintenance costs in the medium term.

Coherence

The ERDF 2007-2013 investments were meant to act as preconditions for participation in international research programmes, and to a significant extent, this proved to be the case. During 2007-2013, Estonian researchers' participation in the FP7 programme remained

rather stable but rapidly increased in the subsequent H2020 programmes during 2014-2020. This can be attributed in part to the explicit recognition of the European research and innovation programmes in the ERDF support for RDI.

There were also strong linkages among different ERDF OPs implemented during the 2007-2013 period. In practice, the complementary approaches proved beneficial and yielded positive results. This also applies to the complementarities which existed across priority axes within individual ERDF OPs. In addition, links with the Baltic Sea Strategy were built to improve the overall competitiveness of the Baltic Sea Region.

EU added value

The case study found that ERDF investments created no direct EU-wide effects. This said the ERDF is seen as one of the main drivers of developing an increasingly international researcher community in Estonia. It is worth underlying that ERDF investments into research infrastructure created a strong basis for Estonian researchers to participate in international research and cooperation programmes. All interviewees valued this effect and underlined that without the ERDF support, Estonia would not have undergone such an important shift in research quality within such a short period.

1. INTRODUCTION

This case study has been carried out in the framework of the Evaluation of Investments in Research and Technological Development (RTD) infrastructures and activities supported by the European Regional Development Funds (ERDF) in the period 2007-2013. The evaluation's main objective is to identify the effectiveness of RTD infrastructures and activities, their coherence with other policies, their efficiency, relevance, and EU added value. The evaluation covers 53 Operational Programmes (OPs) selected by the European Commission, covering a substantial amount of the RTD funding (EUR 14.64 b, or about 85.0% of the EU total for the relevant themes) provided during this programming period.

As part of the evaluation, a total of seven case studies (CS) have been carried out to illustrate the concrete effects of ERDF-supported RTD policy instruments. Case studies were designed to examine the use of funding for different policy instruments in the selected Member States and the specific context in which they were implemented, their rationale, their effectiveness and their long-term sustainability.

The CS have been conducted based on a Contribution Analysis (CA) approach and the underlying development of Theories of Change (ToC) for selected policy instruments. This involved disentangling the complex causal relationships within different stages of implementation and production of these policy instruments' results in light of identifying the contributions made by the ERDF to improving RTD in specific regions and Member States (MS). This approach aimed to build a detailed narrative of the ToC 'at work' in a particular region/MS and context, addressing the specific conditions influencing the policy rationale (further explored in the cross-case analysis), the interplay of different stakeholders, their expectations and observed effects as a result of the policy instruments.

The pilot case study looks into the ERDF support for RTD infrastructure investments in Estonia under the Operational Programme for the Development of the Economic Environment (OP DEE) 2007-2013. The OP DEE covers sectors of entrepreneurship, R&D, transport and information society. The OP covers the whole territory of Estonia, as there are no regional OPs in Estonia. The case study analyses three policy instruments implemented under the OP DEE OP:

4. **Infrastructure investments for research**, where investments into research equipment were carried out;
5. **Infrastructure investments for education in HEIs**, where HEI buildings were renovated or built;
6. **Collaborative R&D projects in Centres of Excellence**, where activities of the Centres of Excellence were funded.

The case study's main aim is to illustrate the impact of ERDF investments on the development of the R&D system in Estonia. When drafting the OP DEE 2007-2013, Estonia took a holistic approach to the development of the higher education and research system: on the one hand, investments in research infrastructure aimed to create a modern research environment; while on the other hand, they sought to support skills development, mobility of researchers and internationalization aimed to complement the modernization with an increase in knowledge and competences of Estonian HE and research institutions. The current case study examines **investments aimed at modernizing the research environment** through the use of ERDF funding. Between 2007 and 2013, all six Estonian public higher education institutions and several research institutions benefited from ERDF support. This represented the first time research and HE institutions could invest in the research environment at such a scale after 30 years. When developing the OP DEE, most research equipment was outdated, representing a real barrier in enabling Estonian research to become internationally competitive.

Upon the selection of policy instruments, the CS was developed based on the following **methodological approach**:

- **Step 1:** Carry out background research on the selected OP and policy instruments;
- **Step 2:** Screening of key stakeholders;
- **Step 3:** Developing an initial Theory of Change (ToC) for each of the selected instrument and identifying performance metrics;
- **Step 4:** Establishing initial contact with key case study stakeholders, including the first interview with Managing Authority to discuss the initial ToC;
- **Step 5:** Interviews with selected stakeholders;
- **Step 6:** Completing the contribution analysis assessment framework for the selected instruments ToCs;
- **Step 7:** Drafting of case study report.

For background research, a number of OP-related documents and reports and other evaluation and study reports were analysed. The main sources of written evidence used in the development and analysis of the Theory of Change (ToC) were collected from the final report of the Priority Axis 2 of the OP DEE (not publicly available), as well as the mid-term evaluation of higher education and research support measures 2007-2013, and additional reports and strategic documents. The combination of written evidence with stakeholder consultations equipped the research team with sufficient data for developing this case study.

Altogether 16 stakeholders have been consulted in preparing this report – nine interviews were carried out with MA and IA representatives, four interviews with HEIs (the main beneficiary group under the policy instruments in scope) and two with research institutions (Centres of Excellence). It is important to highlight that the policy instruments were only targeted at HEIs and research institutions. Thus, companies' participation was limited in these ERDF projects - companies were mainly involved with very reduced budgets. Their contribution was limited to primarily investing in skills (only two companies invested in research infrastructure).

Overall, the implementation of the policy instruments in scope was well documented, and access to documents and information needed to assess the success of ERDF investments was satisfactory. Also, given the direct involvement of the interviewed stakeholders in implementing the policy instruments or projects, they had a good first-hand recollection of the evidence backing their perceptions. The evaluation team faced challenges in finding stakeholders with a sound overview of the OP and policy instruments' design, given the significant time lag between this period and the present evaluation. Therefore the research team set efforts into finding relevant stakeholders as most of these had changed their positions and moved from the MA or IA. Nevertheless, the research team was successful in finding and consulting relevant stakeholders to develop a full picture regarding the rationale behind the development of the OP Priority Axis 2 objectives. The policy set up as well as the theory of change of the policy instruments in scope.

2. ANALYSIS OF THE POLICY CONTEXT AT THE NATIONAL LEVEL

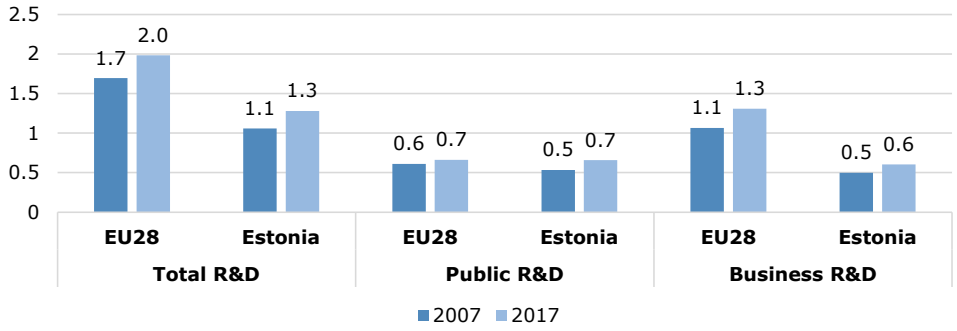
2.1. National RTD objectives and strategies

Estonia joined the EU in 2004 with its more than 1.3m inhabitants as the then second-smallest economy, only trailed by Malta. By the time the programming cycle was launched in 2007, Estonia had almost doubled its GDP while remaining the second-smallest economy throughout the EU. This considerable growth since EU accession is reflected in Estonia's generally liberal economic policy and stable macro environment, which has only been temporarily affected by the 2008 economic crisis (Eurostat, 2020). This economic environment offers favourable economic conditions not only for domestic but also foreign companies. A well-developed ICT and financial sector and relatively fast introduction of ICT in other enterprise sectors have enabled the Estonian economy to grow rapidly. At the same time, relatively cheap production inputs have enabled keeping production costs low while impeding productivity growth. One of Estonia's advantages in global markets is the rule of 0.0% corporate value-added tax on reinvestments.

As defined in the OP 2007-2013, the **main economic challenges** faced by the country include i) low level of R&D and innovation investments; ii) low productivity and added value; iii) inadequate export capability and weak international market position; iv) limited access of starting and innovative enterprises to investment capital; v) concentration of enterprises in Tallinn and around large centres as well as regionally varied and inadequate state of the infrastructure for entrepreneurship; vi) limited knowledge and awareness of entrepreneurship and innovation; vii) low viability and limited growth of newly started enterprises due to low level of entrepreneurship and availability of business development skills; viii) limited collaboration between both enterprises themselves and between enterprises and R&D institutions; ix) limited knowledge and technology transfer. Besides, the lack of human capital and skills related to R&D and higher education is a burning issue in Estonia. This issue, however, is addressed by the OP for Human Resource Development (see latter sections). More specifically, concerning R&D, the OP highlights the main weaknesses of R&D as follows: *i) inadequacies of the physical infrastructure; ii) on average, "satisfactory" and "good" quality of research and development; iii) fragmentation of research and development (overly small research teams); iv) little attention to applied research; v) short-term planning and financing of research and development; vi) inadequate inflow of young R&D specialists and their limited career opportunities within organisations; vii) lack of incentives for collaboration with enterprises;* as well as *viii) low capability for intellectual-property-related issues and administration of contractual research and development work*. All the abovementioned topics are addressed in the OP.

According to Eurostat (2020), the R&D expenditures of Estonian enterprises totalled 0.3% of the GDP in 2004, while the EU25 average was 1.2%. The "Knowledge-based Estonia 2007-2013" strategy adopted the Lisbon strategy goal – a 3.0% share of the GDP – to be achieved by effectively increasing the public sector's share to 1.4% of the GDP (2018: 1.4%, public sector share 0.8%).

Figure 1. Total, public and business R&D expenditure over GDP – 2007 and 2017



Source: CSIL elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of GDP.

In general, the Baltic nation's RTD performance remained stable and largely unchanged between 2007-2017 despite the support received by ERDF (see Figure 1). Weaknesses potentially explaining this performance can be found in the "economic returns that the science system generates and, more narrowly, in the attraction and education of doctoral students in the right areas".[1] A possible explanation may also be the basic structure of the Estonian economy, which continues to be dominated by more traditional sectors lacking higher-added-value potential. Even if the degree of specialisation in these sectors is comparatively high, their R&D potential is by nature rather limited. This notion appears to be representative of the (economic) innovation culture in general, which lacks greater demand-side measures, resulting in a lopsided innovation policy and presence of the notion of innovation as such across all economic and political domains.[2] Further evidence supporting this argument is provided by an identified asymmetry between public and private research and innovation efforts captured in the above-mentioned figures.

The Estonian **science system follows a very different specialisation pattern compared to the business sector** as it finances and supports mostly basic research for which there is little immediate economic demand. At the same time, Estonian manufacturing companies were considered weak in their design and development capacities, both in terms of in-house capabilities and networks they belong to. This results in a situation where public R&DI organisations are not working on applied-research projects, while industry players lack the capacity to engage in such".[3] This mismatch is further applicable to society at large, as societal needs and research, in general, are not in tune and do not serve each other's needs.[4] Moreover, the scarcity of skilled human resources has posed a considerable risk and bottleneck to continued RDI growth in Estonia. While the limited volume of internal skilled labour is as much a logical consequence of the small size of the country; better coordination between economy, industrial, R&DI, social and particularly immigration policies may potentially reduce this bottleneck and improve the overall R&DI system.[1]

The **R&D and higher education framework has gone through major changes** since the beginning of the 1990's - reform of universities (incl. a number of mergers of R&D institutions), R&D funding and higher education has changed the R&D and higher education landscape significantly. The majority of these changes have been funded by the national budget, and even if such changes took place during the implementation period of the OP, they are not directly set as objectives of the OP. R&D policies are drafted by the

1 Christensen, T., Freireich, S., Kolar, J., & Nybergh, P. (2012). Peer-Review of the Estonian Research and Innovation System. Brussels: European Commission.

2 *Ibid.*

3 Eljas-Taal, K., Nausedaite, R., & Beckers, D. (2018). Estonian Research and Innovation System: Background Report. Brussels: European Commission.

4 Makarow, M., Arnold, E., Mercuri, L., Tracey, I., Tsipouri, L., Mulligan, D., Vock, P. (2019). Peer Review of the Estonian R&I System: Final Report. Brussels: European Commission.

Government and reviewed by the Estonian Parliament. The former is advised by the national Research and Development Council. In terms of planning, coordination, execution and monitoring, the Estonian Ministry of Education and Research assume prime responsibility.

Table 1. Evolution of RTD performance in Estonia from 2007 to 2017

	2007	2017	Evolution 07-17
Estonia	Modest +	Modest +	—

Source: CSIL elaboration based on Archimedes

In order to achieve the levels of R&D spending stipulated in the Lisbon Strategy, make Estonia internationally competitive, and an equal partner on the EU level, R&D and innovation activities had to be intensified. The strengthening of Estonia's R&D competitiveness could be ensured by relevant research and technology development in a conjunctive effort between innovation and enterprises to enhance the capability of research and technological development and integrate them into the European research area. At the time of the OP under consideration, Estonia's physical higher education, research and innovation infrastructures were (over-)due to be modernized, and its knowledge base in the form of human capital (e.g. teachers, researchers and top specialists) was considered to benefit from more targeted training and further support mechanisms potentially considerably. In a similar vein, the importance of making use of the cooperation opportunities available to Estonian R&D institutions in the framework of international research organisations (CERN, ESA, EMBC) and the future European Institute of Technology, as well as the opportunities offered by the European Commission was to be stressed.

These trends and proposed measures ultimately link back to the national public R&D budget. While Estonian authorities avoided serious cuts in the budget during the economic crisis 2008-2010, the volume of national contribution to this budget has decreased and has instead increasingly relied on EU sources of funding. This has led to considerable reliance on European structural funds, making up about 50% of all government spending on research. While this does not pose a risk per se, long-term planning and potential consequences are difficult to gauge and may be potentially harmful to a continuous effort to support the development of the RDI system.[3]

The **Estonian RDI Strategy** for the timeframe 2007-2013 called "Knowledge-Based Estonia" builds upon the country's potential while acknowledging as much as addressing the above-mentioned shortcomings. The three main objectives formulated in 2007 concern *i) "the competitive quality and increased intensity of research and development", ii) "innovative entrepreneurship creating new value in the global economy",* as well as *iii) "innovation-friendly society aimed at long-term development."* To achieve these aspirations, measures were grouped in and channelled through four major streams: *i) "development of human capital", ii) "organizing the public sector RD&I more efficiently", iii) "increasing the innovation capacity of enterprises",* as well as *iv)" policy-making aimed at the long-term development Estonia."* In terms of development areas, the national RDI strategy prioritises *i) ICT, ii) Biotechnologies,* and *iii) Material Technologies.*

2.2. The links between national, regional and European objectives and strategies in the field of RTD support

2.2.1. Linkages between national RTD policies and ERDF support

At the time of the 2007-2013 programming cycle, Estonia's RTD policy was developed on a national level and presented in the Knowledge-Based Strategy 2007-2013. RTD activities were funded by public (tax-based) sources through baseline funding and research grants (16% and 84%, respectively)[5]. Baseline funding was supposed to give research and HE institutions stability in funding their basic activities, i.e. covering co-financing participation in ERDF projects. This said, during 2007-2013, the ESIF funding share in the Ministry of Education and Research budget increased significantly, reaching 60% by 2013 (vs about 8% in 2008). ERDF funds were designed to complement national RTD funding under the strategic objectives of the three OPs developed for 2007-2013. In addition to the OP DEE, the two other national OPs which can be linked to RDI development efforts were:

1) **Operational Programme for the Development of Living Environment 2007-2013 in Estonia:** Priority Axis 4 (Integral and Balanced development of Regions), support measure 4.4.4 (Strengthening of the competitiveness of regions) includes activities: Development of regional industrial parks and logistics centres; Creation and strengthening of regional innovation systems and operations directed to the development of regional business networks and competence centres (in particular based on county centres).
2) **Operational Programme for Human Resources development 2007-2013 in Estonia:** Priority Axis 2 (Sustainable and attractive research and development) supports ESF activities in research and development. The priority axis supports the development of research quality, PhD studies and internationalisation, collaborations between universities and innovation, adjusting to a knowledge-based economy, and developing the research funding system of research institutions.

The **strongest synergies** among ERDF OPs existed between the OP DEE (the OP under assessment) and the OP for Development of Human Resources (HRD) 2007-2013. These stemmed from complementarities in training human resources in higher education, R&D human resources, knowledge, and skills for innovative enterprises. In addition to the general technical capacity building objective of the OP HRD, the two main thematic priorities were: supporting human resources for R&D in terms of 'educated and active people and 'R&D capabilities, innovativeness and competitiveness of enterprises. The OP HRD targeted the implementation, as regards the activities funded by the European Social Fund, of the State Budget Strategy 2007-2010, and the priorities of the National Strategic Reference Framework 2007-2013 contained therein: "Educated and active people", "Increasing research and development capability and the innovativeness and productivity of enterprises", "Enhancing administrative capacity". The OP was the foundation for preparing and updating the organisation-based development plans of the Ministry of Education and Research. In programming and implementing the OP, it was considered important to follow the European Community's Initiative EQUAL experience and principles (e.g. partnership, gender mainstreaming, transnational cooperation, and innovation). To create synergies between the OP under assessment and the OP for Human Resource Development:

1) ERDF and ESF support measures for R&D and higher education were prepared at the same Ministry by the same people;

[5] Estonian Research Council: https://www.etag.ee/en/activities/analysis/statistics-rd-funding-estonia/ (last retreived on 24 November 2020)

2) synergies with other ERDF and ESF investments were made in the monitoring committee, which was set up as a joint committee for all three OPs 2007-13;

3) strategic decisions to implement knowledge-based strategy 2007-2013 were taken on the highest level at the R&D Council lead by the Prime Minister; and

4) ongoing discussions on ERDF, ESF and CF implementation were held in strategy action plan working groups, where all ministries responsible for implementing the strategy were involved.

2.2.2. Linkages between ERDF support for RTD and Horizon 2020

In Estonia, 145 institutions participated in FP7 for a total of 535 projects and a total contribution of EUR 98.06 m. As concerns H2020, the number of institutions amounts to 210 for 625 projects and EUR 195.1 m. For both the FP7 and the H2020, the total number of ERDF beneficiaries of RTD interventions participating in FP amounts to 35 (see Table 2 and Table 3).

Table 2. Participation rate in FP7 and H2020 projects amongst ERDF beneficiaries

	Number of ERDF RTD beneficiaries (a)	Number of ERDF RTD beneficiaries also benefitting from FP projects (b)	Participation rate (b/a)
FP7	127	35	27.6%
H2020	127	35	27.6%

Source: CSIL elaboration based on Archimedes Foundation and Cordis data

Table 3. ERDF beneficiaries participating in FP7 and H2020 projects[6]

	ERDF recipients benefitting also from FP	Number of FP projects	Total FP contribution
FP7	35	359	38,363,914,924.04 €
H2020	35	387	146,323,528.59 €

Source: CSIL elaboration based on Task 1 DB Beneficiaries and Cordis data

Generally, the OP DEE was conceived as a **catalyst to foster participation in FP7** as the key areas of Estonia's R&D competences (biotechnologies, ICT, materials technologies) are subsets of the themes of the Framework Programme (healthcare, food, agriculture and biotechnology, ICT, nanoscience, nanotechnologies, new materials and production technologies, energy, environment (including climate change), transport (including air transport), socio-economic and humanitarian sciences, security and space). Updates and restructuring efforts in accounting for HE and research institutions and switching to a full cost expenditure model in 2010 following FP7 regulations were meant to contribute to further internationalisation of R&D in Estonia. In addition, **infrastructure projects related to FP7 activities** and human resources development in technology-related fields were prioritised. The final implementation report of the OP DEE[7] refers to a few FP7 projects and some basic quantitative parameters (number of partners funded, number of total funds disbursed).

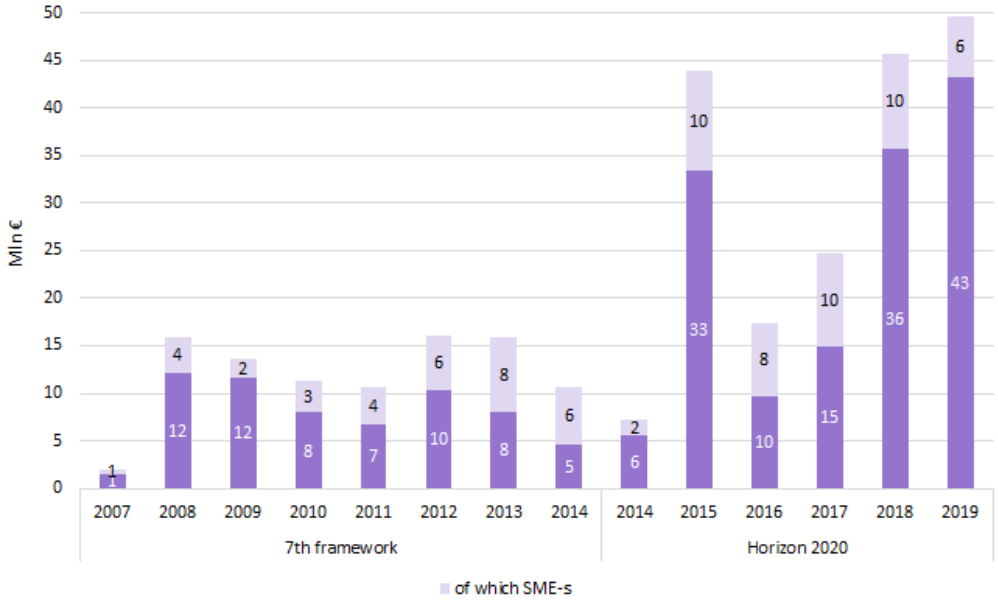
The OP DEE does not contain any explicit references to the European research and innovation programme. However, some indirect links can be drawn with the support

[6] The total number of FP7 projects during the period 2007-2013 amounted to 25,581 for a total contribution of EUR 50.7 b. Instead, the total number of H2020 projects during the period 2014-2020 amounted to 27,017 for a total contribution of EUR 52.5 b.
7 Republic of Estonia. (2010). Operational Programme for the Development of Economic Environment. Tallinn: Republic of Estonia.

programme for research internationalisation, under which the Ministry of Education and Research sought to identify synergies with EU level activities. Based on this experience, direct linkages with H2020 and other EU-level instruments (ERA CHAIR, EIT, ERA-NET) were developed in the OP 2014-20. The OP under assessment's (OP DEE) mid-term evaluation report [8] mentions some basic quantitative measures related to H2020, namely the number of partners funded and comparison of indicators with FP7 statistics.

The expected impact from investments in research infrastructure may be observed with some delay as the participation of Estonia's researchers in Framework Programmes during 2007-2013 remained rather stable. As seen in Figure 2, a significant increase (c.a. three-fold) in Estonia's researcher participation in H2020 can be observed starting in 2015. Based on evidence collected as part of this study, it may be suggested that one of the main drivers behind such a significant increase were the ERDF investments into research infrastructure during 2007-2013. These investments appear to have enabled HE and research institutions to modernise their infrastructure to the extent that they become more visible internationally. Even if there was no explicit linkage between ERDF support and the European research and innovation programme, the linkage may be considered strong in practice.

Figure 2. Funds received from Framework Programmes (EURm)



Source: Estonian Research Council based on eCorda: https://www.etag.ee/tegevused/uuringud-ja-statistika/statistika/raamprogrammide-statistika/ (retrieved on 20 November 2020)
Note: light purple represents participation of SMEs

The R&D objective of the **Lisbon Strategy** was supported by the policy instrument "R&D project support" (eligible activity was applied research in companies; implemented by Enterprise Estonia) Estonian companies in developing or improving new competitive products, services, technologies, product development processes and the "Growth Plan Development Support Measures" (eligible activities were marketing, development of new services and products, personnel development; implemented by Enterprise Estonia). These measures also contributed to the Lisbon Strategy's objective of increasing the international competitiveness of R&D.

In addition to the linkages between the ERDF programming and the European research and innovation programmes, the OP DEE was furthermore linked to the following three objectives of the **Baltic Sea Strategy**:

8 Hagel, A., & Liige, J. (2011). Perioodi 2007-2013 struktuurivahendite vahehindamine. Tallinn.

- No 7 "Unlocking the full research and innovation potential of the region"
- No 8 "Implementing the Small Business Act: to promote entrepreneurship, strengthen small and medium-sized enterprises and improve human resource use" and
- No 12, "Maintaining and increasing the attractiveness of the Baltic Sea region, in particular through actions in the fields of education, youth, tourism, culture and health".

The R&D and Higher Education Infrastructure actions moreover directly or indirectly contributed to two policy areas highlighted within the Baltic Sea Strategy:

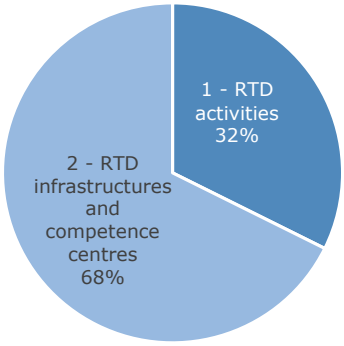
- The sub-objective "Improving the overall competitiveness of the Baltic Sea Region" was supported by the sub-measure "Modernization of National Science Infrastructure" of the "Modernization of Scientific Apparatus and Equipment". The sub-objective 'Improving the overall competitiveness of the Baltic Sea region' also contributed to the sub-objective 'Development of Centres of Excellence for Science, which included cooperation between research institutions in the region.
- The sub-objective "Improving the Global Competitiveness of the Baltic Sea Region" was also supported by the measure "Supporting International Cooperation", which was implemented in January 2011 through the Programme "Internationalization of Science". One of the programme's sub-activities is, for example, the participation of Estonia in international research cooperation initiatives and initiatives developed within the framework of European Union policy initiatives, including the Baltic Sea Strategy. The sub-objective "Contribution of the EU Strategy for the Baltic Sea Region to the implementation of the Europe 2020 Strategy" - contributed to the measures "Modernization of teaching infrastructures for applied higher education and teacher training" and "Modernization of teaching and working environment in research and development institutions and universities."

2.3. Implementation of ERDF funds for the 2007-2013 period in Estonia (3 pages)

2.3.1. Volume of ERDF financing for RTD-related activities and supported OPs

The overarching contribution of cohesion funds represented approximately 3% of the country's GDP between 2007-2013. The OP under consideration in this CS, Development of Economic Environment, funded 548 different projects thanks to a total ERDF contribution of EUR 328.5 m. Of this sum, 32.0% was dedicated to RTD activities, while 68.0% were geared towards RTD infrastructures and competence centres (see Figure 3). RTD activities were funded only by the OP DEE.

Figure 3. Share of RTD themes in ERDF funding for RTD in Estonia in the OP DEE, % of total contribution to RTD themes



Source: CSIL elaboration based on Archimedes Foundation

In terms of the typology of institutions displaying the highest concentration of ERDF contribution channelled through the OP DEE, the vast majority (about 84.0%) were Higher Education Institutions. Research and Technology Organisations, on the other hand, only account for 6% of all contributions made through this OP (see Table 4).

Table 4. Typologies of institutions where ERDF contribution is concentrated in Estonia in the OP Development of Economic Environment

Type of institution	Total ERDF contribution	ERDF contribution as a % of the total ERDF contribution to beneficiaries
2 - Higher education institution	266,303,235.51 €	84%
1 - Research and Technology Organisation	20,590,616.01 €	6%
0 - Others	10,276,636.51 €	3%
7 - Consortium (science and/or industry)	9,619,548.64 €	3%
3 - Enterprise	3,856,188.23 €	1%
9 - Public administration authority	3,597,584.26 €	1%
8 - Non-Profit organisation	3,487,811.48 €	1%
11 - Competence or Excellence Centre	198,341.20 €	0%
6 - Science or Technology Park	17,425.28 €	0%
Total ERDF contribution to beneficiaries	**317,947,387.13 €**	**100%**

Source: CSIL elaboration based on Task 1 DB Projects and Beneficiaries.

2.3.2. The ERDF RTD support policy mix: key instruments and rationale for selection

During the 2007-2013 period, research and innovation activities were supported through ERDF exclusively under the OP DEE, devising a mix of policy interventions to support RTD activities and infrastructures and tackle identified barriers. The rationale behind the mix at the time of formulation is best captured through the following objectives:

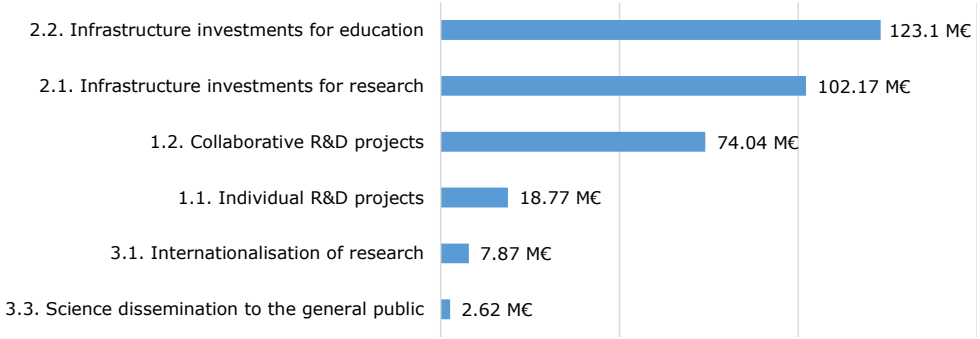
1) Estonia's R&D was focused at highly prospective thematic areas of research quality and business potential (objective 2.2.2.1)
2) Improved research environment and higher education study environment (objective 2.2.2.2)
3) Estonian R&D had to become internationally more competitive (objective 2.3)

Thematic R&D programmes were launched in areas where Estonia had the potential to achieve results in global frontier research, while displaying potential for generating business potential and value-added in the development of a number of fields (cf. the priority fields of the national RD&I strategy including ICT, biotechnologies and materials technologies). In general, a clear tendency towards Priority Axis 2, and thereby the modernisation of research and higher education (also support areas) as well as the increase in attractiveness and internationalisation through the development of Centres of Excellence can be noted. Specifically, the focus was on investments for the modernisation and expansion of university facilities, both educational environment and RTD facilities and equipment, which are particularly common in post-transition countries such as Poland, where a higher need to improve existing R&D capacities is identified in the OPs.

In fact, during the period of 2007-13, about 54.0% of all ERDF funds for R&D were invested into infrastructure development (25.0% in 2014-20) (see Figure 4). These investments filled the gaps in research infrastructure, as the bulk of previous investments in R&D infrastructure dated from the late 1990's. As a follow-up measure, the government

increased baseline funding for research, which was meant to cover costs to maintain the R&D infrastructure. In a similar vein, collaborative R&D projects which sought to bridge the divide between R&D institutions and enterprises had been considerably employed as a tool. On the other hand, direct investments into the internationalization of research or science dissemination to the general public, two of the above-stated RTD barriers identified in the Strategic Reference Framework, received more reduced funding.

Figure 4. Overview of ERDF funding by policy instrument in Estonia in the OP Development of Economic Environment



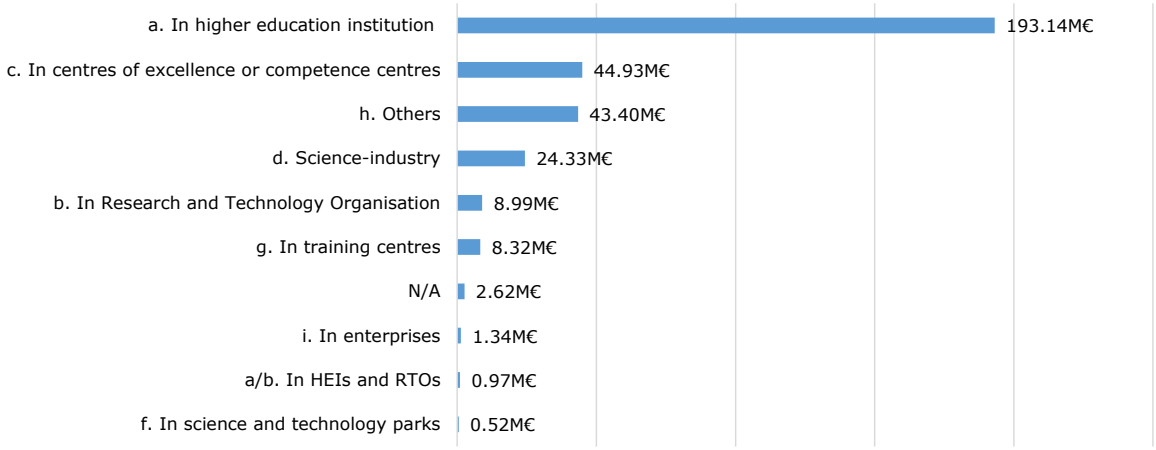
Source: CSIL elaboration based on Archimedes Foundation

One of the means devised for infrastructure development was geared towards the development of **Centres of Excellence**, of which Estonia has established nine to date. These centres could be formed by one or multiple entities of both public or private nature. One of the core goals of these centres is "to improve the quality of research and optimize Estonia's competitive capabilities, specifically for its goals as formulated under Horizon 2020".[3] Hence, Centres of Excellence can be considered to be vehicles of growth or lighthouse projects intended to accelerate the national RTD system and achieve greater outputs, as well as to spur greater innovation capacity throughout the innovation system. Ultimately, an increase and improvement of R&D, technology development and innovation for companies in growth areas, and increased international competitiveness and performance, were seen as ultimate goals of the ERDF in general.[9]

In terms of beneficiaries, **higher education institutions enjoyed the most financial attention**. The reasons for this high degree of importance can be linked to the nature of Priority Axis 2, which have been explored in previous sections of this report. As a second major beneficiary, Centres of Excellence received support specifically for conducting internationally competitive high-quality R&D activities (i.e. research - see Figure 5). In addition, activities needed for establishing and developing the centres were supported and internal and external knowledge transfer. The development of centres of excellence was of particular strategic importance, given the interest in supporting Estonia's integration with the EU and Baltic Sea region research areas.

[9] Ibid.

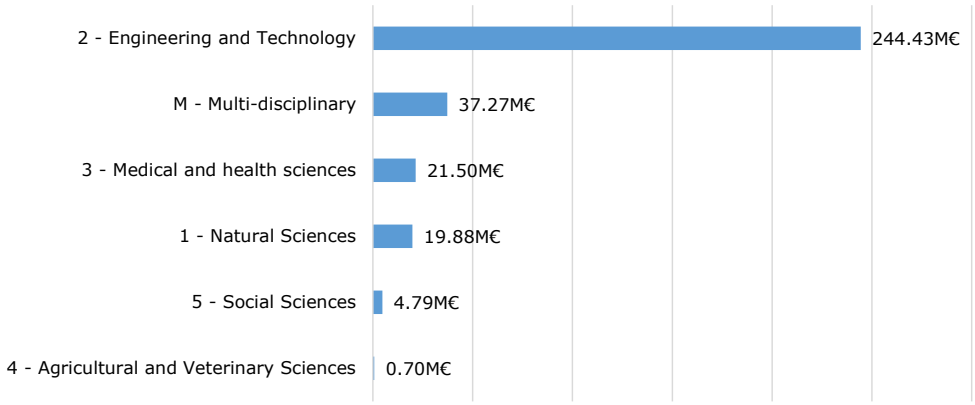
Figure 5. Overview of ERDF funding by target beneficiary in Estonia in the OP Development of Economic Environment



Source: CSIL elaboration based on Archimedes Foundation

Engineering and Technology were the clear prime beneficiaries of ERDF Funding in terms of fields of science. This is clearly in line with the three priority areas of the 2007-2013 national RDI strategy of *i) ICT, ii) Biotechnologies,* and *iii) Material Technologies* (see Figure 6).

Figure 6. Overview of ERDF funding by field of science in Estonia in the OP Development of Economic Environment



Source: CSIL elaboration based on Archimedes Foundation

3. CONTRIBUTION ANALYSIS OF SELECTED POLICY INSTRUMENTS

In this case study, three policy instruments are analysed in more in-depth through the contribution analysis:

1. Infrastructure investments for research (OP DEE support measure 3.2.3)
2. Infrastructure investments for education in HEIs (OP DEE support measure 3.2.2)
3. Collaborative R&D projects in Centres of Excellence (OP DEE support measure 3.2.1)

All three policy instruments were implemented under the OP for the Development of Economic Environment (OP DEE) and funded by ERDF within the period of 2007–2013. There were no major projects implemented in Estonia under the Priority Axis 2 "Improving the competitiveness of Estonian R&D through the research programmes and modernization of higher education and R&D institutions". Also, as the R&D and innovation policy is planned, implemented and monitored on the national level, there were no regional level strategies or activities under the OP DEE.

The analysis of these policy instruments has been conducted based on the Contribution Analysis approach, which in turn has been developed on the basis of a Theory of Change defined for each policy instrument. The aim of this chapter is thus three-fold:

- To present an overview of the policy instrument ToC developed for this evaluation. It is worth noting that this ToC has been built ex-post by the case study team based on available data and information, including information drawn from interviews with the relevant stakeholders. These ToCs are then used as the basis to carry out the CA presented in this section.
- To describe the observed effects of the policy instrument based on the expected results identified in the ToC and on the basis of the data collected by the evaluation team (primary and secondary).
- To provide an assessment of the observed effects as direct results of the ERDF funding and support for the policy instruments and an analysis of the extent to which the overall ToC materialised as initially expected.

The chapter beings with an overview of the Operational Programme under which the policy instruments have been implemented. This overview 'sets the scene' in terms of the policy instruments' rationale and how they link to other measures and ambitions established by the OP. It also presents the general ambitions and rationale of the OP itself.

Each of the following sub-sections presents a comprehensive analysis of each of the selected policy instruments for Estonia. Each section is structured around the following elements:

1) A presentation of the Theory of Change of the policy instrument. It is worth highlighting that the case study team has developed theories of Change to conduct the contribution analysis. As such, Theories of Change are an ex-post reconstruction of the intended goals and purpose of the policy instrument and the causal package intended to lead to the generation of such goals. However, it is worth mentioning that the ToCs presented in each chapter present somewhat of a snapshot of policy-makers intentions at a given point in time. However, ToCs are generally shifting and adapting to the realities of specific territories and the agents in charge of executing. As such, the ToCs presented here, in many cases, underwent gradual changes that we tried to reflect both in the design of the ToCs and the final depiction of the ToC testing.
2) A presentation of the results of the *contribution analysis* conducted based on the ToC for each instrument. This section intends to provide an explanation of what

happened when the policy instrument was implemented, as well as why and how this happened. The contribution analysis has been carried out by assessing the extent to which the different components identified in the ToC took place and the extent to which they influenced the instrument's effectiveness. As such, the contribution analysis assessed each of the following:

- The extent to which expected result thresholds were achieved: this involved identifying specific ambitions for each type of result (e.g. outputs, immediate outcomes, intermediate outcomes, final outcomes and impacts) and assessing whether these thresholds had been reached based on the available data. This section also includes information regarding any identified intended or unintended results.
- The extent to which activities were implemented according to the intended plans, rules and procedures (i.e. were there any significant deviations in terms of implementation of the activities?)
- The extent to which identified pre-conditions took place: this involved assessing whether the necessary pre-conditions existed in reality, as well as the extent to which their existence or absence played a role in achieving intended results.
- The extent to which supporting factors took place and their role in achieving the instruments' intended goals.
- The extent to which identified risks materialized and whether these were effectively managed or mitigated or ended up limiting the instrument's effectiveness.

The combination of the results obtained for each of the previously described assessments led us to establish a contribution claim for the different results observed and verified by the case study team. On this basis, we were able to set one of the following types of contribution claims for every kind of intended result:

- The intended threshold was achieved, and the policy instrument was likely to be the main contributor to this result;
- The intended threshold was achieved, and the policy instrument was only one of the factors which contributed to this result;
- The intended threshold was not achieved or only partially achieved, given that:
  - The activities were not implemented as originally foreseen, or there were flaws in the design of activities;
  - The necessary pre-conditions did not take place;
  - The necessary supporting factors did not take place;
  - Some risks materialized, effectively hampering the effectiveness of the instrument.

We provide a final conclusion on each policy instrument that presents the overall results of the contribution analysis and the underlying explanation of this result.

3.1. Overview of the Operational Programme OP DEE

By 2007, Estonia had been a member of the EU for four years, and the OP for the Development of Economic Environment (OP DEE) was the first OP covering the full 2007-2013 programming cycle. The OP DEE was drafted in line with the EU general objective to develop knowledge-based economies, increase productivity and long-term competitiveness, and strengthen social cohesion in the new Member States.

When the OP DEE was drafted, the level of R&D investments was relatively limited in Estonia, particularly as related to investments in the business sector (see also Section 2 of this report). The rationale behind the OP DEE lies in the fundamental belief that R&D based innovation is the main driver for economic growth. Development of a competitive business sector, which requires quality proof of products and services and guarantees and

improvement of safety to increase the export potential, is vital for increasing employment, productivity, and sustainable economic growth in the EU. The increase in businesses' technological and development capabilities was seen as critical in view of the sustainable growth of Estonia productivity. Such growth requires intensive R&D, which can be founded upon an attractive R&D environment. All areas covered by the OP DEE are interdependent and need to be considered in their entirety.

Furthermore, the OP DEE needs to be understood in the context of the greater National Strategic Reference Framework (NSRF) adopted at the time, which set out the main development path to be followed between 2007-2013. One of the focal areas defined in this framework directly targets RDI and education, which are "among the main levels besides classical economic policy measures that allow and should direct the changes in the economy's structure in becoming a knowledge-based one, i.e. greater creation of value-added".[10] The key objectives of the NSRF were to increase the research and development capacity and the innovativeness of enterprises, develop the key technologies of ICT, biotechnologies and material technologies, solve socio-economic problems and develop centres of excellence. [11]

As relates to R&D infrastructure, at the time of the OP's drafting, **about 80.0% of existing R&D infrastructure was considered to be in poor conditions and outdated**, as a large part of it was inherited from the Soviet period. Such infrastructure failed to contribute to top-level research and educational activities, thereby restricting international research networks participation. Furthermore, the outdated research infrastructure and low attractiveness of Estonia for foreign researchers and companies set limits to increasing the volume of contractual R&D and collaborating with the business sector.

This OP was planned to set the basis for the growth of R&D efficiency, including investments in research and technological development to increase innovation capacity, especially investments, to promote the prioritised trends, including infrastructure. To increase R&D efficiency, it was necessary to ensure a sufficient number of people and establish a competitive infrastructure. R&D and higher education were thus sectors reflected in both the OP for human resources development and in the OP DEE. The OP DEE was prepared by the Ministry of Economic Affairs and Communication in collaboration with the Ministry of Education and Research.

The **aim of the OP DEE** 2007–2013 was to contribute to the country's economic development. The OP DEE covered the following thematic areas:

- Supporting the *development and productivity growth of enterprises* from all sectors by increasing their research and development (R&D) and innovation capacity, development of tourism and creative industries;
- Development of *thematic R&D programmes* targeted at long-term economic development and initiation of thematic R&D programmes within prioritised trends, aimed at R&D and innovation capable companies and R&D institutions;
- Supporting the development *of R&D critical mass and capacity* by developing centres of excellence, infrastructure and equipment of R&D and higher institutions, and international cooperation;

[10] *National Strategic Reference Framework 2007-2013: https://www.struktuurifondid.ee/sites/default/files/estonian_national_strategic_reference_framework_2007-2013.pdf*

[11] *Ibid.*

- Development of the *transport infrastructure* of domestic as well as international routes;
- Development of information society.

All three of the policy instruments analysed as part of this case study were implemented under the Priority Axis 2 of the OP "Improving the competitiveness of Estonian R&D through the research programmes and modernization of higher education and R&D institutions". The goals of this axis were:

1. To focus Estonia's R&D on highly prospective thematic areas of research quality and business potential;
2. Improve the research environment and higher education study environment;
3. Improve the international competitiveness of Estonian R&D.

To implement and reach these objectives, the following activities were foreseen by the OP DEE Priority Axis 2 (activities 2-5 are in scope of the current case study; activity 1 is outside the scope of the contribution analysis in the current case study as it focuses on applied research):

1) Developing thematic R&D Programmes aimed at long-term economic development (c.a. 15.0% of support)
2) Developing Centres of Excellence in research and participating in research cooperation programmes of the EU and the Baltic Sea region (c.a. 16.0% of support)
3) Modernising the general infrastructure of R&D institutions (c.a. 25.0% of support)
4) Modernising the educational environment of institutions of professional higher education and universities (c.a. 12.0% of support)
5) Modernising research equipment (c.a. 32.0% of support)

The OP DEE sought to **take a holistic approach** to the development of the Estonian R&D and higher education system. This combined ESIF investments into research infrastructure ('hard') as well as developing skills, mobility of researchers and internationalisation activities ('soft') (see the intervention logic of Priority Axis 2 in Figure 7).

In addition, a horizontal layer was added to the Priority Axis 2 – activities supporting the development of Estonian **smart specialisation** thematic areas (ICT horizontally across sectors, e-health, efficient use of resources) were aimed to cover at least 40.0% of the funding of the Axis. In parallel, 10.0% of the Axis funds were intended to invest in the internationalisation of R&D and higher education activities.

The ERDF policy instruments for investments into research infrastructure were designed **both through a bottom-up and top-down approach**. When planning the policy instruments, wide consultation with target groups was carried out (bottom-up approach) – research and HE institutions were asked to analyse their investment needs and were involved in the consultations on the policymaking level (this mainly concerned investment research equipment and research buildings). From this combination of top-down and bottom-up, investments for the development of large-scale infrastructure were carried out based on the national research roadmap. The roadmap, which addressed national level research needs, was developed in collaboration with higher education and research institutions and policymakers. Similarly, the scheme for Centres of Excellence was developed by combining existing and future potential of research excellence (bottom-up) and national research objectives (top-down) – to motivate and support high-level research, driving the visibility of Estonian research.

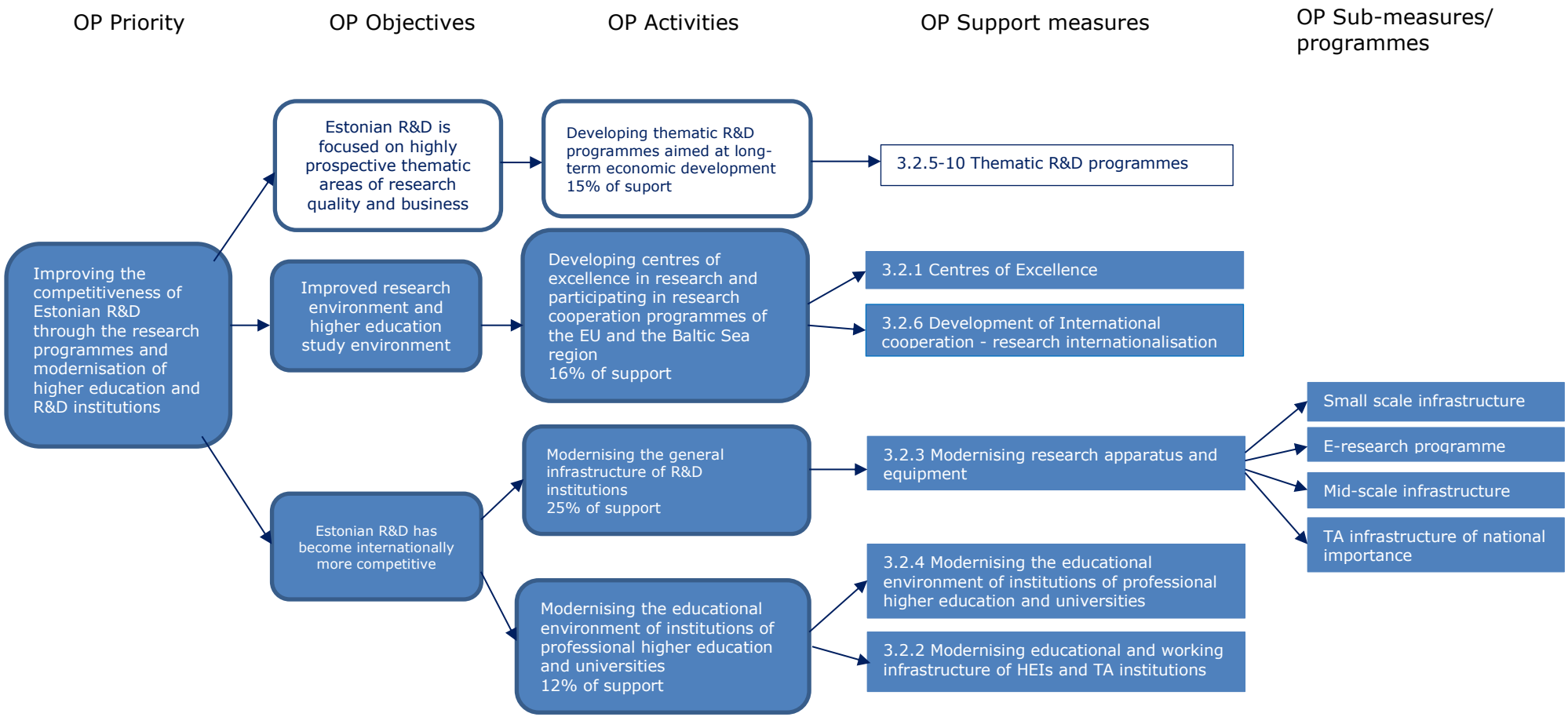
The OP DEE was targeted to private sector (SMEs, large), R&D institutions, higher education institutions, incubator centres, clusters, technology parks, non-profit organisations and public authorities. Having said this, the Priority Axis 2 and particularly the policy instruments therein were mainly **targeted to support both public and private R&D institutions** involved in conducting, implementing and/or funding and organising research and development; including R&D institutions, Centres of Excellence, universities and institutions of professional higher education. Thus, business sector was not a target group for research infrastructure investments under Priority Axis 2.

The OP DEE also fed into the broader cross-cutting themes pursued at the time of its design. This is visible for instance in the context of the horizontal themes of i) regional development, ii) environmental protection, iii) protection of information society as well as iv) equal opportunities. As for the theme of regional development, activities under this priority axis were mainly carried out in two larger cities - Tallinn and Tartu, which possess the highest R&D potential in Estonia. Strengthening Tartu as a R&D centre was seen as potentially generating a positive impact on the development of Southern Estonia. As for environmental protection, this OP aimed to help establishing modern laboratories which generate lower environmental risks as compared to other existing facilities; and had the potential of providing a new base of ideas and schemes which could lead into the development of sustainable environmental technologies. ICT, as a third horizontal theme, was targeted through thematically focussed R&D programmes. The fourth horizontal theme, equal opportunities, was primarily accessed through improved infrastructure that would enable equal access opportunities.

There was one managing authority (MA) (Ministry of Education and Research) and one implementing agency (IA) (Archimedes Foundation) appointed for implementation of the three policy instruments in scope of this CS. The managing authority was responsible for planning of the Priority Axis 2 of the OP DEE "Improving the competitiveness of Estonian R&D through the research programmes and modernization of higher education and R&D institutions", developing legal framework for implementation of ERDF as well as monitoring. Archimedes was responsible for implementing the higher education and research policy instruments in Estonia. Also, Archimedes was the first contact point for beneficiaries for the three policy instruments in scope.

As an overall approach, all recipients of structural assistance were required to indicate (usually in the project reports) the compliance of their operation (or the lack thereof) to **state aid rules**. Based on this, the data on the number of operations and the financial volume of assistance directed towards achievement of state aid rules was gathered and monitored through the Structural Funds reporting system. On the basis of collected evidence, no state aid rules were applied to ERDF support under the policy instruments analysed as part of this CS. The main reason for this was that the instruments focused exclusively on supporting HE and research institutions, to which state aid rules did not apply.

Figure 7. OP DEE priority "Improving the competitiveness of Estonian R&D through the research programmes and modernisation of higher education and R&D institutions" intervention logic



Source: Mid-term evaluation of the higher education and R&D support measures 2007-2013 (2011), available at https://www.struktuurifondid.ee/sites/default/files/teadus-_ja_arendusmeetmete_rakendamise_hindamine.pdf
Note: boxes on the blue background present policy instruments and activities in the scope of the case study

3.2. Policy instrument: Infrastructure investments for research

3.2.1. Theory of Change of the Infrastructure Investments for Research policy instrument

When the OP DEE was developed, Estonian researchers lacked experience in using modern R&D infrastructure, and the opportunities for participation in international research and partnership programmes were also limited. As recognised by multiple higher education accreditation reports, limited research infrastructure capacity was among the main factors hindering the growth of Estonian R&D and innovation[12] [13]. However, the modernization of research infrastructure (mainly considered here as research equipment) wasn't considered a target itself. It was rather seen as a mechanism allowing to improve higher education, research and innovation, and cornerstone for economic and social development.

Considering the wider context of research, this policy instrument must be considered alongside the policy instrument for educational environment investments. The latter focused on renovation and building new educational buildings to offer better learning conditions for students and working conditions for researchers and teachers. Together, these two policy instruments aimed to create the necessary **physical preconditions** for increasing the quality of Estonian research, its competitiveness and visibility internationally.

The policy instrument was designed by the Ministry of Education and Research in collaboration with the Ministry of Economic Affairs and Communication, and the Archimedes Foundation implemented it. During the implementation from 2007 to 2013, **no major changes** were introduced to the instrument. This said, there was some reallocation of funds between policy instruments within the OP Priority Axis, which increased the budget of this particular policy instrument and provided five open calls instead of the three originally planned calls. The increased funding was greatly welcomed by research institutions and absorbed efficiently, given the high number of applications received in all five open calls.

The policy instrument for investments into research equipment aimed to enable research and higher education institutions to modernize their research equipment. The policy instrument was divided into three sub-instruments:

1. support to **small-scale** research infrastructure – was targeted to research groups holding baseline funding (granted baseline funding was a precondition for applying for support under this policy instrument), budget EUR 13.6 m;
2. support to **medium-scale** research infrastructure – was targeted to research institutions to modernize their research equipment, budget EUR 35.1 m;
3. support to **large-scale** research infrastructure targeted to nationally important research infrastructure (a precondition for funding was being included into national research infrastructure roadmap), budget EUR 26 m.

There were two types of activities funded:

1. Developing **lab installations** and service infrastructure necessary for high-level research, incl. exploitation costs within the start-up period for instalment and introduction stages (i.e. setting the equipment up and getting it running)

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[12] *M. Nedeva, L.Georghiou, Assessment of the Estonian research Development Technology and Innovation Funding System, 2003: https://dspace.ut.ee/bitstream/handle/10062/40773/Teadus_FundingSystem.pdf?sequence=1&isAllowed=y*

[13] *Teaduse ning teadus- ja arendustegevuse finantseerimissüsteemi evalveerimine, Estonian Academy of Science, 2004: https://www.digar.ee/arhiiv/et/raamatud/19887*

2. Modernising the **research equipment** necessary for developing professional higher education provision (especially engineering, manufacturing and processing, construction, transportation services, health care).

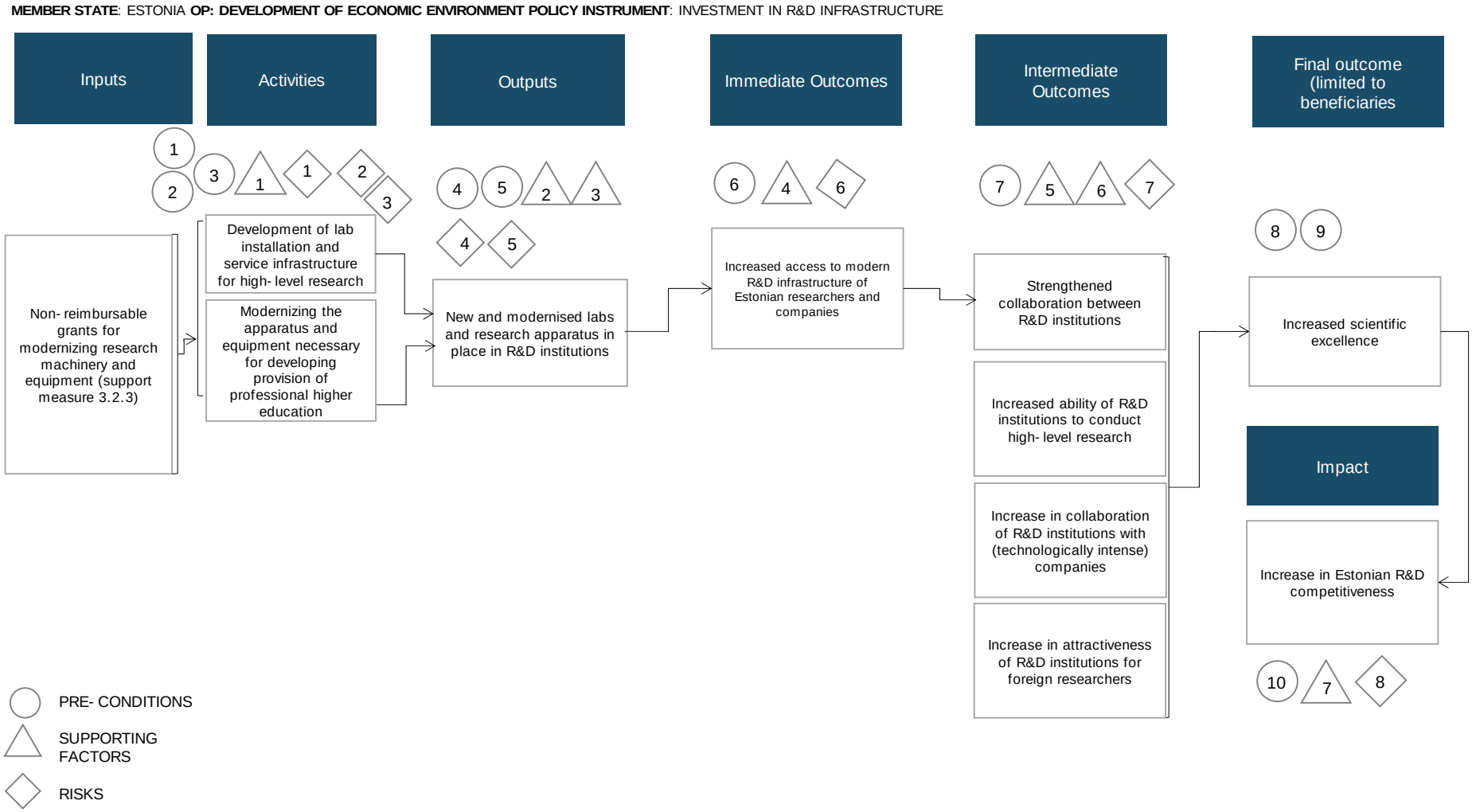
The main precondition for institutions to receive funding for their research equipment was an analysis of research infrastructure needs. This forced institutions to carefully analyse their research capacity (i.e. human resources, research domains, funding) and critically assess future research domains and their potential for excellence. The careful planning and needs analysis was also aimed to avoid duplication of research infrastructure and labs in institutions while guaranteeing that investments would meet the future research needs. Furthermore, developing infrastructure roadmaps motivated institutions to collaborate as it was a common interest to all Estonian research institutions to get research infrastructure of national importance funded.

As an output of the policy instrument, Estonian research institutions' research equipment become modernized and meet modern research requirements. As a precondition, it was expected that institutions had the required knowledge and capacity to use modern equipment.

As an immediate outcome, it was foreseen that Estonian researchers and companies would gain access to modern research equipment, which would in the long-term lead to an increased level of scientific excellence and internationalisation and increased collaboration among themselves well as with the private sector. As a supporting factor for making the newly renovated and created labs and purchased equipment sustainable, continuous state funding was expected to be in place. Also, for making the equipment accessible for both researchers and companies, clear rules on the use of equipment had to be in place in institutions. However, and as will be described in the following section, in reality, the lack of flexibility of the ERDF funding rules became a major obstacle for private-sector beneficiaries, particularly as they faced challenges gaining access to the new labs out of fear of infringing ERDF funding rules (ERDF investments cannot be used for profit-making for more than 20.0%).

The wider expected outcome of the policy instrument was an increase in scientific excellence. Furthermore, when the OP was drafted, it was expected that ERDF investments would support the increased capacity and competitiveness of Estonian research. ERDF support into modernizing research equipment is considered major support in achieving this result – all interviewees agreed that these investments (together with modernising the educational environment) enabled a huge development leap for the Estonian research system.

Figure 8. Theory of Change of the policy instrument of infrastructure investments for research



Source: researchers' team based on primary and secondary data collected

Supporting factors

1. Research institutions' technological competence for absorption of in-house R&D capacity and accumulation of skills to purchase R&D
2. Existing collaboration with companies to use the R&D infrastructure
3. Funding is foreseen in R&D institutions' budgets
4. Modernised R&D infrastructure meets researchers and companies' needs for research
5. Existing collaboration between R&D institutions and companies
6. Existing collaboration between R&D institutions
7. Increase in Estonian R&D institutions participation in EU research programmes (i.e. H2020, COST etcs)

MEMBER STATE: ESTONIA **OP: DEVELOPMENT OF ECONOMIC ENVIRONMENT POLICY INSTRUMENT**: INVESTMENT IN R&D INFRASTRUCTURE

Pre- conditions

1. Research institutions have analysed and mapped the need for R&D investments
2. Roadmap for research infrastructure is in place
3. Availability of R&D institutions' cofunding
4. R&D institutions' knowledge and capacity to use modern R&D apparatus
5. R&D institutions' financial capacity to manage new infrastructure
6. Rules for using the R&D infrastructure are in place and clear
7. Sufficient level of state funding of R&D institutions
8. R&D infrastructure is modernised
9. Sufficient capacity of R&D institutions to absorb the R&D infrastructure
10. Stable government funding of R&D

MEMBER STATE: ESTONIA **OP: DEVELOPMENT OF ECONOMIC ENVIRONMENT POLICY INSTRUMENT**: INVESTMENT IN R&D INFRASTRUCTURE

Risks and threats

1. Modernised R&D infrastructure do not match with actual research needs
2. Modernised R&D infrastructure will be underused after investments due to strict EU competition rules (limited availability of labs for enterprises)
3. Deviations and failures following the public procurement rules may cause delays in implementation of activities
4. New and renewed R&D infrastructure is underused
5. Unforeseen costs for managing the renewed R&D infrastructure
6. Access to modernised R&D infrastructure is not equally open for researchers and companies due to legal restrictions
7. Major changes in economic structure may lead to mismatch of the existing R&D infrastructure and companies' needs
8. Insufficient level of government funding of R&D

3.2.2. Contribution analysis of the Infrastructure Investments for Research policy instrument

Verification of intended intervention implementation

Interviews and data collection did not reveal any deviations in the implementation of planned activities under the instrument (beyond the financial reallocations mentioned previously). The activities foresaw purchasing of research equipment for HE and research institutions. The activities were implemented to a full extent, and no changes in the original plan were detected. Due to high levels of interest in the policy instrument, funds were reallocated from another policy instrument. This enabled the launching of two additional calls leading to selecting a higher number of projects than originally envisaged. Additional financial resources did not change the focus of initially planned activities, but rather raised the bar in terms of the expected outcomes' volume and significance.

Achievement of intended and unintended effects at the level of the expected threshold

As there were only very limited quantitative targets and indicators set for the policy instrument, the assessment of the extent to which they reached these targets is mainly based on qualitative data and information. In the opinion of the Ministry of Education and Research, as well as Archimedes and beneficiaries, the policy instrument was very successful in reaching its goals. This is also the conclusion of the final report of the OP DEE [14] came to. According to the final report, one of the underlying reasons for success may be linked to the significant demand for the instrument's support and the smooth rollout of ERDF support. By the end of 2015, the end of disbursements' deadline, all funds targeted to the policy instrument were used as planned - 99.9% of ERDF funds were spent.

As a result of the policy instrument, 293 projects were funded under small-scale research infrastructure sub-programme, where research groups purchased small-scale research equipment. Research and HE institutions were funded through 100 projects for investments into medium-scale research infrastructure (research equipment and laboratories). In addition, 9 research objects of the Estonian research roadmap were funded addressing national interest needs. In total, EUR 83 m of ERDF funds were invested into the modernisation of research equipment.

Nevertheless, the results of the instrument can be indirectly linked to the achievement of the strategic objectives of the RDI strategy, as they acted as enabling preconditions to the achievement of these objectives:[15]

- Number of PhDs awarded in an academic year: 2008: 161; 2013: 233; 2020: 300;
- Scientific publications among the top 10% of most-cited publications worldwide as % of total scientific publications of the country: 2007: 7,56%; 2013: 7,6%; 2020: 11%;
- Number of scientific publications per million of population: 2007: 800; 2013: 1439; 2020: 1600.

As the aim of the policy instrument, together with the instrument of modernisation of research environment (renovating and building new buildings), was to create preconditions for high-level research, it can be concluded that the preconditions existed / we generated, and the policy instrument was successful in achieving its main goals. This was verified by all interviewees during the case study. On the basis of data collected, no unintended results have been observed.

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[14] OP DEE Final Report (2017):
https://www.struktuurifondid.ee/sites/default/files/mark_lopparuanne.pdf
15 Haridusslim. (n.d.). Retrieved November 02, 2020, from https://www.haridussilm.ee/

The policy instrument in its set up was clear and straightforward: the goal was to promote investment into R&D infrastructure. The only eligible applicants were R&D and higher education institutions and research groups, and the policy instrument was fully targeted for research. Interviewed policymakers and research institutions agreed that investments into research infrastructure **have played a crucial role** in increasing Estonian research visibility and thwarting its quality to a new level. Increased access to modern research infrastructure has led to higher scientific excellence, strengthened collaboration between R&D institutions, increased ability to conduct high-level research and increased competitiveness of Estonian researchers and capacity of the entire Estonian research system. Conditions for better access to research equipment for companies were created. However, research equipment is still used mainly by researchers and only to a limited extent by companies.

All three sub-programmes of the instrument (small, medium and large-scale infrastructure investments) were implemented successfully – all projects were completed and funds absorbed. There were 293 projects funded under the sub-programme of **small-scale infrastructure** investments through five open calls. Only research groups already having baseline funding or institutional research grants were eligible for applying under the sub-programme. According to the OP DEE final report and interviews, as the need for such small-scale research equipment investments was significant, combined with the limited number of eligible research groups, by the end of the period, all applications were accepted and grant-making the funds 100% contracted.

There were four open calls for grant applications under the sub-programme for **medium scale R&D infrastructure**. The last open call eligibility conditions in 2014 were amended to strengthen synergies with the infrastructure investments for education in higher education institutions policy instrument: R&D institutions already renovating or building a new building were prioritised. A total of 100 projects were funded, and 99.75% of the funds were used. There were 9 R&D infrastructure objects in the investment plan for **large-scale infrastructure** (see also Box 1). By the end of 2015, all projects were completed, and 99.98% of funds were used.

Examples of some investments are presented below:

Box 1. Example of investment into large-scale infrastructure

Project Example

Within the sub-measure, the project "Estonian Environmental Observatory" was implemented, in which the beneficiary was the University of Tartu and the project partners were the Estonian University of Life Sciences, Tallinn University of Technology, Tallinn University, Tartu Observatory and the Environmental Agency. The project support from the ERDF was EUR 4.21 m. In the course of the project, the network of experimental stations for environmental research was developed and improved together with the supporting geomatics and informatics research laboratories. The experimental stations of the Environmental Observatory are located in different natural environments on land, inland waters and in the coastal sea all over Estonia. By virtue of this project, preconditions were created for the joint activities of Estonian research institutions through the use of common infrastructure and data, thereby raising the quality of research and development in the field of environment, including the development of interdisciplinary research groups and work. With the establishment of new laboratories and bases as well as the renovation of existing ones, the quality of study and practical experiences labs significantly increased and the conditions for conducting research improved. Thanks to the acquired equipment, the possibility to perform more detailed, science-based monitoring and research improved, which helps to refine or model the data collected by state monitoring. Several partner institutions of the Environmental Observatory carry out state environmental monitoring through field bases, such as the Estonian Maritime Institute on the island of Keri, the Limnology Station by Lake Võrtsjärv and the Tõravere Observatory.

Fotography (Triin Brenner): Laelatu biostation in Hanila county, West-Estonia
Source: OP DEE final report of Priority Axis 2, p.19

Verification of assumed pre-conditions

Based on the collected evidence, the preconditions identified in the ToC were observed to a high degree. The 2007-13 ERDF funding period was the first opportunity for Estonian research institutions to invest in research infrastructure in such a significant amount. In order to select the priority research equipment, research institutions applying under the mid-scale research infrastructure sub-programme had to **analyse their scientific**

performance, map investment needs and prioritise their research infrastructure. This applied both for the research equipment (current policy instrument) and new or renovated buildings (the policy instrument of infrastructure investments for education in HEIs). Mapping and prioritizing institutions' investment needs were the most important preconditions for applying for a grant under the ERDF. Not all institutions welcomed this prioritizing as it was not natural for them to analyse and prioritise their investment needs. Nevertheless, they all provided their analysis and applied for the ERDF grant according to their identified priorities.

Another precondition for funding was that the research equipment funded under the policy instrument had to be coherent with investments under the policy instrument of investments into education in HEIs. Those two instruments were designed to **build synergies**: the purchasing of new research infrastructure had to be in line with the physical research environment's needs and conditions (buildings). Also, the last open call of the mid-scale research infrastructure required an ongoing renovation of existing infrastructure or construction of a new facility to ensure that the brand-new buildings would be properly equipped with relevant infrastructure. However, this precondition did not apply to the small-scale infrastructure, where research groups were eligible applicants.

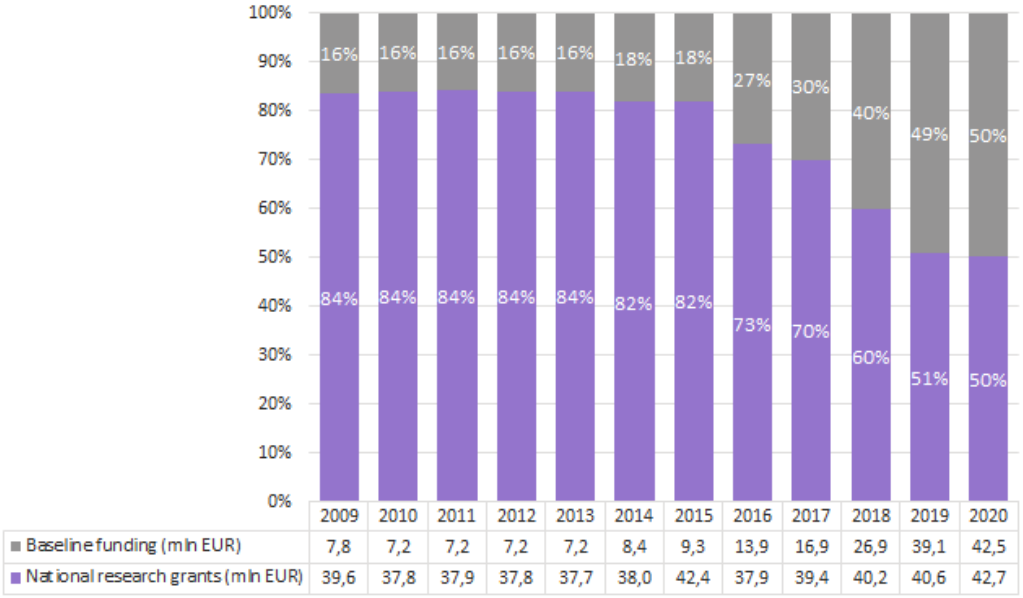
Regarding the large-scale research infrastructure, only projects identified in the **national research infrastructure roadmap**[16] were eligible for applying for ERDF funds. This required joint efforts on behalf of the government and research institutions in charge of developing the roadmap. The research infrastructure roadmap was a long-term (10-20 years) planning instrument, including the list of new or modernized research infrastructure of national importance. The roadmap is updated every 3-5 years and constitutes the basis for making investment decisions. However, a research infrastructure included in the roadmap does not automatically get funded. Also, projects in the list were not in prioritized order. The Roadmap included 20 research objects, out of which nine were of international importance, and four were part of the European Strategy Forum on Research Infrastructures (ESFRI).[17]

Another important precondition for the absorption of ERDF funds for modernizing research infrastructure was **stable funding by the government**. Baseline funding was meant to finance R&D institutions to achieve their strategic development objectives, including co-financing national and foreign projects and opening new research directions and investing in the infrastructure. Baseline funding is provided to R&D institutions that have received a regular positive evaluation from the state budget via the Ministry of Education and Research budget. Once the baseline funding was allocated, research and higher education institutions were at liberty to decide how to invest it. During the 2007-2013 period, the share of baseline funding and research grants remained stable: 16.0% of the government research funding was allocated through baseline funding and 84.0% for research grants (see Figure 10). Stable state funding helped to ensure a sufficient level of cofounding by institutions.

[16] https://www.etag.ee/en/funding/infrastructure-funding/estonian-research-infrastructures-roadmap/

[17] *Government of Estonia (15.06.2010): Decision of R&D Council. Not publicly available*

Figure 9. Share of baseline funding and research grants (EURm)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Baseline funding (mln EUR)	7,8	7,2	7,2	7,2	7,2	8,4	9,3	13,9	16,9	26,9	39,1	42,5
National research grants (mln EUR)	39,6	37,8	37,9	37,8	37,7	38,0	42,4	37,9	39,4	40,2	40,6	42,7

Source: Estonian Research Council, https://www.etag.ee/tegevused/uuringud-ja-statistika/statistika/teadus-ja-arendustegevuse-rahastamise-yldpilt/

In 2015, the government decided to move towards a financing scheme that gave equal weight to baseline funding and research grants (50/50 share). This was done to provide more stability to research institutions in their performance and decrease dependency on research grants. In 2020 this share was achieved.

When mapping and analysing their investment needs, research institutions also had to analyse their human resources skills and capacity to use the new research equipment and manage the new lab. They had to ensure that the newly purchased and created research infrastructure would be used to a full capacity. While most beneficiaries reported making full use of newly purchased equipment, some admitted that some equipment were not used to a full capacity or were already outdated and required new investments. Nevertheless, these are rather exceptional cases as most of the new equipment has been used extensively. Furthermore, beneficiary institutions had to develop rules for using the newly purchased infrastructure. This was generally done by the institutions hosting the infrastructure, which were given the liberty of doing so. This led to the development of various rules that changed between different institutes within one research institution, making it sometimes difficult for researchers and companies to navigate these rules.

Verification of supporting factors

Evidence collected through interviews points to a significant presence of supporting factors having taken place. In some cases, the research institutions' technological competence for absorption of in-house R&D capacity and accumulation of skills to purchase R&D, as well as existing collaboration with companies to use the R&D infrastructure, took place only to a limited extent or with some level of delay. As said before, the 2007-2013 period was the first time Estonian research institutions had the opportunity to invest in their research infrastructure on such a significant scale. This required **knowledge and capacity to absorb these funds**. Both policymakers and research institutions agreed that ERDF absorption required institutions to have necessary administrative (also academic) staff and competences in place. Some institutions beneficiary institutions were quicker than others in learning and following the ERDF requirements. Nevertheless, as all HEIs displayed high motivation levels when it came to accessing and implementing ERDF funds, putting significant effort into effectively absorbing these funds.

ERDF rules set a **co-financing** requirement for all institutions applying for a grant. As discussed before, stable government baseline funding was guaranteed for research institutions over the programming period. It was the responsibility of the research institution to guarantee ERDF co-funding from the baseline funding. In practice, all HEIs had the necessary co-financing to contribute to their ERDF infrastructure projects. Furthermore, given the interest many research institutions had in modernising their infrastructure, they were eager to increase their co-funding share to ensure projects were successfully completed on time.

Collaboration between research institutions was a supporting factor for reaching expected results. At the same time, it was a precondition in investments into large-scale infrastructure (the research roadmap objects), as the roadmap objects had to be agreed upon between research institutions. Purchasing small- and medium-scale research infrastructure was more about the institution's choice and decision. Large-scale research infrastructure investments were made into national importance objects, which required collaboration and co-decision making between research institutions and government. In general, as the Estonian research community is small, research institutions often collaborate internally and are co-applicants in European level initiatives and programmes. Therefore, it was observed that good collaboration between research institutions made facilitated and expedited the roadmap development.

Box 2. Example on creating synergy between different funding sources and activities: Estonian Biobank (as of the end of 2015)

A good example of creating synergy between different funding sources and activities is the Estonian Biobank, which has received grants from many sources and has been able to combine them into one successful entity:

1. In addition to a number of regular projects, the Framework Program has also received FP7 REGPOT support for the Opening Estonian Genome Project for the European Research Area (OPENGENE). This was something similar to the previous FP7 period, as is now the H2020 widening measure.

2. Within the framework of ESIF measures, the Biobank has been included in the national roadmap of research infrastructures; received the Center of Excellence and many other grants.

3. The Estonian Biobank is part of BBMRI's pan-European infrastructure

4. At the time the Biobank was created, Estonian government supported the collection of tissue samples for the Biobank. Nowadays, this is an important part of the personal medicine pilot project.

All these activities have created synergy and raised Biobank's capacity to the level that has attracted both Estonian researchers abroad as well as foreign researchers to work at the Biobank. Biobank's activities have also been addressing national health policy goals.

Verification of risks and threats

Evidence collected through interviews showed that some of the risks identified in the ToC did materialise. However, in most cases, this did not significantly impact the implementation of the policy instrument or the achievement of key objectives.

The main risks of implementing the policy instrument related to the novelty of the instrument and the uncertainties around research institutions' capacity and competences

to absorb and execute the allocated funds. The economic downturn generated another layer of risks and threats as this was not foreseen when the policy instrument was planned. While the main risks identified and managed by the ERDF management stakeholders mainly related to failures in public procurement; project beneficiaries mainly dealt with risks relating to the sufficient (or insufficient) level of absorption capacity and knowledge, whether new infrastructure would meet researcher and institutional needs, and the capacity to accurately forecast and guarantee co-financing and maintenance budgets as well as guaranteeing the new research infrastructure would be properly used. This illustrates that research institutions had to manage a lot more than just purchasing new infrastructure. In turn, ERDF investments forced them to conduct accurate strategic planning and needs forecasting.

Overall, the newly purchased research infrastructure was found to **meet researchers' needs** – the list of investment needs and prioritisation was carried out by institutions, which allowed them to identify the research infrastructure characteristics in demand. In some cases, **unexpected costs** for maintaining new infrastructure arose but appear to have been adequately managed by research institutions.

The policy instrument designers expected the majority of the risks to exist within the realm public procurements: missing public procurements in purchasing of equipment (researchers just purchased what was needed without providing public procurement procedure), mistakes in procurement procedures, and misinterpretation of public procurement rules. While these risks materialised in the real implementation process, they did not appear to impact project goals significantly. In most cases where procurement issues appeared, solutions were generally identified in collaboration between research institutions and Archimedes, the instrument implementing agency. From Archimedes' point of view, these were 'lessons learned', which, while leading to some delays, did not significantly impact the instrument's performance.

Another aspect is that the 2007-2013 ERDF policy instruments took place during the **economic downturn** of 2008-2010. It was indeed not possible to predict or foresee the consequences of this when drafting the OP. However, in practice, there were no major implications for the policy instrument and its beneficiaries. In some cases, it did appear to have made the implementation phase slightly more complex. For instance, some of the delivery deadlines had to be rescheduled as a result of this. The economic landscape changes during 2008-2010 didn't lead to any substantial changes in the policy instrument. It was fully targeted towards research institutions, which were not directly affected by the economic downturn.

In some cases, institutions admitted that **access to new labs or equipment** is not always open to companies and is mostly limited to researchers and students. It has proven challenging for companies to gain access to them due to EDRF competition rules (if the equipment is used more than 20% of the time for business purposes, grants may have to be reimbursed). In 2020, research institutions still had to follow this rule and, in many cases, admit that it hampers their collaboration with companies. On the other side, the Ministry of Economic Affairs and Communications' view of the point is rather that when researchers give access to companies and generate a profit, they could also be in a position to be financially more sustainable (and reduce the need for grant support). There is a clear gap in interpreting this ERDF rule – researchers and the Ministry of Education and Research do not share the Ministry of Economic Affairs and Communications' perspective on this particular issue.

3.2.3. General assessment of the Infrastructure Investments for Research Policy instrument

Despite a significant lack of more quantitative data and evidence regarding the instrument's scope and depth, there is widespread consensus among interviewed stakeholders that the instrument has allowed moving the needle when it comes to the quality and performance of the Estonian education and research system.

However, it is important to mention that given the absence of a formal and robust monitoring and performance tracking system, this contribution analysis has been conducted based on limited (yet reliable) information and evidence. Further, the available information and evidence focus strongly on instrument outputs and immediate outcomes. Data and information on intermediate/final outcomes were very hard to come by. In total, there were 393 projects funded for purchasing research equipment and nine research objects of national importance. Considering the number of projects funded and the fact that there was a huge demand for such funding, all interviewees admitted that the policy instrument was relevant and very well welcomed. The examples of synergies between different funding sources of research institutions presented in Boxes 1 and 2 enable us to assess that the policy instrument was successful in creating preconditions for increasing the research quality.

During the planning phase of the 2007-13 ERDF programmes, the Ministry of Education and Research shared research institutions' view about the need to modernise the country's research infrastructure and decided to take a **holistic approach to boost Estonian research**. This approach favoured investing in research infrastructure in terms of the built research environment (renovating or building new buildings) and research equipment (labs and apparatus). It also sought to invest in developing human resources through policy instruments of Centres of Excellence, researcher mobility, supporting doctoral studies and internationalisation, educating teachers, supporting collaboration and innovation between higher education institutions. Furthermore, it aimed to have a system-level approach in modernizing higher education institutions' financing system. Thus, investments into research infrastructure have to be seen as part of the whole picture of developing the Estonian higher education and research system.

The interviews as well as the number of projects funded and national statistics on RDI strategy indicators, allow us to indirectly infer that the policy instrument **made a significant change in the landscape of Estonian research.** It increased the Estonian research excellence and capacity significantly, made Estonian research more visible in the international arena, and increased the competitiveness of Estonian research. The policy instrument analysed as part of this case study is considered one of the main causes and contributing factors to the achievement of these changes. Modernised research equipment enabled Estonian researchers to become part of international research teams. It opened doors to a number of European research and cooperation programmes and increased the attractiveness of Estonian higher education and research institutions among international students and researchers. Investments in 2007-2013 paved the way for further developing the Estonian R&D system and research during the subsequent 2014-20 programming period. R&D programmes in 2014-2020 could not have been designed or implemented without basic investments carried out in 2017-2013.

Another big shift that took place as a result of this instrument relates to the **management of research institutions**. These had to undertake long-term strategic planning for high-potential research areas, research equipment needs, as well as competences required. This has contributed to the modernization of Estonian higher education and research institutions' management structures through mergers and reorganisations of these institutions. As a result, more effective and efficient higher education and research institutions are in place. Also, performance contracts were introduced in 2015 measuring

performance and financing higher education institutions based on the size of entrepreneurial contracts, number of high-level publications, doctorate graduates and patents. The introduction of this approach has led to a shift in research that may contribute to broader social and economic challenges and needs.

Figure 10. Theory of Change of the policy instrument of infrastructure investments for research, reflecting the results of the contribution analysis

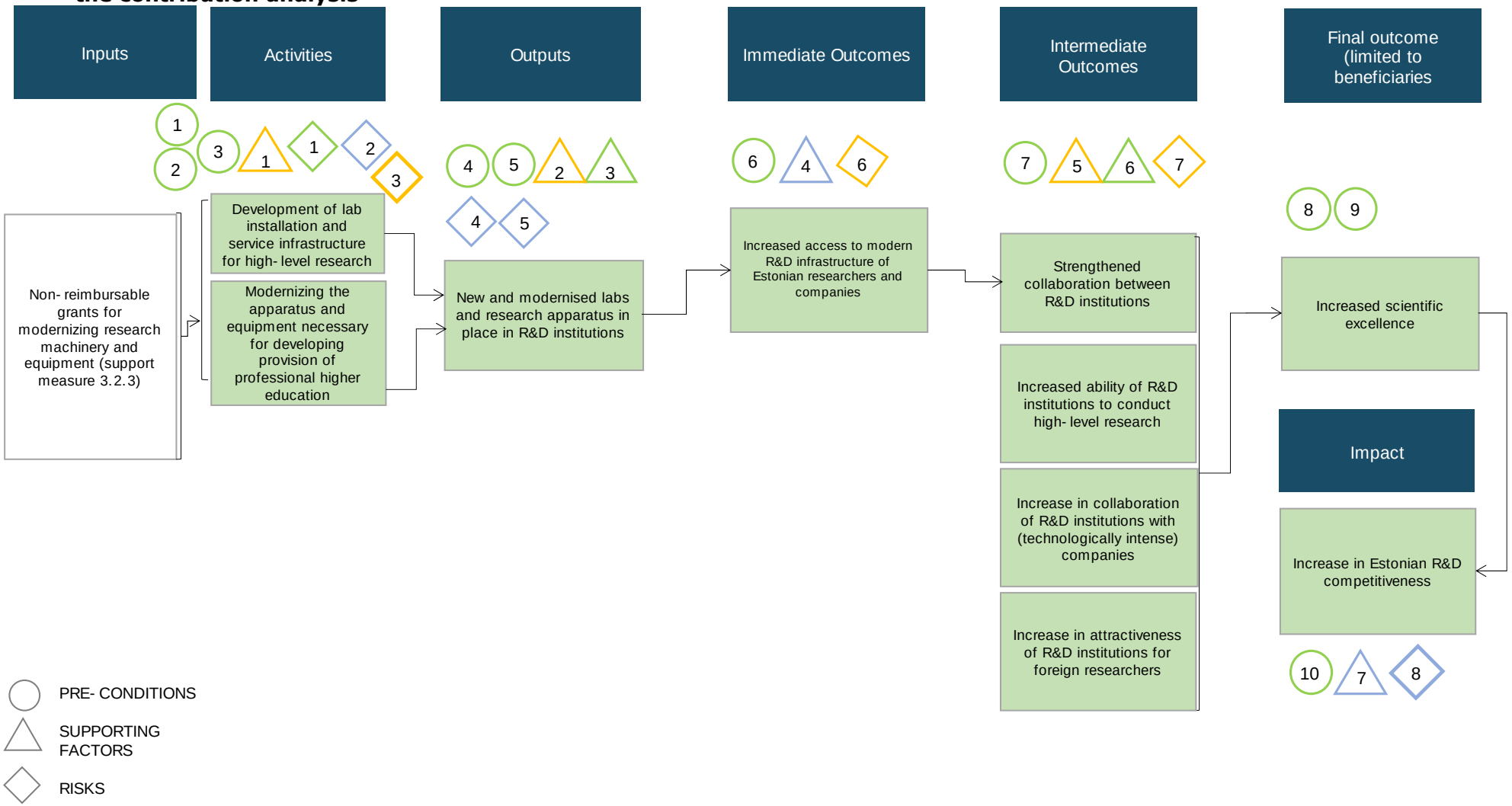
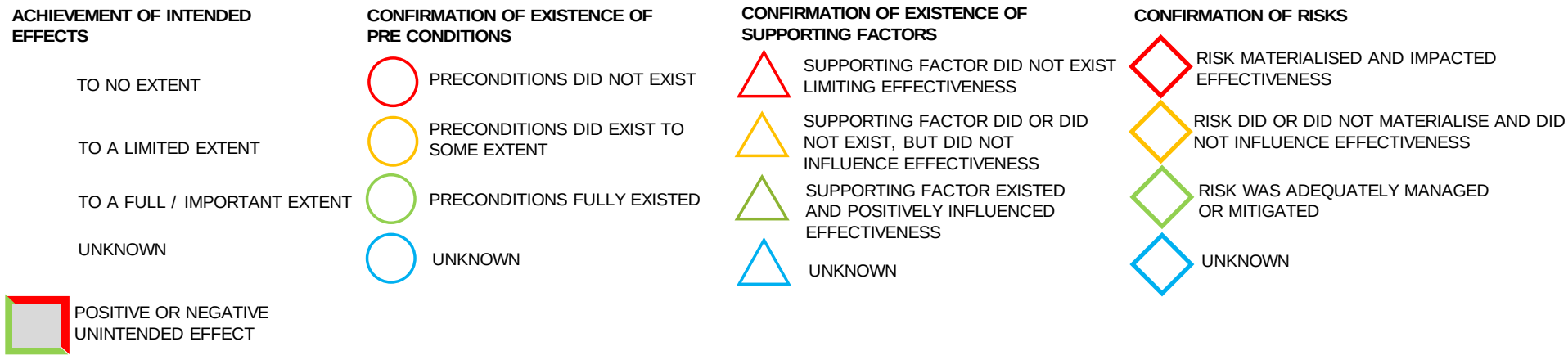
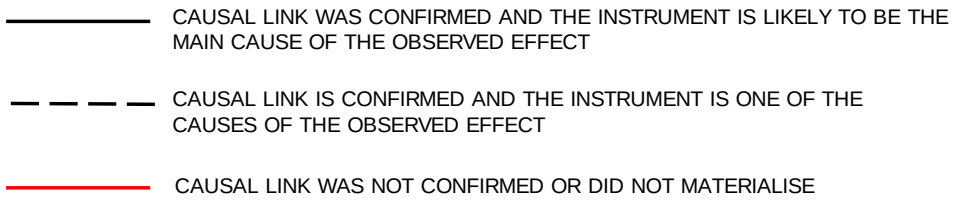


FIGURE LEGEND



CONFIRMATION OF CAUSAL LINKS



3.3. Policy instrument: Infrastructure investments for education in HEIs

3.3.1. Theory of Change of Infrastructure Investments for education in Higher Education Institutions policy instrument

The policy instrument of infrastructure investments for education in HEis (renovating and building new buildings) is similar to the policy instrument for infrastructure investments for research (purchasing new research equipment) presented in the previous section (see section 3.2), in terms of their wider objectives, expected impact and target groups. Furthermore, these two policy instruments complement each other: while the research environment was modernized under this policy instrument, the research equipment was purchased under the other policy instrument. Both instruments were targeted at research and HE institutions, aiming to create better conditions for high-level research. Furthermore, the wider impact was expected as a result of the potential synergy from both policy instruments. The main difference between these two policy instruments is in the outputs – research equipment vs buildings. Having said this, the majority of preconditions, supporting factors and risks are common to both policy instruments.

Similarly to the policy instrument for infrastructure investments for research (see the previous section), the **main driver** behind this policy instrument was outdated and limited studying and working conditions for students and researchers in the Estonian higher education and research institutions. At the time of implementation, it was widely acknowledged that to ensure the necessary quality of Estonian higher education and academic personnel needed for business and society development, the establishment and modernization of professional higher education and university infrastructure had to be supported. This included renovation and refurnishing of existing buildings and construction of new ones. Higher education institutions were asked to review their needs for modern infrastructure and analyse what buildings required a renovation and the needs for new infrastructure. This analysis concluded that a number of buildings were too old and didn't meet the requirements of modern research or generated high exploitation costs for further exploitation.

Another aspect that was taken into account was the **spatial location** of higher education and research infrastructure. The approach of a campus-style environment was adopted from the very early stages – buildings should be combined with the concept of an efficient learning and research environment[18]. Such an approach stresses the importance of learning and research as a precondition for economic development: modern knowledge generation is the most efficient in campus-style environments, which combine higher education institutions with research institutions, enterprises and venture capital.

Along with the modernizing of research and higher education infrastructure, Estonia was also **focusing on creating a critical mass and creating the necessary infrastructure** for sustainable R&D; while keeping in mind the decreasing and ageing population, including researchers. It was estimated that ERDF would modernize 20.0-25.0% of research infrastructure, including workplaces, and about 5-8% of the higher education infrastructure.

The **three main activities** implemented under this policy instrument were: the creation of campus-style research environments for R&D activities, the renovation and equipping existing research buildings or building new ones if necessary, and developing supporting

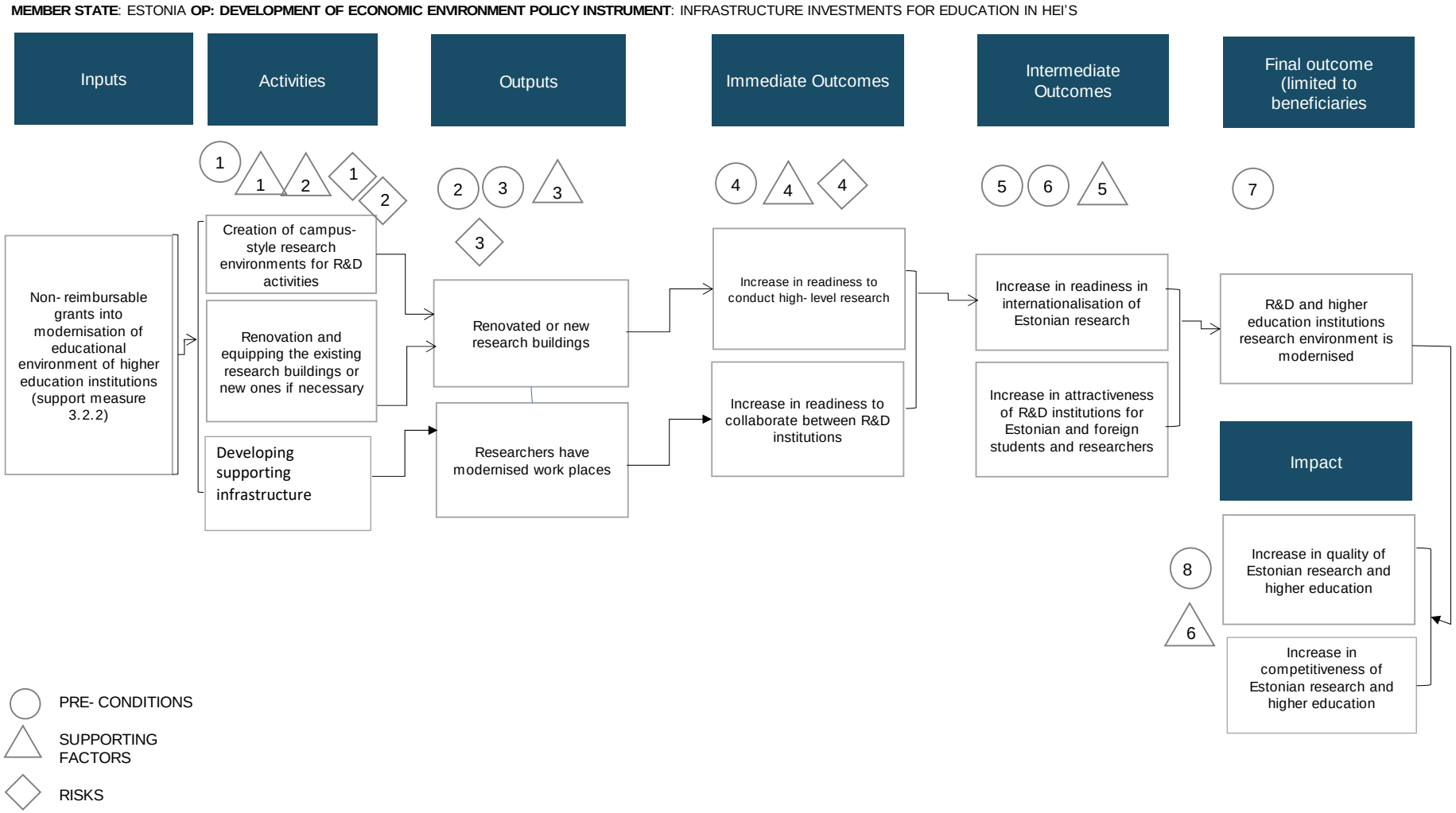
[18] *National Strategic Reference Framework, p 86: https://www.struktuurifondid.ee/sites/default/files/modified_economic_environment_op_070311.pdf*

infrastructure. Projects were funded based on the investment plan approved by the government. The only precondition the higher education and research institutions had to meet to access support was proof of having conducted a good analysis and understanding of their infrastructure needs. As this policy instrument was mainly about construction and renovating, it required a number of public procurement procedures to be conducted by institutions. Therefore, a stable economic environment and institutional know-how and competences in providing public procurement were considered an important supporting factor.

On the other hand, the main risks linked to the instrument stemmed from potential deviations in the economic environment, which could cause an increase in construction prices. In addition, public procurement failures were considered a serious risk for reaching the expected results of the policy instrument. As will be explained later in the report, both risks materialized during the policy instrument's lifetime.

There were two **main outputs** expected from this policy instrument – renovated or new research buildings and researchers having modernized workplaces. These outputs were significantly expected to support the achievement of both immediate and intermediate outcomes – strengthening cooperation between research institutions and increasing the level of high-level research, the attractiveness of Estonian research institutions and readiness for internationalization.

Figure 11. Theory of Change of the policy instrument Infrastructure investments for education in HEIs



Source: researchers' team on the basis of primary and secondary data collected

MEMBER STATE: ESTONIA **OP: DEVELOPMENT OF ECONOMIC ENVIRONMENT POLICY INSTRUMENT**: INVESTMENT IN R&D INFRASTRUCTURE

Pre- conditions

1. Clear understanding of funding needs
2. Knowledge in providing public procurements
3. R&D institutions' cofunding is planned in the budget
4. Public procurements for renovating or building research buildings are provided
5. Sufficient competences of R&D institutions' to conduct high-level research
6. Willingness to collaborate between R&D institutions
7. Renovated or new research buildings meet the needs for research environment
8. All projects are implemented as planned

MEMBER STATE: ESTONIA **OP: DEVELOPMENT OF ECONOMIC ENVIRONMENT POLICY INSTRUMENT**: INVESTMENT IN R&D INFRASTRUCTURE

Supporting factors

1. Previous experiences in renovation and building of research infrastructure
2. Stable economic situation
3. Implementing Body's support for providing public procurements is available
4. Renovated or newly built research buildings match with other research infrastructure or buildings enabling together reaching strategic objectives of the R&DI and entrepreneurship strategies
5. Existing collaboration between R&D institutions
6. Stable economic environment

MEMBER STATE: ESTONIA **OP: DEVELOPMENT OF ECONOMIC ENVIRONMENT POLICY INSTRUMENT**: INVESTMENT IN R&D INFRASTRUCTURE

Risks and threats

1. Increase in costs of renovating or building research buildings
2. Deviations and failures following the public procurement rules may cause delays in implementation of activities
3. Deviations in public procurements' processes may cause postponing the finalisation of projects
4. Low quality of construction of research buildings may lead to unexpected maintanance costs in exploitation

3.3.2. *Contribution analysis of the Infrastructure Investments for education in Higher Education Institutions policy instrument*

Verification of intended intervention implementation

As was the case for the research instrument's infrastructure (see the previous section), interviews and data collection did not reveal any deviations in the implementation of planned activities under the infrastructure for the education instrument. The originally planned activities as part of the instrument were implemented to a full extent and without any major alterations.

The **policy instrument's main aim** was to **modernize the educational and research environment** by modernising building new educational buildings. It was a straightforward policy instrument implemented through an investment plan with three main activities: the creation of a campus-style research environment, renovation and equipping the existing research buildings or building new ones and developing supporting infrastructure. As research institutions had to map their needs for R&D infrastructure (buildings) and prioritise them before accessing the funds, the investments were carefully analysed. This prioritisation concluded with an investment plan, which was approved by the government. In addition, the implementation of this policy instrument was, to a large extent, supervised by the Ministry of Education and Research. Some deviations in implementing the planned activities took place due to the economic crisis in 2008-2010, linked mostly to public procurements procedures (e.g. when construction prices increased or procurement processes were extended). However, these changes did not fundamentally hamper the implementation of activities and the achievement of objectives. Even if these deviations did require some adjustments in the implementing processes (e.g. amending guidance for public procurement or offering more support to research institutions), all activities were implemented as planned initially.

Achievement of intended and unintended effects at the level of the expected threshold

Evidence collected through data collection and interviews point to a high level of achievement of expected results/targets. According to the final report of the Priority Axis 2 only two projects by the University of Tartu were cancelled at the beginning of the implementation phase, given that the planned investments were no longer considered necessary for the university. ERDF funds (EUR 111 m) under the policy instrument were fully used by the end of the period.

17 buildings were renovated or built through the implemented projects, as presented in table 5.

Table 5. Renovated and built buildings of HEIs during 2007-2013

HEI	NO. OF BUILDINGS
University of Tartu	4 buildings
Tallinn University of Technology	4 buildings
Tallinn University	1 building
Tartu Observatory	1 building
Estonian Biocentre	1 building
Estonian Literature Museum	1 building
Estonian University of Life Sciences	2 buildings
Tartu Aviation College	1 building
Tartu Health Care College	1 building
Tallinn Health Care College	1 building

Source: Addendum No 247 of the Decree of the Government of Estonia from 30.05.2008, Investment plan for modernisation of research and higher education study environment

This said, the managing and implementing authorities only used two indicators to measure the progress/success of the policy instrument, as presented in the following table 6.

Table 6. Indicators measuring achievements of the policy instrument

INDICATOR	TARGET	ACHIEVEMENT
RESULT INDICATOR:		
R&D working places created in new or upgraded facilities of R&D institutions by the target year	800	1,336
Students using new or upgraded facilities of higher education institutions by the target year	1,500	6,450
OUTPUT INDICATOR:		
New or upgraded facilities of R&D institutions	25,000	78,047
New or upgraded facilities of higher education institutions	12,000	40,634

Source: Final report of the OP DEE

As seen in Table 6, the policy instrument results exceeded initial expectations concerning official performance indicators. However, one reason for this can be linked to underestimating targets as there were no previous experiences to build on. The established targets can not necessarily be seen as a trustworthy performance yardstick for this instrument. During interviews, the representatives of universities expressed a high degree of satisfaction with regard to the instrument's capacity to satisfy their investment needs. Higher education institutions stated that this was the first time they could invest in developing complex and holistic teaching and learning environment. Furthermore, the renovated and newly constructed buildings enabled institutions to accommodate new research equipment, illustrating a clear synergy between this policy instrument and the infrastructure investments for the research policy instrument.

Examples of investments involve:

Box 3. Box Developing Estonian Biocentre Gene and Biotechnology Centre

The project's general objective was to ensure the sustainability and international competitiveness of biotechnology as one of the key fields of research and development in Estonia. Achieving this objective is possible thanks to the Gene and Biotechnology Centre's development meeting the needs of contemporary research tr6ends and the development of the business sector based on the Estonian Biocentre and the University of Tartu Riia and Vanemuise St. campus.

The results of the project are as follows:

→ Through the established contemporary working environment, cooperation of Estonian research and development activity in the field of biotechnology has increased

→ Research and development infrastructure has been built

→ Appropriate gene bank has been established

Source: https://www.struktuurifondid.ee/eng/developing-estonian-biocentre-gene-and-biotechnology-centre [retrieved November 18, 2020]

Box 4. Development Project of the Infrastructure of Tartu Observatory

The project developed the Tartu Observatory located in Toravere, Noo Rural Municipality, Tartu County, into a contemporary centre for space research and technology. The project has created the infrastructure necessary for achieving and maintaining international competitiveness.

The results of the project are as follows:

→ Three-storey main building was renovated and an extension with a surface area of appr. 720 m2 was established

Both the ventilation, cooling and electricity system and the communications network were updated, the building was insulated and received a new external and internal finish

New active equipment of the computer network, equipment for the computer class and the information centre, furnishings, office equipment and furniture was purchased

Source: https://www.struktuurifondid.ee/eng/development-project-infrastructure-tartu-observatory [retrieved November 18, 2020]

Box 5. Developing the University of Tartu Transplant Medicine Centre

The objective of the National Transplant Medicine and Clinical Research (SIME) infrastructure is to bring research in the field of medical examinations in Estonia to a higher level than before. Interaction with customers is flexible, offering them accurate and personal customer-oriented solutions. The Centre has highly qualified employees with wide experiences who can find a solution to all the customer's needs. Quality management systems ISO 9001:2008 and GLP (good laboratory practice) are implemented in work.

The results of the project are as follows:

→ Services on offer: contemporary modelling of diseases and phenotyping of animal models
→ Pre-clinical and toxicological analyses
→ Infrastructure that enables working with pathogens of Class 3 biosafety
→ In vivo and ex vivo display technologies
→ Regenerative medicine services
→ Prescribing medicinal products in clinical trials
→ Metabolomics services
→ Transgenic technology services

Source: https://www.struktuurifondid.ee/eng/developing-university-tartu-transplant-medicine-centre [retrieved November 18, 2020]

Box 6. University of Tartu Institute of Physics

As a result of the project, an internationally competitive institute of physics was completed. A research environment meeting contemporary international requirements and conditions is attractive to both young scientists starting out in research and experienced scientists. The institute of physics houses foremost laboratories and offices for researchers and auditoriums and practice rooms for carrying out research and teaching of physics, information technology, and material technology.

The results of the project are as follows:

→ An internationally competitive Institute of Physics was completed

→ The project has an impact that supports regional development. The project makes a significant contribution to developing Tartu as an internationally competitive education and research campus

→ The project modernized the working environment of 286 researchers

→ 43 new jobs were created by 2015

Source: https://www.struktuurifondid.ee/eng/university-tartu-institute-physics [retrieved November 18, 2020]

Verification of assumed pre-conditions

During data collection, all interviewees confirmed all planned preconditions took place and influenced the implementation positively. Given the similarity between the infrastructure instruments, the most important precondition (and eligibility requirement) for this policy instrument was the existence of a **mapping and analysis of investment needs**. All investments into the educational environment required conducting public procurement – these were complicated procedures for the construction or renovation of complex buildings. Beneficiary institutions had to ensure that they had the relevant in-house **knowledge and experiences** for preparing and providing public procurements. As admitted by Archimedes, the implementing agency, pitfalls in public procurements did occur frequently.

Another important precondition that was considered necessary to ensure a smooth implementation of the policy instrument was **stable government funding,** guaranteeing the capacity for beneficiary institutions to provide co-financing to the ERDF support received. Co-funding of institutions normally remained between 5% and 30% of total

investments, with some exceptions having existed.[19] No evidence was found indicating any issues with cofounding by institutions, on the opposite, the representatives of the Ministry of Education and Research confirmed during the interviews that "*institutions were motivated to absorb ERDF investments and in some cases, when the approved level of ERDF support was less than applied, they were eager to co-finance even more than required, in order the investments could be done*".

Verification of supporting factors

Evidence collected also indicates that the great majority of supporting factors took place, except for a stable economic environment.

Given that this was the first full Structural Funds programming period for Estonia, according to Archimedes, the implementing body, and the Ministry of Education and Research, not all management functions were fully in place at the beginning of the period. Nevertheless, Archimedes underwent a prompt restructuring process, and roles with the Ministry of Education and Research were defined. A Special Structural Funds unit was created at Archimedes. Positions and staff were quickly equipped with **relevant skills.** Given that this process took place prior to the economic downturn, the labour market was active, and relevant skills were available. Archimedes oversaw one task to guide and supervise institutions in providing public procurement to minimise legal risks and failures. In general, the implementing body was competent to guide and provided effective support to beneficiary institutions. However, the interpretation of ERDF rules did lead to some disagreements between Archimedes and beneficiary HEIs. The main complaint on behalf of the latter was that ERDF rules didn't match well with scientists' needs (e.g. every cost had to be justified, and public procurement became the norm).

Another important supporting factor for this policy instrument was the existence of a **stable economic environment**. However, the economic downturn in 2008-2010 did impact the execution of public procurement and related contracts of the development of HEI infrastructure (some procurement processes were extended, in some cases, prices went up). However, the unstable economic environment does not appear to have significantly negatively influenced the implementation of the instrument.

Verification of risks and threats

Evidence collected through interviews and data collection confirmed that risks identified in the ToC materialised to some extent. However, in practice, this did not appear to hamper the achievement of intended final results significantly.

The main risks associated with this instrument were related to public procurement. As already described above, the economic downturn caused a delay in public procurements or increased costs in some cases. These were not specific to this policy instrument, but rather horizontal for all ERDF investments in Estonia (i.e. construction-related public procurements were also provided in the environmental sector for renovating or building wastewater treatment plants). According to the final report of the Priority Axis 2 of the OP DEE, the main challenge observed was related to public procurements. There were mistakes or smaller failures in following **public procurement rules**, but Archimedes' strong supervision helped to intervene quickly, which in hand avoided more significant failures. Overall, the **quality of renovated or newly built buildings** was satisfying, except one case brought up by an interviewee: the new Tartu University Chemistry building. The main complaint was poor ventilation and thermal resistance of the building.

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[19] *Addendum No 247 of the Decree of the Government of Estonia from 30.05.2008, Investment plan for modernisation of research and higher education study environment*

While the project was completed, the university still has to manage with consequences of poor construction quality.

3.3.3. General assessment of the Infrastructure Investments for education in Higher Education Institutions policy instrument

As was the case for the infrastructure for research instrument, the infrastructure investments for education instrument is also considered to have been very successful. The indicators measuring the level of achievement of the policy instrument were overachieved. Also, there is widespread consensus among interviewed stakeholders that the instrument has allowed moving the needle when it comes to the quality and the performance of the Estonian education and research system. The CS found strong evidence confirming the objectives and expected outcomes were achieved. Furthermore, the expected impact has to be seen together with the outcomes of the policy instrument infrastructure investments in research.

Under the policy instrument, infrastructure investments for education in HEIs 17 HEI buildings were implemented for a total ERDF support of EUR 111 m (35.5% of OP expenditures). Under the policy instrument, ERDF 2007-2013 funds were invested in renovation and new buildings for Estonian higher education and research institutions. For example, Tartu University Institute of Physics or library for the Tallinn University of Technology was built. All planned activities were implemented, and results achieved.

All interviewees highlighted that **investments into HEI infrastructure enabled** Estonian scientists to be part of important international research groups, developed the basis for increasing the research quality, as well as increased the attractiveness of Estonian universities for international PhD students and academic staff. The policy instrument created conditions for increasing the number of qualified researchers and skills to conduct scientific activities. Furthermore, Estonian research became more visible in the international landscape. It became more attractive for international students and researchers as well as increased the competitiveness of Estonian research. With this said, this instrument was relatively and comparatively simple in its design, and its ambitions remain modest. This is reflected in its fairly straightforward design, which if looked at closely, fails to acknowledge or address how improved infrastructure should and can directly lead to broader economic and societal changes / improvements.

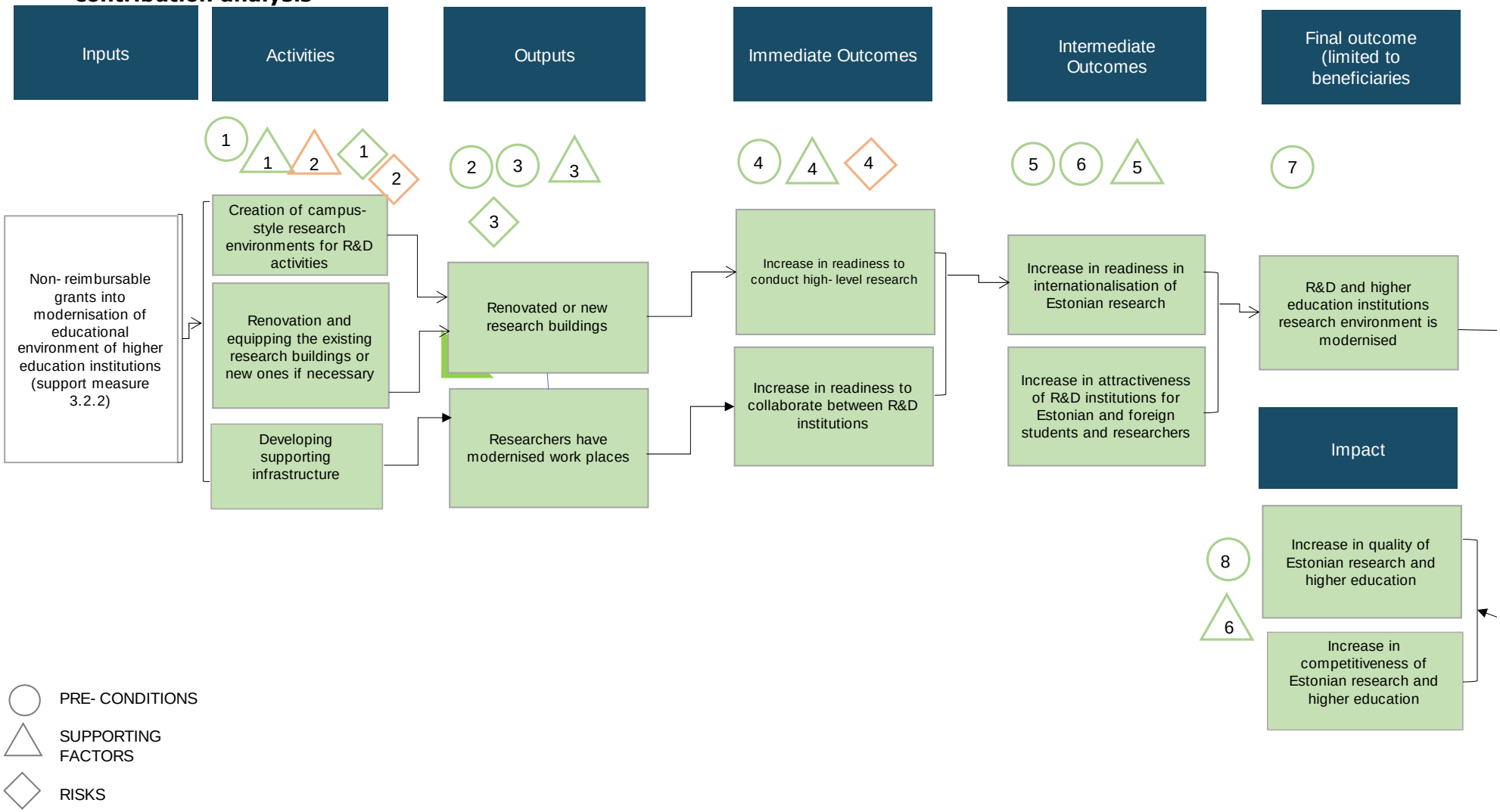
The contribution of the instrument to the observed results is considered to be high. In light of the confirmation of the different causal relationships that were originally envisaged, the instrument is considered to have been one of the main causes leading to the achievement of such results. The instrument was delivered based on what is considered by this evaluation to be a sound design and management system. A number of necessary precautions and measures were introduced for necessary pre-conditions to be met (e.g. the obligation to carry out infrastructure needs assessment) and avoid any disruptive consequences stemming from the rise of unforeseen circumstances (e.g. the economic downturn). This said the results that have been observed are unlikely to have taken place in the absence of the combined support provided by other ERDF RDI instruments and other ESIF programmes. Combined, these investments into research equipment and laboratories as well as into human resources gave a real boost to Estonian higher education and research overall.

Investments in the modernization of R&D infrastructure prepared the landscape for further growth and development of Estonian higher education and research. Thanks in part to the ERDF support provided over this period, the shift in the physical, educational environment was huge. The subsequent 2014-2020 policy instruments and investments would have been not possible without the foundations established by the ERDF 2007-2013

investments. The actual results of 2007-2013 investments can be seen in 2014-2020 - as an example, the number of high-level publications of Estonian researchers has steadily increased and doubled during 2008 – 2018 [20] ; or the participation of Estonian researchers in FP7 and Horizon 2020 has increased from EUR 1 m to EUR 43 m during 2007-2019 (see Figure 12). All stakeholders agree that Estonian research has grown and ERDF 2007-2013 investments into physical research infrastructure played a crucial role in shifting in quality.

[20] *Estonian Research Council: https://www.etag.ee/tegevused/uuringud-ja-statistika/statistika/bibliomeetria/*

Figure 12. Theory of Change of the policy instrument of infrastructure investments for HEI, reflecting the results of the contribution analysis



The colored figure legend is available in section 3.2.3 of the report.

3.4. Policy Instrument: Collaborative R&D projects in Centres of Excellence

3.4.1. Theory of change of the Collaborative R&D Projects in the Centres of Excellence policy instrument

The support of Centres of Excellence in the 2007 – 2013 period was a continuation of investments launched during the 2004–2006 ERDF period. The idea behind the Centres of Excellence was to create critical masses of knowledge to produce high-level research in national priority areas for economic development. Centres of Excellence were meant to conduct large strategic research projects deemed necessary for research intensive economic growth and the creation of better conditions for international research cooperation. The National Strategic Support Framework 2007-2013 defines the Centres of Excellence as "…incubators of top specialists and researchers in internationally competitive fields of research".[10] The Centres of Excellence programme can be seen as one of the longest-living funding instruments in Estonian research - launched in 2001. It enjoyed significant funding during 2004-2006 and 2007-2013 and continued during the 2014-2020 period. However, the number and scientific domains of Centres of Excellence funded throughout these periods have fluctuated.

The policy instrument was focused on supporting very high-quality research contributing to international-level research. This support was targeted to internationally-visible and top-level research groups in order to:

1) Create an environment for high-level research;
2) Create preconditions for the Estonian Centres of Excellence to join international networks and research cooperation in the framework of EU research policy;
3) Facilitating and stimulating cooperation between related or complementary research groups.

In broader terms, Centres of Excellence were meant to contribute to more comprehensive efforts for the internationalisation of Estonian research through increased participation in international research and cooperation programmes, increased collaboration in the Baltic Sea region, and an increase in competitiveness of Estonian research globally. Also, the Centres of Excellence were aimed to increase the administrative capacity of R&D and higher education institutions.

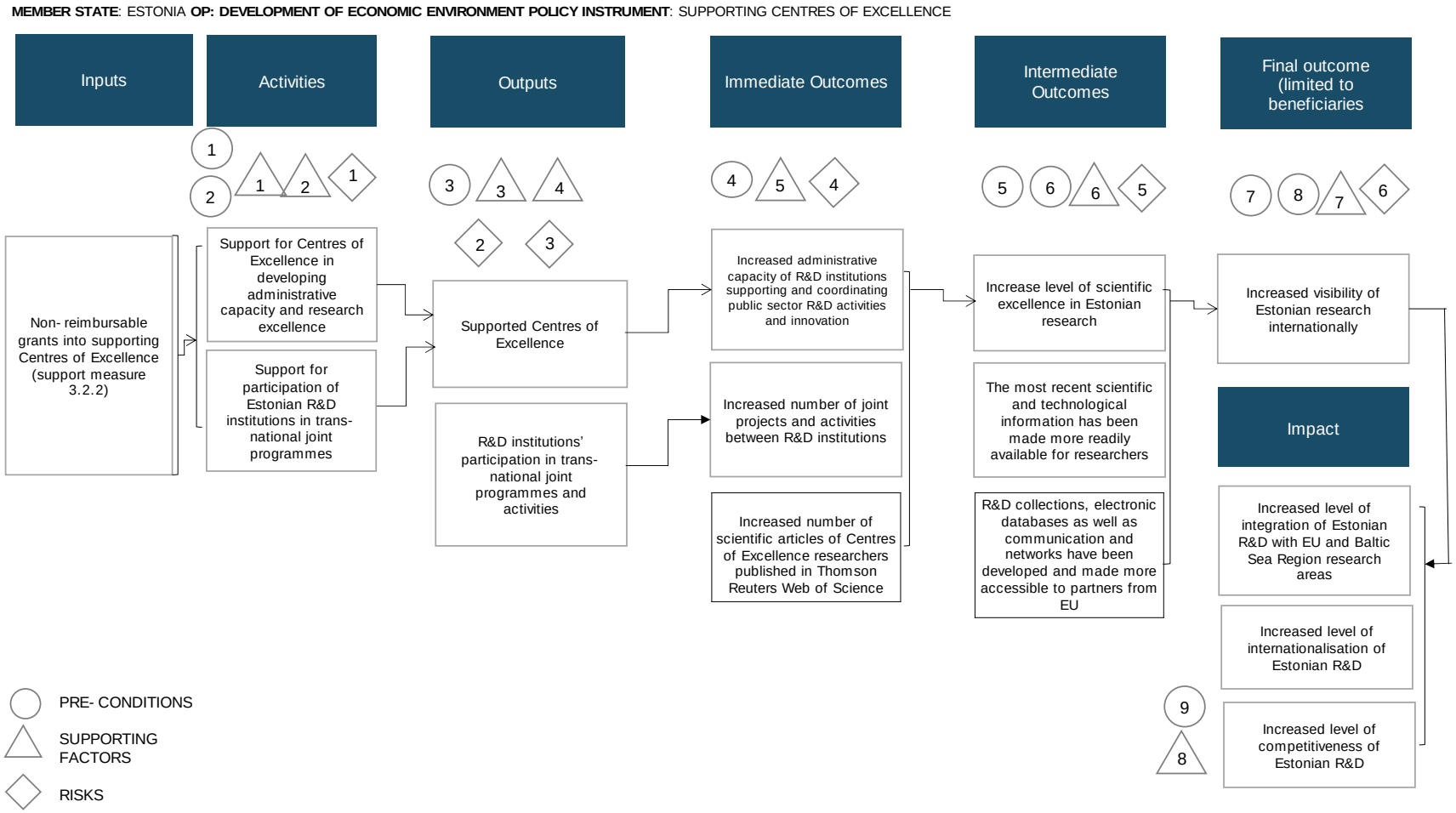
Two types of activities were planned under this instrument:

1) Support for Centres of Excellence for conducting internationally competitive high-quality R&D activities, i.e. research (but also activities needed for establishing and developing the centres) and cooperation with other research teams and the transfer of knowledge between them, etc.)
2) Support for the participation of Estonian R&D institutions in trans-national joint programmes and activities (e.g. ETI, JTI, CREST, FP7, ETP)

Previous experiences and competences gained from managing Centres of Excellence and participation in international cooperation programmes were considered an important supporting factor capable of feeding into the success of the policy instrument. As an output of the ERDF (and national) funding, 12 Centres of Excellence were funded and, leading to their participation in a number of international joint activities and programmes. The modernized research infrastructure and purchase of new equipment enabled by the two previously analysed instruments (see previous sections) can be considered a pre-condition to the success of the Centres of Excellence.

In the short-term, Centres of Excellence were expected to increase the administrative capacity of R&D institutions, to higher numbers of joint projects and activities between R&D institutions, and increased numbers of scientific publications by researchers they hosted. In the long-term, they were thought to lead to overall increases in scientific excellence and a better systematization and access to electronic scientific databases and research networks. Centres of Excellence were funded on a competitive basis. One important pre-condition for funding in addition to the scientific merit of the project was to set out a clear vision regarding objectives, activities and expected outcomes of the Centre. As a final outcome, Estonian research was meant to become more visible internationally. The main expected impact from Centres of Excellences was an increased level of internationalization and competitiveness of Estonian Research and a strengthened international collaboration and integration into EU and the Baltic Sea region research areas.

Figure 13. Theory of Change of the Policy Instrument of supporting Centres of Excellence



Source: researchers' team based on primary and secondary data collected

Pre- conditions

1. Clear understanding of funding needs
2. Sufficient level of competences and knowledge of Estonian researches to participate in international programmes and initiatives
3. Sufficient R&D infrastructure in place in R&D institutions
4. Sufficient level of qualified staff of R&D institutions and Centres of Excellence in place
5. Clear vision and understanding on developing Centres of Excellence
6. Clear understanding of potential and added value from participation in trans-national joint programmes and activities
7. Stable government R&D funding in place
8. Readiness of TA institutions in participation in international cooperation
9. Centres of Excellence and participation in trans-national joint programmes and activities are supported

MEMBER STATE: ESTONIA **OP: DEVELOPMENT OF ECONOMIC ENVIRONMENT POLICY INSTRUMENT**: INVESTMENT IN R&D INFRASTRUCTURE

Supporting factors

1. Previous experiences from supporting Centres of Excellence
2. Previous experiences from supporting participation in trans-national joint programmes and activities
3. Stable government R&D funding
4. Clear understanding of Estonian research excellence (e.g. which disciplines or thematic areas have potential becoming internationally excellent)
5. Previous knowledge and experiences in participation in trans-national joint programmes and activities
6. Clear understanding of potential and added value from participation in trans-national joint programmes and activities
7. Administrative support (by Implementing Agency) for R&D institutions is in place
8. Stable and clear strategic approach towards R&D internationalisation

MEMBER STATE: ESTONIA **OP: DEVELOPMENT OF ECONOMIC ENVIRONMENT POLICY INSTRUMENT**: INVESTMENT IN R&D INFRASTRUCTURE

Risks and threats

1. Management system failures in managing grants may lead to misuse of EU funds
2. Cuts in stable government R&D funding
3. Low capacity of Centres of Excellence in absorption of funds
4. Researchers lack time for participation in trans-national joint programmes and activities
5. Insufficient level of capacity and capability to manage Centres of Excellences
6. Deviations from initial projects' implementation plans may lead to changes in final outcomes

3.4.2. Contribution analysis of the Collaborative R&D Projects in the Centres of Excellence policy instrument

Verification of intended intervention implementation

All intended activities were implemented as planned, without any major alterations. Centres of Excellence were funded through different sources (targeted financing, institutional and personal grants, other programmes) on a competitive basis. The **main activities** funded by ERDF 2007-2013 were aimed at supporting Centres of Excellence in conducting internationally competitive high-quality R&D activities, i.e. research and supporting Estonian R&D institutions' participation in trans-national joint programmes and activities (e.g. ETI, JTI, CREST, FP7, ETP). There were 12 Centres of Excellence funded between 2007-2013: 7 Centres were funded during 2008-2015, and 5 Centres were added later during 2011-2015.

The mid-term evaluation of research and higher education support measures 2007-2013 concludes that Centres of Excellence were among the **success stories** of the 2007-2013 Structural Funds period[21]. In addition to the Centres, research institutions and researchers admit that this funding model is attractive mostly because of its flexibility. Different funds can be combined, allowing to cover a wide range of costs such as investments and cover costs for salaries and guarantee a competitive level of rewards for top researchers. Similarly, ERDF support enabled Centres to decide how to invest the financial support granted. For applying for the ERDF grant, the Centres had to develop their business plan and ensure achieving their main aim – research excellence.

Competition for access to funds was very high, and as such, not all research groups were funded in the first round. As Centres of Excellence's aim was to support the excellence of Estonian research and collaboration between research groups and institutions, the only eligible applicants were research groups and institutions. Research groups applying for a grant had to guarantee at least 5.0% of co-funding. The main criteria were that the research groups consist of researchers having international-level research results, and the participating institutions had to be internationally evaluated[22]. There was no direct requirement for the research area to be in line with the R&D strategy's priority areas. However, the areas of the Centres of Excellence funded during 2007-2013 to a large extent were related to the priority areas of biotechnology, ICT and nanotechnology:

Table 7. Centres of Excellence funded during 2007-2013

Centre of Excellence	Leading research institution
Centres of Excellence 2008-2015	
Estonian eXcellence in Computer Science (EXCS)	University of Tartu
Centre of Excellence on Biodiversity	University of Tartu
Centre of Excellence on Genomics	Estonian Biocentre
Centre of Integrated Electronic Systems and Biomedical Engineering	Tallinn University of Technology
Centre of Excellence on Chemistry Biology	University of Tartu

[21] *Mid-term evaluation of higher education and R&D support measures 2007-2013 (2011): https://www.struktuurifondid.ee/sites/default/files/teadus-_ja_arendusmeetmete_rakendamise_hindamine.pdf*

[22] *Decree of the Ministry of Education and Research on Rules and Conditions for the support measure "Development of Centres of Excellence" from 18.01.2008: https://www.riigiteataja.ee/akt/12914003?leiaKehtiv=*

Centre of Excellence	Leading research institution
Centre of Excellence on Cultural Theory	University of Tartu
Centre of Excellence on Translational Research Neuroimmunological Diseases	University of Tartu
Centres of Excellence 2011-2015	
Dark Matter (Astro)particle Physics and Cosmology	Institute of Chemical and Biological Physics
Centre of Excellence on Environmental Changes	University of Estonian Life Sciences
Centre of Excellence Advanced Materials and High-technology Devices for energy recuperation systems	University of Tartu
Centre of Excellence on Theory and Applications of Mesosystems	University of Tartu
Centre for Nonlinear Studies	Tallinn University of Technology

Source: Ministry of Education and Research: https://www.hm.ee/et/tegevused/teadus/baasfinantseerimine-ja-tippkeskused

ERDF support enabled the Centres of Excellence to conduct both fundamental and applied research and development activities. In practice, however, they mainly engaged in **fundamental research**. As Estonian research is very much founded on a project-based approach, fundamental research has traditionally suffered from a lack of funding. This is one of the reasons for the Centres of Excellence focused heavily on fundamental research.

Centres of Excellence aimed to **boost collaboration between research groups** as it was one of the main tools bringing Estonian researchers together and increasing collaboration between research institutions. The Centres were normally physically located on the premises of the leading research institution. Still, labs and research equipment were equally used by all researchers and institutions affiliated with the Centre. Investments into research equipment were eligible under the policy instrument. According to interviewees, however, these investments were mostly funded through the ERDF infrastructure instruments, which turned the Centres of Excellence funding on the financing of research activities and related salaries for researchers at the Centre.

In the end, ERDF was able to support more Centres of Excellence than planned initially. This became possible because of reallocations of funds from other policy instruments conducted in light of the very high demand for support under this instrument. Initially, there was one open call planned. This call led to a very high number of applications and the selection of Seven centres. This very low selection rate created frustration among centres that were not selected but met eligibility criteria. Three years later, after extra funds were reallocated to the policy instrument, an additional five Centres were funded. This explains the difference in Centres of Excellence's implementation period – seven Centres were funded for seven years and five Centres for four years.

Achievement of intended and unintended effects at the level of the expected threshold

Interviews with stakeholders and data collected confirmed the outcomes and outputs were achieved as expected initially. However, most data and evidence collected is qualitative and stems from the interviewees' perceptions conducted as part of this evaluation. Here again, the robustness of baseline values is low, and the definition of targets is quite arbitrary.

While initial expectations were to support seven Centres of Excellence, an additional five Centres were supported during the second half of the period, leading to 12 supported centres (total budget EUR 40 m). Two indicators were established to measure the success of the policy instrument:

- Result indicator: Publications by researchers working in the Centres of Excellence entered in the ISI Web of Science for the current year was exceeded (target: 300; achieved: 1270)
- Output indicator: Number of centres of excellence co-financed by the ERDF was also exceeded (target: 7; achieved: 12)

However, both indicators say little about the actual changes brought about by the support provided to the Centres of Excellence. In addition, targets should have been reviewed upon the re-allocation of additional resources to the instrument.

During the interviews, the Centres admitted that ERDF funding had enabled them to focus on high-level research while lessening the burden of maintaining premises or paying salaries. They consider the ERDF support and the government approach to Centres of Excellence as crucial and essential support for their research. Furthermore, many Centres of Excellence funded during 2007-2013 were also funded during 2014-2020, thus enabling researchers to continue their research and achieve even higher results. The interviewed researchers were proud of the results they had achieved, and in many cases, these results would not have taken place were it not for the support provided by the ERDF. However, in the current context, there does appear to be a high level of uncertainty regarding the potential sustainability of the funding, putting the future of existing lines of research at risk.

Box 7. Example on creating synergy between different funding sources and activities: Centre for Translational Medicine (as of the end of 2015)

A good example of the impact of ESIF funds can be presented in the case of the University of Tartu Translational Medicine Center SIME, which had received grants from various sources and has been able to combine them into one successful entity:
1. The University of Tartu H2020 ERA Chair project TransGeno: The ERA Chair for Translational Genomics and Personalized Medicine is closely linked to the University of Tartu Center for Transitional Medicine (SIME), which was funded with the support of ESIF.
2. The construction of the SIME house has been financed during 2004-2006 by the 'roadmap policy instrument' and the purchase of scientific equipment was funded by ERDF 2007-2013 investments into research infrastructure (medium-sized infrastruscture sub-programme) policy instrument.
3. SIME is a member of EATRIS ERIC - EATRIS participation fees were also funded by ESIF.
4. SIME has also received support from ESIF to join the International Regenerative Medicine Consortium (under the Internationalization of Research programme funded by the OP HRD).
5. SIME had received approx. EUR 16 m of ESIF funding for infrastructure investments. The final report of the OP DEE claims that without SIME, the ERA Chair project would not have happened at the University of Tartu.
6. Furthemore, due to EATRIS membership H2020 applications have also been successful. SIME's research activities are carried out with the support of national funding. In addition, the Center is involved in at least three international research cooperation projects funded by ESIF (cooperation with the USA, the UK and Vietnam).
7. The FP7 2008-2011 REGPOT project "Advancing scientific performance and regional potential of Estonian biomedical research" (ESTBIOREG) also contributed to the creation of SIME.

In their 2007-2013 final reports, the Centres of Excellence have highlighted the contributions made to scientific achievements and the increases in the levels of awareness in their research area. As an example, the Centre of Excellence on Computer Science states that "our research results, especially those concerning information security and software development related to e-government and e-services, as well as developments in language technology, are of great importance for Estonia in terms of the application of technologies. Our research in data mining and bioinformatics is becoming increasingly important. The Centre of Excellence on Computer Science has also played an important role in popularizing and disseminating topics to the public, especially among young people, as well as policymakers." [23]

The final report of the Centre of Excellence for Biodiversity states the following regarding the sustainability of the Centre's activities: "Participation in the Centre's work increased the participating research teams' sustainability as the quality and quantity of their research improved. This will give a better starting position for new funding applications, and the experience gained, allowing for higher quality applications. The Centre of Excellence members have successfully applied for research grants, which ensures the continuity of research and development activities of research groups. However, in the Estonian context, this aspect is overshadowed by the fact that since 2008 research funding has not increased in real terms. It is also a positive development that the cooperation developed within the

[23] *Ministry of Education and Research (2015), Final Report of the OP 2007-2013 Priority Axis Improving the competitiveness of Estonian R&D through the research programmes and modernisation of higher education and R&D institutions*

Centre of Excellence led to the creation of an integrative nature conservation biology working group, which then applied for funding under a grant and received a positive funding decision and is currently funded through the institutional research grants. This shows that the substantive integration that has taken place through the Centre of Excellence leads to qualitatively new developments, which also prove to be sustainable."[24]

Verification of assumed pre-conditions

The significant majority of identified preconditions took place in support of the achievement of final results. In addition to the set of formal requirements for funding, the Centres of Excellence had to meet; they also had to present clear objectives, activities, and competences and knowledge to run the Centre. **Previous experiences** in running the Centre of Excellence could be seen as a precondition. However, it wasn't an official requirement to access funding. Similarly, as one of the policy instrument's aims was to increase Estonian R&D institutions' participation in trans-national joint programmes and activities, previous experiences stemming from such collaboration were seen as a precondition. As all indicators and expected results were achieved and a number of Centres of Excellences were funded already in 2004-2006 and in 2014-2020 period, the Centres of Excellence have had time to grow and equip themselves with qualified staff.

A very strong precondition for the Centres was the **existence of relevant research infrastructure**. In some cases, the infrastructure wasn't there at the beginning of the funding period, but as investments into research infrastructure were eligible cost, the infrastructure level improved in parallel with running the Centres of Excellence and was part of their activities. It is essential to have **qualified staff** working with research infrastructure – as the Centres were targeted to high-level research, it was an interest of Centres to equip themselves with relevant skills. Also, to increase the research quality, it was an interest of Centres to participate in international cooperation programmes and be aware of their **research potential** and **added value** in participation in international cooperation. All listed preconditions for a successful operation of a Centre of Excellence were observed.

Verification of supporting factors

Interviews and data collected confirmed that all supporting factors took place and supported the achievement of intended results. As already said earlier and similarly to the other policy instruments, **stable government funding** played a crucial role also for Centres of Excellence – it can be seen both as a precondition (they had to guarantee co-funding for at least 5.0% from the total grant) as well as supporting factor (Centres were funded from different sources). Even if Centres of Excellence and the research community overall still expect public financing levels to increase, sources of funding allowing to cover ERDF co-funding were always guaranteed for the Centres of Excellence.

The government's approach to focus funds on high-level and the highest potential scientific fields were introduced during the 2004-2006 period. Hence, a number of research groups already had experience in running these types of centres. Similarly, public authorities had **previous experiences** from supporting Centres of Excellence, which made launching the 2007-2013 Centres of Excellence smoother. As before 2007-2013, Estonian researchers' participation in international research and cooperation programmes was rather uncommon; previous international cooperation experiences were rather limited.

One of the main objectives of the policy instrument is strengthening collaboration between research groups and institutions. The role of already **existing collaboration** cannot be underestimated – researchers already having close contacts found more easily joint

[24] *ibid*

research topics, and they were used to work together. It supported the creation of a Centre of Excellence and was easier to manage activities. The Centres of Excellence admitted that **the centre's joint objectiv**e was one of the main motivations for collaboration. For example, during 2007-2013, every Centre of Excellence could spend 10% of their ERDF budget for joint activities – the guaranteed funding motivated researchers to provide joint activities – seminars, conferences, lectures, public awareness events depending on the thematic area of the Centre. In the 2014-2020 period, they do not have this luxury – they still have to organize joint events and activities, but there is no clear budget for that – every research team is responsible for covering their costs. This arrangement reduces the motivation for joint activities. Furthermore, as research funding to a large extent is project-based (i.e. individual and institutional grants), competition for funding between researchers is increasing – it's the same state budget for all researchers in Estonia.

Verification of risks and threats

Interviews and data collected confirmed that no risk materialised during the implementation of the policy instrument. As the 2007-2013 period was the first full-time ERDF financing period, not all management systems were fully operational at the beginning of the period. Nevertheless, Archimedes' implementing agency was quickly equipped with relevant skills, and a special Structural Funds unit was established. They implemented education and research related policy instruments, including providing relevant documentation and open calls, giving advice and guidance to applicants and beneficiaries. Normally, Archimedes was the first contact point for Centres of Excellence and was a supportive body for beneficiaries. **No major failures of the management system** were detected. However, there were many cases where there were misinterpretations of ERDF rules both by beneficiaries and the implementing agency. The variety and level of detail of rules were often the sources of frustration in Centres of Excellence and all researchers related to the absorption of the Structural Funds funding.

As discussed above, **stable government financing** was a crucial element of running the Centres of Excellence. During 2007-2013 government baseline funding remained stable at 16% of government funding, enabling Centres of Excellence to guarantee stable co-funding. The interviewed Centres of Excellence were quite satisfied with the funding model during 2007-2013, where they used several funding sources and had the flexibility to reallocate funds within the Centre.

The nature of this type of research establishment puts researchers under heavy pressure and high workload, as they are expected to produce high-level research, teach, and be active outside the university (e.g. do business, popularize science, etc.). At the same time, Centres of Excellence have objectives to achieve, bearing risks in the **low absorption capacity of funds**. According to the final report of the OP DEE Priority Axis 2, the Centres of Excellence achieved their objectives and implemented all activities by the end of the period. Similarly, researchers are interested in participating **in international joint scientific programmes**; they are motivated to investing their time and capacity into attending joint activities.

3.4.3. General assessment of the Collaborative R&D Projects in the Centres of Excellence policy instrument

Based on the elements presented in the previous section, the evaluation team has conducted a general assessment of the policy instrument and the individual causal claims identified in the original ToC. The CS collected sufficient levels of evidence to assess the instrument for Centres of Excellence and qualify it as successful. It's been one of the longest existing policy instruments for supporting research, existing since 2001 and funded through three ESIF periods.

Under the policy instrument, Collaborative R&D projects in the Centres of Excellence 12 Centres were funded during 2007-2013, constituting 14% of the OP expenditure (EUR 40 m). According to the OP DEE final report, all funds were used up to 99.55%[25]. The Centres aimed to support high-level research and internationalization of Estonian research. Centres were selected on a competitive basis through two rounds of open calls. The Centres of Excellence were funded from various sources, and they had flexibility in deciding how to allocate funds internally. ERDF funding was mostly spent on researchers' salaries, joint activities and awareness rising (i.e. marketing) activities, organizing and attending seminars and conferences, and investing in R&D infrastructure. However, as the budget for Centres was limited, investments into equipment were applied from the policy instrument for infrastructure investments.

Mid-term evaluation of higher education and R&D support measures 2007-2013,[26] but also the final report of the Priority Axis 2 of the OP DEE 2007-2013[27] admit that the policy instrument for the Centres of Excellence had been assessed as **one of the most effective** ones - it was **the best instrument functioning having the biggest impact**. In their final reports, the Centres have highlighted valuable aspects of both high-level research achievements and awareness-raising in the field, both of which have been the aim of the Centres of Excellence's activities.

Once funding was received, the Centres of Excellence were the most satisfied with the funding model, which gave them the flexibility to decide and allocate funds within the Centre. It allowed scientists to focus on their work and not worry about existential issues. On the other side, using ERDF funds set an enormous **administrative burden** for the Centres – there were too many rules the scientists were not used to following, and they found unnecessary. At the beginning of the period, the Centres struggled to meet all ERDF requirements, but they quickly realised that they have to follow the donor's rules to do their research. The Centres were convinced that ERDF rules do not match the nature of research – the rules were targeted rather for a profit-making type of activities.

Administrative burden was also mentioned by the implementing agency Archimedes and the Ministry of Education and Research. Both admitted that, especially at the beginning of the period, they had to support the Centres in setting up a reporting system and explaining eligibility rules. There were made smaller mistakes in public procurements in every Centre – researchers were used to not providing procurements for purchasing chemicals of smaller laboratory equipment and purchasing travel tickets, as an example. Still, using ERDF funds, they had to follow procurement rules also for those small expenditures. These failures, in many cases, led to the reimbursement of ERDF funds (total amount reimbursed EUR 53,825). Even if these cases were not prevailing and amounts were small, it created an administrative burden both for the Centres and Archimedes.

Collaborative R&D projects represent the typical type of intervention mobilised to foster networking and collaboration and stimulate international research cooperation. Even though it was eligible under ERDF rules to cover costs both for fundamental and applied research, as confirmed by interviewees, the Centres were **mostly focused on fundamental research**. This is fully in line with the Centres' aim – to support high-level research and internationalization of Estonian research. The scope of scientific fields of the Centres varied between being a very narrow scientific area (e.g. the Centre on Dark Matter

25 Ministry of Economic Affairs and Communication (2015), OP DEE Final Report: https://www.struktuurifondid.ee/sites/default/files/mark_lopparuanne.pdf
26 Technopolis Group, Praxis & Institute of Baltic Studies. (2011). Euroopa Liidu tõukefondide perioodi 2007-2013 teadus- ja arendustegevuse ning kõrghariduse meetmete rakendamise vahehindamine. Tallinn: Government of Estonia.
27 Ministry of Education and Research (2015), OP DEE Final Report: https://www.struktuurifondid.ee/sites/default/files/mark_lopparuanne.pdf

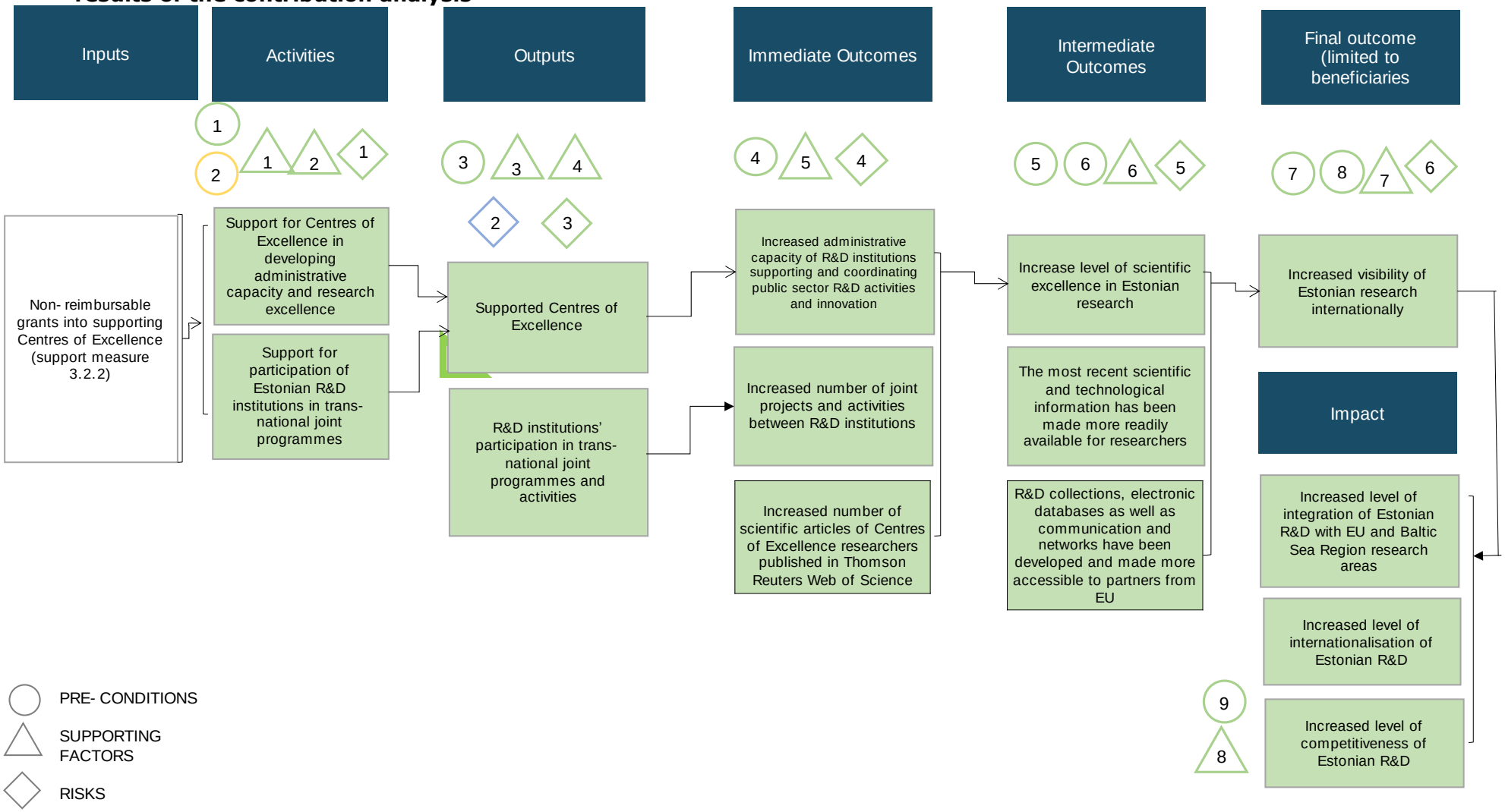
(Astro)particle Physics and Cosmology) to the pretty wide one (e.g. the Centre on Environmental Changes). Not having applied research in their portfolios is the main reason why Centres of Excellence had no connection with the business sector – the research was too fundamental for any businesses. On the other side, as an example, the Centre on Dark matter admitted that, in some cases, researchers of the Centre created a company to offer some services to the market – this was a response to the market demand and was not aimed for any long-term sustainable activity.

One of the most valued aspects of the Centres of Excellence, admitted by representatives of the Centres and the Ministry, is strengthened collaboration between research institutions. When researchers and research institutions are partners and competitors at the same time (for applying for government funds but also for EU funds), the Centres of Excellence offered a **joint goal for a partnership** of research groups. The Centres were formed based on a number of research groups – there were at least two research institutions involved with more than one research group from every institution – this model of cooperation offered excellent opportunity to work together and work together **interdisciplinary**. The latter is another positive aspect to be mentioned in the Centres of Excellence.

All collected evidence confirms that the Centres of Excellence **have definitely played an important role in the Estonian research landscape** – researchers of the Centres have been listed among the world's top 1% of researchers in the Clarivate Web of Science[28]. Also, Estonian researchers' participation in international cooperation programmes has increased[29] , and the number of high-level publications has increased[30]. Preconditions for ERDF absorption as well as supporting factors were to a very large extent there, and no major risks materialised. As said before, there were smaller mistakes in public procurements (which were expected), but none of them hampered the policy instrument's implementation. For sustainability of Estonian research quality, it is important to continue funding Centres of Excellence – stable funding will give researchers a signal from the government that their work is valued and ensure addressing societal challenges in the long-term.

[28] *Clarivate Web of Science: https://recognition.webofscience.com/awards/highly-cited/2020/*
[29] *Estonian Research Council: https://www.etag.ee/tegevused/uuringud-ja-statistika/statistika/raamprogrammide-statistika/*
[30] *Estonian Research Council: https://www.etag.ee/tegevused/uuringud-ja-statistika/statistika/bibliomeetria/*

Figure 14. Theory of Change of the policy instrument of infrastructure investments for Centres of Excellence, reflecting the results of the contribution analysis



The colored figure legend is available in section 3.2.3 of the report.

4. GENERAL FINDINGS AND LESSONS LEARNT

4.1. Key achievements of ERDF support in the Member State (i.e. effectiveness)

As a result of ERDF 2007-2013 investments, all six Estonian public universities' research investment needs were addressed significantly. To illustrate this point, ERDF financed 17 renovated or newly built buildings amounting to a total of EUR 111 m of ERDF funds. Furthermore, 293 projects were funded under the small-scale research infrastructure sub-programme, where research groups purchased small-scale research equipment. Research and Higher Education institutions were funded through 100 projects for investments into medium-scale research infrastructure (research equipment and laboratories). Also, 9 research objects of the Estonian research roadmap were funded, addressing national interest needs. All in all, EUR 83 m of ERDF funds were invested in the modernisation of research equipment. Also, during 2007-2013 12 Centres of Excellence were funded, amounting to a total ERDF amount of EUR 40 m.

Even though this study remains critical of the performance frameworks established under ERDF RTD activities, all OP performance indicators for research infrastructure were overachieved. For example, it was foreseen 12,000m2 of modernised space of research and Higher Education Institutions were to be built or renovated. However, the actual result was closer to 40,634m2. Also, it was foreseen that seven Centres of Excellence would be funded, while in practice, a total of 12 Centres were funded. While it is clear that indicators and targets were underestimated when the OP was planned, the real need for investments was so high that institutions could absorb more than initially planned. Also, reallocations from other Priority Axis enabled more open calls for research infrastructures and Centres of Excellence, enabling more investments than planned.

Evidence collected as part of the case study confirm that the strategic decision to invest in the modernisation of research infrastructure was reasonable – the highest impact is seen in the increased level of quality and internationalisation of Estonian research. Estonia has also become more attractive for both international students (i.e. PhDs) and researchers. Furthermore, the combination of investments into 'bricks' and 'brains' has increased the sustainability of investments, institutions' capacity and competences, and collaboration among institutions. All interviewed higher education and research institutions confirmed that the modernisation of their research infrastructure (both buildings and equipment) created conditions for more high-level research, which in hand 'opened doors' for international scientific collaboration programmes. Even if the expected national level impacts were not, perhaps, visible at the end of the 2007-2013 period, they became and are becoming visible in subsequent years. For example, the participation of Estonian scientists in H2020 programmes and the number of high-level publications has increased significantly during 2014-2020. This shift would not have been possible without ERDF investments during 2007-2013.

There is no direct evidence that investments in research infrastructures have impacted collaboration with the business sector or economic development overall. Given that the research infrastructure policy instrument was targeted towards HE and research institutions, the participation of private companies/industry in the instrument was very limited. A handful of high-level R&D companies conducted investments in research equipment, but their role was minor. Also, as the academia-industry collaboration was not the focus of these instruments, there was no observed impact on strengthened collaboration between these actors.

However, evidence collected during the CS supports the conclusion that the 2007-2013 ERDF investments have played an important role in modernising the Estonian higher education and research environment. ERDF investments have led to a **significant shift in**

the quality and internationalisation of Estonian research. In addition, the achievements triggered by the ERDF 2007-2013 investments greatly improved the conditions under which subsequent actions were conducted during the following period.

The CS found that policy instruments' effectiveness was greatly driven by a **smooth ESIF management system** and **stable government funding**. The whole ESIF management system in Estonia was set up based on a principal rule maximising added value of the EU support and minimising irregularities in the use of the funds. This principle was a cornerstone for the use of all ESIF funds in Estonia. Interviewed beneficiaries and the implementing agency confirmed that the ERDF rules were difficult to apply to research investments. This materialised in a number of disputes between the implementing agency and beneficiaries concerning the interpretation of ERDF rules during the whole lifetime of the 2007-2013 period. Nevertheless, collected evidence confirms that all ERDF funds were used effectively and that implementation was rather fluid (despite a steep learning curve for involved beneficiaries).

As concerns, the roll-out of ERDF investments allowed the HE and research institutions to co-finance the ERDF investments. The average co-financing rate was 15%, which had to be covered by the beneficiaries' financial recourses. Government baseline funding of HE and research institutions remained stable over 2007-2013, accounting for 16% of all government funding for HE and research institutions. Stable government funding guaranteed ERDF beneficiary institutions could cover their co-financing obligations, even if, from the point of view of institutions, the baseline funding never covers all necessary costs.

A significant shift took place made in the **management of research institutions**. When applying for investments for both research equipment and research buildings, institutions had to analyse, map and prioritise their investment needs. They had to conduct long-term strategic planning for high-potential research areas, research equipment needs, and required competencies. This has contributed to the modernization of Estonian higher education and research institutions' management structure through institutional mergers and re-structuring. As a result, more effective and efficient higher education and research institutions are in place. Performance contracts were also introduced in 2015, measuring the performance and financing of higher education institutions based on the size of entrepreneurial contracts, number of high-level publications, doctorate graduates and patents. This approach to performance contracts has led to a shift in these organisations' thinking, leading to a more entrepreneurial and society-driven reflection.

The CS found that the main risks and problems encountered during the implementation of the policy instruments were related to the **interpretation of ERDF and public procurements rules**. All interviewees highlighted these issues, irrespective of which side of the management system they were from. For policymakers, this increased the required level of communication with beneficiaries, more consultations with MA and Auditing Authority, and created a risk for irregularities at a country level. At the same time, for HE and research institutions, the rules also appeared to lack clarity. In many cases, stakeholders found that neither ERDF nor procurement rules matched scientists and research institutions' needs. Research institutions felt the rules were too bureaucratic. Both sides claimed that this complexity/uncertainty led to a high administrative burden, which in some cases caused extended procurement processes or repayments. However, scientists and research institutions quickly realised that they had to accept ERDF and public procurement rules if they were to conduct investments. This said, disputes around the interpretation of ERDF or public procurements rules did not affect the implementation of policy instruments and can be mostly considered to represent part of the country's learning curve during this period.

Policy instruments for **investments into research equipment and renovation/construction of new buildings** shared similar objectives but were implemented through different activities. Both were aimed to modernise the research infrastructure through investments. Investments into research equipment were implemented through three different sub-programmes: small-scale infrastructure (targeted for research groups), medium-scale infrastructure (targeted for research institutions) and large-scale infrastructure (research objects of national interest in research roadmap). This diversification allowed to target different needs of institutions and optimise administrative costs (having more or less simplified application procedures), and motivating collaboration on different levels. While applying for small-scale infrastructure required collaboration between research teams, accessing a large-scale infrastructure object funded required effective collaboration between research institutions and the government. Estonia's HE and research institutions built or renovated 17 buildings, which represented an unprecedented level of investment in the country's research infrastructure. All in all, the final report of the OP DEE recognises that through ERDF RTD 2007-2013 investments, the great majority of investment needs of Estonian public higher education institutions were addressed.

The policy instrument for Centres of Excellence was a continuation of the 2004-2006 period. The role of Centres cannot be underestimated – their ultimate aim is to produce high-level fundamental research. Content-wise, their performance is measured by the number of high-level publications, participation in international research programmes, or Estonian research visibility internationally. These goals have been achieved greatly, and ERDF is also seen as a great catalyst behind these results. All interviewees admitted that having modern research equipment and environments have played a crucial role in increasing Estonian research visibility worldwide. The Centres of Excellence programme can be seen as one of the most stable funding instruments in Estonian research - launched in 2001; it enjoyed significant funding during 2004-2006, 2007-2013 and 2014-2020. However, in their interviews, the Centres expressed unclarity about the future as it is not yet known whether and how the programme will be continued beyond 2021. From the perspective of Estonian research's sustainability and achieved results so far, it would be important to continue providing government funding. Future discussions will look at the most efficient funding schemes and the optimal amount of government funding to do so.

Overall, **ERDF investments have significantly supported** the development of the Estonian economy and increase the level of quality of Estonian research. This is supported by national statistics (e.g. increase of the number of companies and overall export, level of high-tech in enterprises, private R&D investments) as well as a recent mid-term evaluation of the OP 2014-2020 (even if the evaluation covered the current programming period, the effects and results of 2007-2013 are visible also today). The mid-term evaluation of higher education and research support measures 2007-13 highlighted that R&D infrastructure investments had been one of the main focal points of the 2007-13 period, even though the sustainability of this infrastructure is not entirely ensured. In addition, investments into R&D infrastructure in 2007-13 have enabled Estonian scientists to be part of important international research groups, develop a basis for improved research quality, and increase the attractiveness of Estonian universities for international PhD students and academic staff.

4.2. Relevance

The present case study's findings clearly show that **ERDF support addressed the most pressing demands of the Estonian RTD system**. There was a huge gap in investments for research infrastructure during previous decades – the existing infrastructure was

outdated and didn't meet modern research needs. This was the main challenge ERDF support for RTD set out to tackle.

The R&D and innovation policy was planned, implemented and monitored at a national level, as there were no regional level strategies or activities for R&D investment. The ERDF policy instruments for investments in research infrastructure were designed **based on a bottom-up and top-down approach**. Collected evidence showed that the planning of the policy instruments involved wide consultation with target groups (bottom-up approach) – research and HE institutions were asked to analyse their investment needs, and they were also involved in consultations at the policymaking level (this mainly concerned investment in research equipment and research buildings). Based on this approach, investments in large-scale infrastructure built on the priorities set by a national research roadmap. The roadmap, addressing national-level research needs, was developed in collaboration with HE and research institutions and policymakers. Similarly, Centres of Excellence's scheme was developed using the combination of existing and future potential of research excellence (bottom-up) and national research objectives (top-down) – to motivate and support high-level research making Estonian research internationally more visible.

Geographically, activities under Priority Axis 2 were mainly carried out in two bigger cities - Tallinn and Tartu, which possessed the highest R&D potential in Estonia. Strengthening Tartu as an R&D centre had a positive impact on the development of Southern Estonia. As for environmental protection, this OP aimed to help establish modern laboratories that run lower environmental risks than existing facilities and could provide a new base of ideas and schemes that will lead to the development of sustainable environmental technologies.

Engineering and Technology were clear prime beneficiaries of ERDF funding. This, in turn, is clearly in line with the three priority areas of the 2007-2013 national RDI strategy of *i) ICT, ii) Biotechnologies,* and *iii) Material Technologies.*

4.3. Efficiency

Covering R&DI and entrepreneurship under one OP was expected to drive investments in R&D, enabling companies to innovate while boosting economic development. Therefore, the OP DEE's main aim was to support economic development through several means, including R&D. The wider rationale behind the Priority Axis 2 **was to take a holistic approach** to the development of Estonian R&D and the higher education system. ESIF expenditure combined investments in research infrastructure ('hard') with skills, researchers' mobility, and internationalisation activities ('soft'). These two types of interventions aimed to concentrate ERDF support within research and HE institutions and complement each other in reaching wider objectives. The CS found that ERDF investments were significant enough to generate a major shift and bring Estonian research and HE institutions to a new performance level. The ERDF funds targeted at the modernisation of Estonia's research infrastructure reached unprecedented levels - about EUR 235 m of ERDF funds were invested into research infrastructure during 2007-2013 (c.a. 75% of the Priority Axis 2).

The OP DEE specifically targeted the private sector (SMEs, large), R&D institutions, higher education institutions, incubator centres, clusters, technology parks, non-profit organisations and public authorities. The Priority Axis 2 and particularly the policy instruments in scope were mainly **targeted at supporting both public and private R&D institutions** involved in conducting, implementing and/or funding and organising research and development; including R&D institutions, Centres of Excellence, universities and institutions of professional higher education. However, a limited number of companies benefitted from investments in research infrastructure overall.

4.4. Sustainability and replicability

No direct evidence was collected, which would point to the existence of significant threats to the sustainability of ERDF investments. This said some more minor doubts were shared during interviews. For instance, the perceived lack of flexibility of ERDF funding rules has become a major obstacle for private sector users of new infrastructure and equipment. As such, the access and use of these by the private sector was strongly limited. Beneficiary institutions purposely limited the use of this infrastructure by private-sector third parties. They were worried about infringing ERDF rules (ERDF investments cannot be used for profit-making for more than 20.0% of the equipment's total time). The situation hasn't improved in recent years either, as research equipment is, to a large extent, still used by students and researchers (and to a very limited extent by companies).

The CS found that the most important aspect of sustainability is the stability of funding of HE and research institutions, and especially the continuation of the Centres of Excellence programme. Government baseline funding, which is the most important government funding for institutions, has increased in recent years. Once funded, institutions can allocate baseline funding within the institution according to their needs. The Centres of Excellence programme continued during the 2014-2020 period, enabling researchers to continue their research and build upon initial results obtained through previous work. Today, it is not yet clear whether and in which way the programme will continue after 2020. This uncertainty places heavy pressure on researchers and threatens the long terms sustainability of their work.

There are valuable lessons learned which can be learned from the programming of ERDF RTD resources during the 2007-2013 period in Estonia. First of all, using three different sub-programmes to support the modernisation of HE and research institutions' research equipment, depending on the size of the equipment and targeting the actual needs of different target groups, proved to be a very efficient approach catering to several needs and challenges. Secondly, the **Centres of Excellence** programme has also proven to be quite successful in enabling scientists to focus entirely on their research and produce world-class high-level results. Centres of Excellence's role has been important in increasing the quality of research and bringing Estonian research visible internationally. This experience can be replicated, especially as the Centres are funded through different sources and have proven to blend different funding types successfully.

4.5. Coherence

The OP under assessment was conceived as a catalyst to foster participation in FP7 as the key areas of Estonia's R&D competences (biotechnologies, ICT, materials technologies) were subsets of the themes of the framework programme (healthcare, food, agriculture and biotechnology, ICT, nanosciences, nanotechnologies, new materials and production technologies, energy, environment (including climate change), transport (including air transport), socio-economic and humanitarian sciences, security and space). Even if Estonian participation in FP7 programmes remained stable during 2007-2013, the country witnessed a rapid increase in H2020 programmes during 2014-2020. ERDF 2007-2013 investments were meant to create the necessary preconditions for participation in international research programmes, which was achieved significantly.

The ERDF investments in research infrastructure ('bricks') were planned to be complemented by investments in skills and mobility and internationalisation programmes ('brains') under the OP for Human Resources Development. Both investments in 'bricks' and 'brains' were seen as a holistic approach to modernising the Estonian higher education and research system. Thus, the strongest synergies were between these two OPs. ERDF investments in research infrastructure built strong preconditions for Estonian companies

to become more innovative and technology-intense, thus making an indirect link with the OP DEE Priority Axis 1 (Innovation and Growth Capacity of Enterprises). Also, links with the Baltic Sea Strategy were built into improving the overall competitiveness of the Baltic Sea Region.

4.6. EU added value

The CS found that there were no direct EU-wide effects created by ERDF investments. However, it is worth underlining that ERDF investments in research infrastructure formed a strong basis for Estonian researchers to participate in international research and cooperation programmes. All interviewees valued this effect and mentioned that without ERDF support, Estonia would not have carried out such a strong shift in research quality in such a short period. Interviewees confirmed that the strengthened cooperation has mainly been observed between research and HE institutions in different MS rather than at an MS level.

Annexes

ANNEX I. OVERVIEW OF EVIDENCE COLLECTED FOR THE POLICY INSTRUMENT "INFRASTRUCTURE INVESTMENTS FOR RESEARCH."

EFFECT TYPE	EXPECTED EFFECT	TARGETS DEFINED BY MA	SUMMARY OF EVIDENCE COLLECTED	LEVEL OF ACHIEVEMENT OF THRESHOLD
Outputs	New and modernised labs and research equipment in place in R&D institutions	No	There were 405 projects implemented under the policy instrument. Besides that, many research groups modernised their equipment, a number of labs were created/modernised in HEIs and R&D institutions, and the number of research infrastructure for national importance was funded.	To a full extent
Immediate outcomes	Increased access to modern R&D infrastructure of Estonian researchers and companies	No	Research equipment was purchased based on institutions' mapping - all HEIs agreed during interviews that access to modern research equipment had increased significantly. At the same time, increased access of businesses to research infrastructure is difficult to assess as ERDF rules restrict the use of research infrastructure. All HEIs admitted that limited access of businesses to research infrastructure is one of the major issues when collaborating with companies.	To a full extent
Intermediate outcomes	Strengthened collaboration between R&D institutions	No	All interviewed policymakers and HEIs admitted that the policy instrument forced HEIs and R&D institutions to collaborate. Collaboration was the highest while developing the national R&D infra roadmap - all institutions wanted to have their interests covered. Also, in purchasing small-scale research infra, research groups (often interinstitutional) had to collaborate.	To a full extent
	Increased ability of R&D institutions to conduct high-level research	Yes	There are national-level targets in Knowledge-based strategy to be observed: The annual number of PhDs: 2008: 161; 2013: 233; 2020: 300 Published articles in 10% the most citated academic journals: 2007: 7,56%; 2013: 7,6%; 2020: 11%. Number of scientific publications per million of population: 2007: 800; 2013: 1439; 2020: 1600 Source: https://www.haridussilm.ee	To a full extent
	Increase in collaboration of R&D institutions with (technology intense) companies	No	There are national-level targets in Knowledge-based strategy to be observed: The annual number of PhDs: 2008: 161; 2013: 233; 2020: 300 Published articles in 10% the most citated academic journals: 2007: 7,56%; 2013: 7,6%; 2020: 11%. Number of scientific publications per million of population: 2007: 800; 2013: 1439; 2020: 1600 Source: https://www.haridussilm.ee	To a limited extent
	Increase in attractiveness of R&D institutions for foreign researchers	No	All interviewed policymakers and HEIs admitted that Estonian R&D and HE institutions' attractiveness increased significantly due to the ERDF support. The institutions have world level R&D infrastructure, which attracts foreign researchers, research groups, and students and enables Estonian researchers to participate in international research and cooperation programmes.	To a full extent

Final outcomes	Increased scientific excellence	Yes	All interviewed policymakers, HEIs and Centres of Excellence agreed that Estonian research quality has significantly increased due to ERDF 2007-13 investments into R&D infrastructure. This is not only about the increased number of high-level publications, number of PhDs or level of investments into research, but it also the Estonian researchers participating in EU FP7 and H2020 and other scientific cooperation programmes as well as Estonian research being on a world-class level in some research domains (like bio- or nanotechnology)	To a full extent
Impact	Increase in Estonian R&D competitiveness	No	Number of foreign researchers and students is increased: Published articles in 10% the most cited academic journals: 2007: 7,56%; 2013: 7,6%; 2020: 11%. Number of Estonian researchers/HEIs participating in FP7 programmes	To a full extent
	Increase in the capacity of the Estonian R&D system	No	Number of Estonian researchers (FTE): 2007: 5002; 2013: 6048 The annual number of PhDs: 2008: 161; 2013: 233; 2020: 300	To a full extent

ANNEX II. OVERVIEW OF EVIDENCE COLLECTED FOR THE POLICY INSTRUMENT "INFRASTRUCTURE INVESTMENTS FOR EDUCATION IN HEIs"

EFFECT TYPE	EXPECTED EFFECT	TARGETS DEFINED BY MA	SUMMARY OF EVIDENCE COLLECTED	LEVEL OF ACHIEVEMENT OF THRESHOLD
Outputs	Renovated or new research buildings	Yes	OP DEE final report: 1) the output indicator new or upgraded facilities of R&D: 78047 m2 2) and HE institutions were achieved: 40634m2	To a full extent
	Researchers have modernised workplaces to produce research	Yes	OP DEE final report: 1) the outcome indicator R&D working places created in new or upgraded facilities of R&D institutions by target year was achieved: 1336 2) Output indicator students using new or upgraded facilities of higher education institutions by target year: 6450	To a full extent
Immediate outcomes	Increase in readiness to conduct high-level research	No	All interviewees said that Estonian research had increased a lot due to the R&D infra investments.	To a full extent
Intermediate outcomes	Increase in readiness for internationalisation of Estonian research	No		To a full extent
	Increase in attractiveness of R&D institutions for Estonian and international students and researchers			
Final outcomes	R&D and higher education institutions' research environment is modernised	No		To a full extent
Impact	Increase in quality of Estonian research and higher education	No		To a full extent
	Increase in the competitiveness of Estonian research and higher education	No		To a full extent

ANNEX III. OVERVIEW OF EVIDENCE COLLECTED FOR THE POLICY INSTRUMENT "COLLABORATIVE R&D PROJECTS IN CENTRES OF EXCELLENCE"

EFFECT TYPE	EXPECTED EFFECT	TARGETS DEFINED BY MA	SUMMARY OF EVIDENCE COLLECTED	LEVEL OF ACHIEVEMENT OF THRESHOLD
Outputs	Supported Centres of Excellence	Yes	OP DEE final report: achieved level: 12 centres of excellence	To a full extent
	R&D institutions' participation in trans-national joint programmes and activities	No		To a full extent
Immediate outcomes	Increased administrative capability of R&D institutions supporting and coordinating public sector R&D activities and innovation	No		To a full extent
	Increased number of joint projects and activities between R&D institutions	No		To a full extent
	Increased level of scientific publications published by researchers from Centres of Excellence	Yes	OP DEE final report: achieved level 1447 publications	To a full extent
Intermediate outcomes	Increased level of scientific excellence of Estonian research	No		To a full extent
	The most recent scientific and technological information has been made more readily available for researchers	No		To a full extent
	R&D collections, electronic databases as well as data communication and networks have been developed and made more accessible to partners from the EU	No		To a full extent
Final outcomes	Increased visibility of Estonian research internationally	No		To a full extent
Impact	Increased level of internationalisation of Estonian R&D	No		To a full extent
	Increased level of competitiveness of Estonian research	No		To a full extent
	Increased level of integration of Estonian R&D with EU and Baltic Sea region research areas	No		To a full extent

ANNEX IV. INTERVIEW LIST

STAKEHOLDER CATEGORY	ORGANISATION	ROLE IN THE ORGANISATION	NAME
Managing authorities/policymakers	Estonian Research Council	Adviser, Research Infrastructures 2008-2012: Archimedes Foundation, Estonian Scientific Competence Council, R&D Officer	Priit Tamm
Managing authorities/policymakers	Ministry of Education and Research	Deputy Secretary-General on Research	Indrek Reimand
Managing authorities/policymakers	Ministry of Education and Research	Head of higher education department	Margus Haidak
Managing authorities/policymakers	Ministry of Education and Research	Senior Expert, Research department 2007-2013: worked in Archimedes, Structural Funds unit	Mariann Saaliste
Managing authorities/policymakers	State Service Centre	Expert, Responsible for Centres of Excellence	Kristel Meesak-Seesma
Managing authorities/policymakers	Ministry of Education and Research	2020: University of Tartu, Head of Grant Centre 2007-13: expert at the research department in the Ministry of Education and Research	Taivo Raud
Managing authorities/policymakers	Ministry of Education and Research	2020: Expert at the Ministry of Economic Affairs and Communications 2007-2013: Expert at the research department	Ene Jürjens
Managing authorities/policymakers	Ministry of Economic Affairs and Communications	2020: Enterprise Estonia 2007-13: worked in the department of economic development	Kaupo Reede
Managing authorities/policymakers	Ministry of Economic Affairs and Communications	2007-13: worked in the department of economic development	Marika Popp
Universities	University of Tartu	Institute of physics, professor in Experimental Physics 2012-2017: Vice-Rector for Research	Marco Kirm
Universities	University of Life Sciences	Head of Strategy Department	Andi Pärn
Universities	Tallinn University of Technology	School of Engineering, Department of Mechanical and Industrial Engineering, Professor 2015-2020: Vice-Rector for Research	Renno Veinthal

STAKEHOLDER CATEGORY	ORGANISATION	ROLE IN THE ORGANISATION	NAME
Universities	Tallinn University of Technology	Institute of Geology, Senior Researcher 2005-2010: Vice-Rector on Research	Rein Vaikmäe
Centres of Excellence	Dark Matter in (Astro) Particle Physics and Cosmology	National Institute of Chemical Physics and Biophysics, Research Professor	Martti Raidal
Centres of Excellence	Centre of Excellence in Environmental Adaptation	Manager of the centre	Tiia Kurvits

ANNEX V. BIBLIOGRAPHY

Addendum No 247 of the Decree of the Government of Estonia from 30.05.2008, Investment plan for modernisation of research and higher education study environment

Christensen, T., Freireich, S., Kolar, J., & Nybergh, P. (2012). Peer-Review of the Estonian Research and Innovation System. Brussels: European Commission.

Eljas-Taal, K., Nausedaite, R., & Beckers, D. (2018). Estonian Research and Innovation System: Background Report. Brussels: European Commission.

Makarow, M., Arnold, E., Mercuri, L., Tracey, I., Tsipouri, L., Mulligan, D., Vock, P. (2019). Peer Review of the Estonian R&I System: Final Report. Brussels: European Commission.

Republic of Estonia (2007). Estonian National Strategic Reference Framework 2007-2013. Tallinn: Republic of Estonia.

Eljas-Taal, K., Tatar, M., Käger, M., Tiits, M., Kalvet, T., Tambur, M., Haa. (2019). Mid-term evaluation of the Operational Programme for Cohesion Policy Funds 2014-2020. Tallinn: Rahandusministeerium.

Nedeva, M., & Georghiou, L. (2003). Assessment of the Estonian Research Development Technology and Innovation Funding System. Manchester: The University of Manchester.

Eesti Teaduste Akadeemia. (2004). Teaduse ning teadus- ja arendustegevuse finantseerimissüsteemi evalveerimine. Tallinn: Eesti Teaduste Akadeemia.

Estonian Research Council. (2019, March 19). Bibliomeetria. Retrieved from https://www.etag.ee/tegevused/uuringud-ja-statistika/statistika/bibliomeetria/

Estonian Research Council. (2020, August 26). Eesti osalemine raamprogrammides . Retrieved from https://www.etag.ee/tegevused/uuringud-ja-statistika/statistika/raamprogrammide-statistika/

Riigi Teataja. (2013, June 22). Meetme «Teaduse tippkeskuste arendamine» tingimused. Retrieved from https://www.riigiteataja.ee/akt/12914003?leiaKehtiv=

Hagel, A., & Liige, J. (2011). *Perioodi 2007-2013 struktuurivahendite vahehindamine.* Tallinn.

Republic of Estonia. (2010). *Operational Programme for the Development of Economic Environment .* Tallinn: Republic of Estonia.

Haridusslim. (n.d.). Retrieved November 02, 2020, from https://www.haridussilm.ee/

Technopolis Group, Praxis & Institute of Baltic Studies. (2011). *Euroopa Liidu tõukefondide perioodi 2007-2013 teadus- ja arendustegevuse ning kõrghariduse meetmete rakendamise vahehindamine.* Tallinn: Government of Estonia.

Haridus- ja Teadusministeerium. (n.d.). *Baasfinantseerimine ja tippkeskused*. Retrieved October 24, 2020, from https://www.hm.ee/et/tegevused/teadus/baasfinantseerimine-ja-tippkeskused

Ministry of Economic Affairs and Communication. (2015). *Majanduskeskkonna arendamise rakenduskava seirearuanne.* Tallinn: Ministry of Economic Affairs and Communication.

Clarivate. (2020). *Highly Cited Researchers*. Retrieved November 12, 2020, from https://recognition.webofscience.com/awards/highly-cited/2020/

Reid, A., & Walendowski, J. (2006). *Evaluation of the design and implementation of Estonian RTDI policy: implications for policy planning.* Tallinn: Ministry of Economic Affairs and Communications of the Republic of Estonia.

Mihkelson, P., Rebane, T., Kitsing, M., & Lember, K. (2014). *ETTEVÕTLUS- JA INNOVATSIOONIPOLIITIKA V AHEHINDAMINE.* Tallinn: Enterprise Estonia.

Technopolis Group, Ismeri Europe, Merit, Logotech & Lacave, Alemand et Associes Consultants. (2006). *Strategic Evaluation on Innovation and the Knowledge Based Economy in relation to the Structural and Cohesion Funds, for the programming period 2007-2013.* Brussels: European Commission DG Regional Policy.

Riigikontroll. (2017). *Hariduse ja teaduse, tööturul vajalike oskuste arengut ning lõimumist ja kohanemist soosivate tegevuste rahastamine Euroopa Liidu toetustest.* Tallinn: Riigikontroll.

Roolaht, T. (2012). *The Problems of Estonian R&D and Innovation Strategy and the Demand-Side Innovation Policies.* Tartu: University of Tartu.

Kask, K., Espenberg, S., Puolokainen, T., & Themas, E. (2018). *Teadusaparatuuri ja -infrastruktuuride kasutamise hindamise metoodika väljatöötamine.* Tartu: Tartu Ülikool.

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