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

The RTD Cookbook for ERDF supported investments

Written by CSIL, Prognos AG, Technopolis
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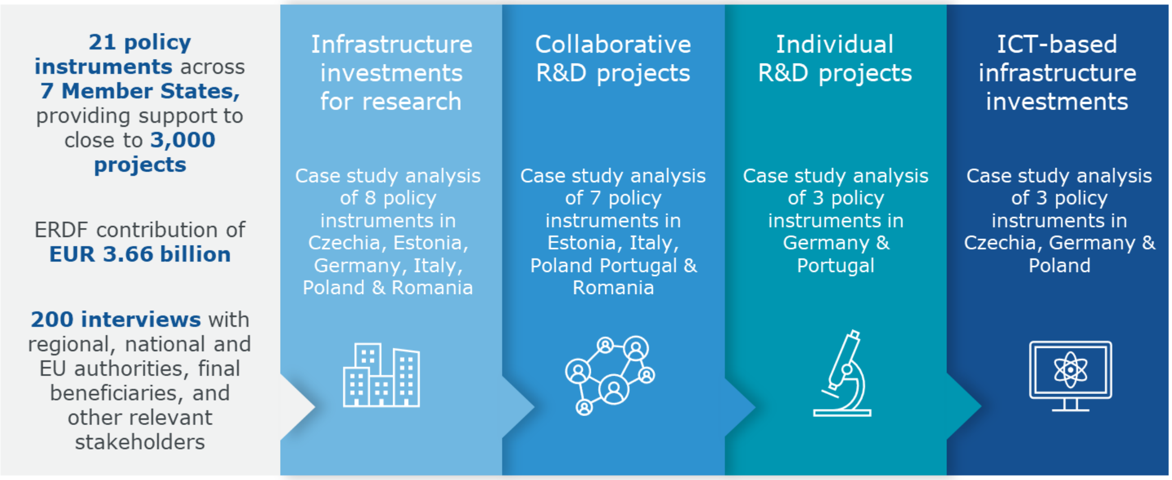
1. RTD Cookbook: What is it, and who is it for?

The RTD Cookbook can be regarded as a **decision-aid tool for policymakers** in the development of ERDF supported investments in research and technological development infrastructures and activities. To this end, it seeks to identify salient learnings and insights from the ex-post evaluation conducted to aid policy practitioners in the upcoming programming period. Specifically, it highlights significant contextual factors, such as preconditions, supporting factors and important risks, which can help identify good practices that can be used to avoid common pitfalls. As a result, the Cookbook serves to outline key ingredients for effective RTD policy instruments.

The information basis upon which the Cookbook was developed is the ex-post evaluation of investments in research and technological development infrastructure and activities supported by the ERDF in the period 2007 – 2013. The evaluation consisted of a comprehensive analysis of 21 policy instruments across seven Member States, which provided ERDF support of EUR 3.7 billion to close to 3,000 RTD projects. Moreover, the evaluation included around 200 interviews with regional, national and EU authorities, final beneficiaries, and other relevant stakeholders. An in-depth analysis of four overarching types of RTD policy interventions serves as the primary empirical foundation for the RTD Cookbook. As shown in Figure 1 below, the four policy interventions are infrastructure investments for research, collaborative R&D projects; individual R&D projects; and ICT-based infrastructure investments.

Figure 1 – Empirical basis of RTD Cookbook: ex-post evaluation of RTD investments supported by the ERDF (2007 – 2013)

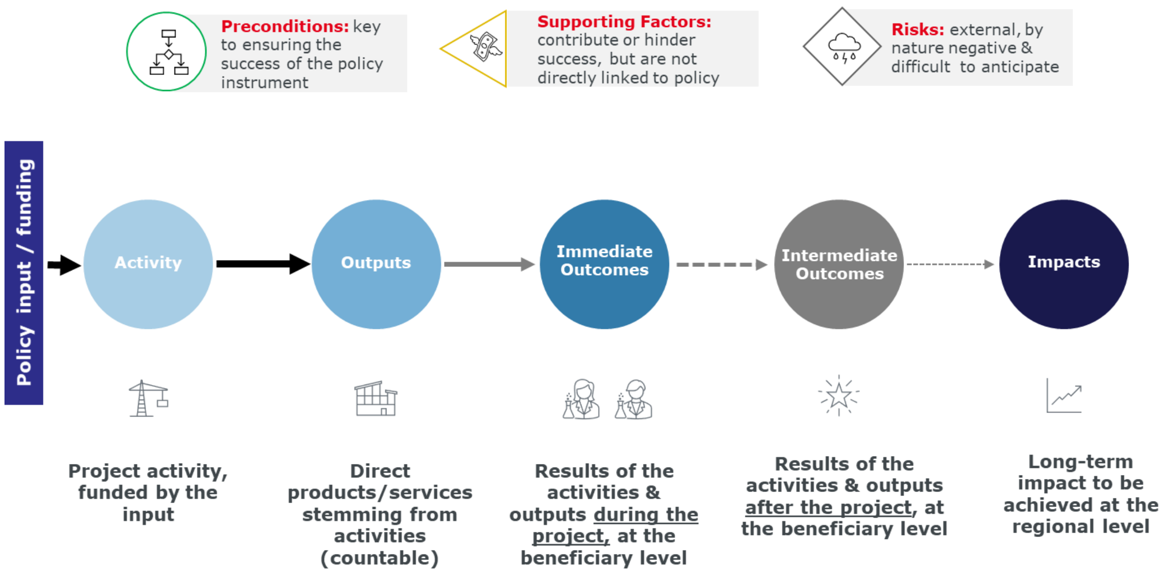


Source: Prognos AG, CSIL, Technopolis (2021)

The Cookbook will base its recommended considerations upon the analysis of these four policy interventions. This includes the valuable insights generated from two validation seminars conducted with more than 250 stakeholders, including representatives of Managing Authorities, RTD policymakers and evaluation experts. These seminars presented, discussed and validated the findings from the ex-post evaluation and provided recommendations and improvements for future RTD policy support.

The analysis of the policy interventions is embedded within a Generalised Theory of Change, which helps disentangle the interactions of the different components of the causal package of RTD interventions. In this regard, special attention is attributed to the role of **contextual factors**. The degree of effectiveness of a policy intervention depends largely on the setting in which it occurs. Specifically, there are various preconditions, supporting factors, risks, and other contextual factors that play a significant role in whether or not a policy intervention serves its purpose and to what degree it does so. The intervention logic of policy interventions and the associated role of contextual factors is visualised in Figure 2 below.

Figure 2 – Simplified intervention logic of a policy instrument



Source: Prognos AG, CSIL, Technopolis (2021)

Designed as a decision-aid tool for policy practitioners, the **Cookbook seeks to help in the process of planning a policy instrument**. To this end, it highlights what must be considered on the path from initial activities to desired impacts. Since contextual factors play such a significant role, the Cookbook will highlight prevalent preconditions, supporting factors and risks that were significant in the period of inquiry. This is done to invite policymakers to critically think about and diligently plan for such contextual factors ex-ante since they have shown to influence the policy's success rate.

In the following sections, we outline the generalised theory of change associated with each of the four overarching policy interventions identified above. For each one, **key ingredients** (or contextual factors) will be highlighted that had significant effects on the effectiveness of the respective policy, thereby serving as important factors to consider for upcoming RTD interventions. Upon the basis of these analyses, the Cookbook concludes with the provision of 12 guiding questions that seek to accompany policymakers on the policy journey – from the initial preparatory and ideation phase to the launch of the policy intervention.

2. Policy Intervention 1: Infrastructure investments for research

2.1. Generalised Theory of Change for Infrastructure Investments for Research

The type of policy intervention first considered is that of infrastructure investments for research. This kind of policy sought to address the lack of sufficient or modern physical and technological infrastructure, an essential component in fostering knowledge creation. As the period of investigation was the 2007-2013 programming period, many of the newer Member States of the EU experienced a research infrastructure gap that affected the effectiveness of the country's R&D capabilities. Frequently infrastructure at HEIs was underfunded, not providing sufficient capacity and quality for students and researchers as research equipment was outdated or not following modern education and research standards. Investments aimed at upgrading existing infrastructure and equipment and replacing obsolete or outdated ones. The investments sought to develop new research capacities that aimed to match the level of quality and research excellence at the European and international levels. As such, this type of policy was not seen an end in itself but rather regarded as a mechanism that would improve the quality of research and the innovative capacity of economies.

2.1.1. Inputs, activities, & output

The input or activity of this kind of policy intervention took the form of funding to build, modernise or equip higher education and public research institutions' equipment and infrastructure. The specific nature of the projects funded ranged from support for new or reconstructed infrastructure, such as buildings, plants, laboratories, to investment in research-related equipment, such as lab instruments, machinery, highly specialised apparatuses, and supporting infrastructure. The outputs of such investment were newly constructed or renovated research buildings, the purchase of new technologies, scientific instruments, equipment, new or modernised laboratories, and research apparatus.

2.1.2. Immediate and intermediate outcomes

Immediate outcomes of these kinds of investments increased the capacity of higher education and public research infrastructure and instruments and improved the research operating standards, providing better conditions for research and research-oriented teaching. Specifically, this involved gaining access to new and modern research equipment, being able to pursue research in modernised workplaces, or, for instance, the start of certain research projects and experiments that necessitated specific instruments. These immediate outcomes (during the life-cycle of a project) were followed by more intermediate outcomes (after the completion of a project), such as a generally increased attractiveness and competitiveness of research institutions at regional, national, and international levels due to an increased ability to conduct high-level research. This manifested itself in, for instance, a greater interest of post-graduate level students, an increased number of publications and patents, and more frequent participation in international research collaborations. Moreover, heightened administrative and technological capacity enabled research institutions to deliver R&D services to enterprises better and increase opportunities to collaborate with industry partners.

Box 1 – Examples from the ground: supported infrastructure investment projects in Romania

Project Example 1 – CARDIOPRO

The infrastructure development project *'Expansion and modernisation of research infrastructure in order to increase competitiveness in the field of cardiovascular disease, diabetes and obesity'* implemented by the Nicolae Simionescu Institute of Cellular Biology and Pathology - a flagship medical research organisation - produced sustained effects that consist of:

- setting up new and specialised research units
- intensified collaboration with other medical institutions
- higher employment attractiveness of graduates

Project Example 2 – CEUREMAVSU

The project, '*Euro-Regional Centre for the Study of Advanced Materials, Surfaces and Interfaces'*, implemented by the National Institute of Materials Physics – Romania (INCDFM) highlighted the following achievements:

- collaboration with new partners from EU member countries
- a significant increase in presenting scientific results, with impacts on visibility and recognition
- a significant increase in research staff as a result of attractiveness in terms of better premises and equipment
- career development opportunities
- an improved working environment as a result of the organisational culture and management style.

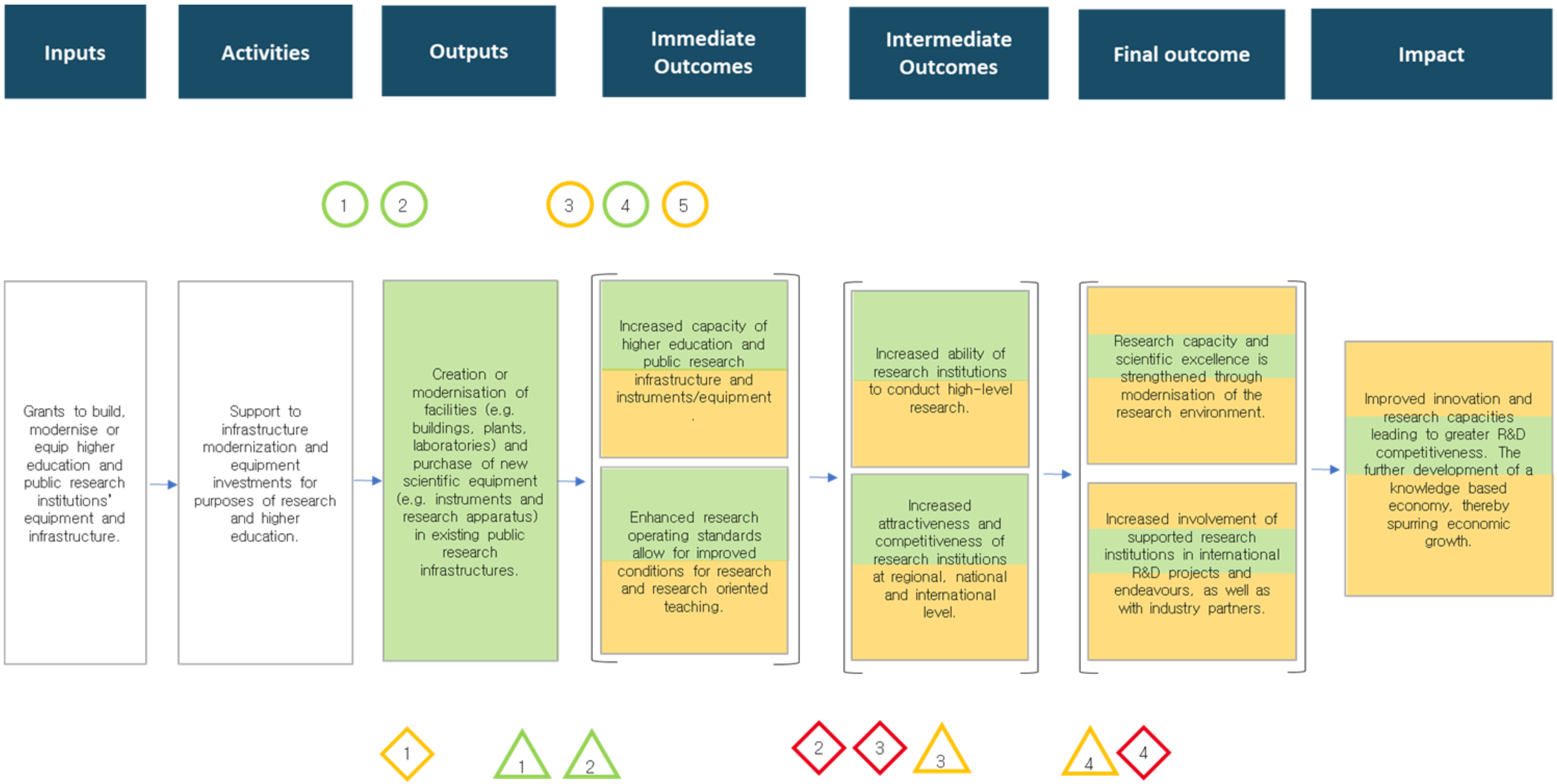
Source: Prognos AG, CSIL, Technopolis (2021)

2.1.3. Final outcomes and impacts

As for longer-term outcomes, research capacity and the scientific excellence of a region through the modernisation of the research environment was achieved. In turn, this led to increased involvement in international R&D endeavours and greater collaboration with industry partners in certain settings. Finally, longer-term impacts allowed for improved research and innovation capacities among research institutions, leading to heightened R&D competitiveness. This helped develop knowledge-based economies and thereby contributed to economic growth.

The figure below outlines the tested Generalised Theory of Change for policy interventions focused on infrastructure investments for research. It illustrates the causal chain of such a policy, tracing the path from the initial input to longer-term impacts. In so doing, it depicts to what extent the change or effect took place (upper half of the box) and what the causal relationship (lower half of the box) with other elements of the theory of change was. The colour spectrum ranges from green (indicating the achievement of effects to a full extent or a strong causal relationship) to red (indicating that effects were not achieved or no causal relationship was identified). Moreover, the figure includes preconditions, supporting factors and risks or threats associated with the policy intervention and describes to what extent these contextual factors played a role. The colour spectrum of these factors ranges from green (preconditions and supporting factors existed and risks did not materialise) to red (preconditions and supporting factors did not exist and risks materialised). In the following section, we highlight and discuss a selection of these contextual factors that have demonstrated to be consequential and thus can be considered as key ingredients for effective policy instruments focused on infrastructure investments for research.

Figure 3 - Generalised Theory of Change for Infrastructure Investments for Research



Note: the visual representation is to be interpreted as follows. Each element of the intervention chain (outputs, outcomes, impacts, etc.) is divided into the achievement of effects (top half) and the causal relationship (bottom half). The range for the achievement of effects is 1 (to no extent), 2 (to a very limited extent), 3 (to a limited extent), 4 (to a significant extent) and 5 (to a full extent). The range for the causal relationship is 1 (causal link was not confirmed or did not materialise), 2 (causal link is confirmed and the intervention is one of the causes of the effect) and 3 (causal link is confirmed and the intervention is likely to be the main cause of the effect). The colour codes are presented on the following page, as are the interpretations for the preconditions, supporting factors and risks.

Legend:

Preconditions:

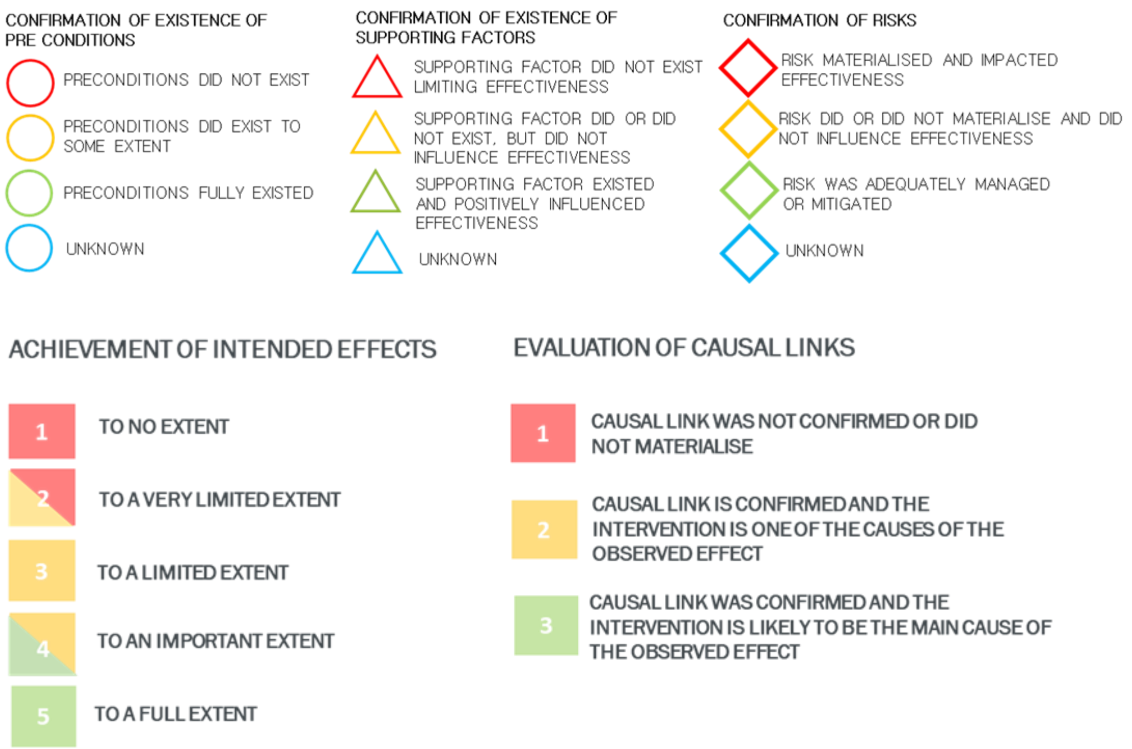
1. The beneficiary is able to ensure coordination of the procurement process and/or of the construction work
2. Well-established framework rules for the allocation of support to individual HEIs, RTOs, centres of excellence by the MA to ensure high-quality and relevant project proposals
3. Funds are disbursed timely and according to smooth procedures
4. Adequate capacity for the preparation and implementation of projects on the side of universities incl. public procurement procedures and organisation of construction works
5. Sufficient expert capacity on the side of the Managing Authority to successfully organise and administrate the support

Supporting factors:

1. The research infrastructure receives additional funding from other national or regional sources (e.g. Regional OPs)
2. Synergies and complementarities with projects supported by the ESF-funded OPs at the ERDF-supported HEIs.
3. Existing collaboration with companies to use the R&D infrastructure
4. Infrastructure investments are part of wider regional development (innovation) strategy

Risks and threats:

1. Uncertainty about the interpretation of public procurement rules, long-lasting and complex processes related to public tenders.
2. Modernised R&D infrastructure will be underused after investments due to strict EU competition rules (limited availability of labs for enterprises).
3. Beneficiary universities do not have the necessary staff and resources to manage and oversee the new/modernised equipment and conduct practical activities.
4. Unfavourable demographic development undermining a decline in the number of students



2.2. Key ingredients (contextual factors): preconditions, supporting factors and risks when planning and implementing R&D infrastructure projects

When considering the effective implementation of policy intervention, it is important to consider any explanatory factors that help explain how and why certain effects occurred, did not occur or manifested themselves to different degrees. This also allows for deeper insight into the role and influence of contextual factors on policy intervention. The evidence collected throughout this evaluation suggests **salient insights and key contextual factors** be conscious of when considering infrastructure investments for research. The context in which funding mechanisms are implemented depends on several identified preconditions, such as the **administrative and institutional capacity of the Managing Authorities** and a transparent evaluation and project selection procedure. Moreover, other supporting factors, such as having sufficient human resources who are appropriately qualified to employ the new infrastructure, proved to be significant. Furthermore, potential risks, such as persisting uncertainty regarding **state aid regulations**, impacted the intervention to some degree.

These salient factors are discussed in some more detail below:

- **Administrative and institutional capacity** both at the level of the research institution and the responsible Managing Authorities. The evidence suggests that the long duration of the evaluation and project selection process contributed to significant delays in project implementation. In this context, a high fluctuation of staff in responsible institutions also played a role since it caused delays in providing clear guidelines for applicants and verifying reimbursement requests. Indeed, issues relating to the timely disbursement of funds were, in some settings, a significant cause for the delayed implementation of projects since other sources of funding had to be identified. Finally, uncertainty and ambiguity regarding public procurement and other legislative laws also negatively influenced the implementation of projects and, in some cases, caused projects to stop for a while.

- **In some settings, a limiting factor was a lack of human resources available to employ the newly acquired research equipment or operate in the new or modernised infrastructure**. As a result, for instance, laboratories were not operational or functioning at a significantly reduced degree due to the inability to hire R&D staff to operate the instruments effectively. Naturally, this limited the effectiveness of the investments for infrastructure and the purchasing of research equipment.

- **Uncertainty regarding state aid rules** affected the impact of the newly acquired research equipment and modernised infrastructure. In some settings, access to the infrastructure was at first not allowed for private sector use, while in other settings, it was strictly limited. Such regulations limited the intervention to generate a more diversified use of the new infrastructure and possibly identify new revenue sources. Moreover, it hampered research organisations from using the infrastructure to engage in more pro-active knowledge transfer and cooperation with private sector partners, thereby reducing collaborations efforts.

3. Policy Intervention 2: Collaborative R&D Projects

3.1. Generalised Theory of Change for Collaborative R&D Projects

The next type of policy intervention under consideration is that of **collaborative R&D projects**. The projects undertaken occurred either between research institutions and HEIs themselves or in collaboration with private industry partners. As described by Laudel (2002), a **research collaboration** can be defined as a system of research activities by several actors related functionally and coordinated to attain a research goal corresponding with these actors' research goals or interests. As Keraminiyage et al. (2009) proposed, research collaboration can be viewed as a system to functionally relate together a group of researchers affiliated to different organisations to conduct research that brings in mutually beneficial outcomes to all. In the context of the present evaluation, support for collaborative R&D activities may refer to collaborations between research organisations and science-industry collaborations. The latter is understood as any interaction between research organisations and businesses for mutual benefit and is widely considered an essential driver of knowledge-based economies and societies. Davey et al. 2018 describe that this form of collaboration may have a significant impact at the level of individual organisations and upon the economy, which can help tackle societal issues. According to the R&I State Aid Framework, in a collaboration project, at least two partners participate in the design of the project, contribute to its implementation, and share the risk and output.[1] Collaborative efforts funded by this policy intervention had various aims, ranging from addressing industrially relevant or societal challenges, stimulating technological advancement in specific areas, and boosting international cooperation by conducting internationally competitive high-quality R&D activities.

3.1.1. Inputs, activities, & output

The input or activity stemming from this kind of policy intervention took the form of non-refundable grants to fund investments of collaborative R&D proposals and projects. The specific nature of the projects funded ranged from supporting technological upgrades of existing local productive specialisation to funding the collaboration with international experts in addressing industrial research or experimental development activity, to supporting centres of excellence that would generate a critical mass of knowledge for the production of high-level research in priority areas. Outputs included a significant expansion of research in various scientific fields, resulting in the implementation of collaborative R&D projects.

3.1.2. Immediate and intermediate outcomes

The immediate outcomes of the collaborative R&D projects increased the number of joint projects and activities between R&D institutions and in collaboration with private sector partners. The research pursued by these collaborative entities led to technological advancements and thereby improved or developed new products, processes, and services. Moreover, researchers across research institutions and those in private enterprises developed skills and competencies that increased their scientific and technological knowledge. These immediate outcomes (during the project) were supplemented by more intermediate outcomes (after the project), such as the economic benefits stemming from the commercial valorisation of R&D results, which varied in degree across different settings.

[1] (European Commission 2006)

Moreover, an enhanced knowledge transfer between science and industry partners was expected and materialised, though again to different extents due to contextual factors.

Box 2 – Examples from the ground: collaborative R&D projects achieving intended results in Italy

Project Example 1 - OFRALSER

Objectives: The project aimed to promote innovations in the agri-food sector, specifically in fruit and vegetable processing. The project developed and tested technological solutions that could support product differentiation and improve service content while also improving products' organoleptic and nutritional characteristics.

Results: The project can be considered a success. Interviewees pointed out that, at the end of the project, there were about 26 works published in ISI journals, 20 other non-ISI publications, and at least 20 other articles published later. Important results were also achieved from a business perspective: for instance, one of the partner companies had the opportunity to renew its product portfolio. Additionally, following the project implementation, specific testing activities translated into adopting innovative solutions within the business process.

Project Example 2 - DIATEME

Objectives: The project aimed to develop tailored biomedical devices for different applications, more precisely the development of 'PVC free' polymer-based biomedical devices and of programmed functionality devices.

Results: Overall, the project developed four different prototypes of innovative devices in line with intended objectives. However, not all of them were then developed and marketed, nor patented.

Project Example 3 - SIGMA

Objectives: The project objective was to develop an integrated system to acquire, integrate and process heterogeneous data from different sensor networks to strengthen the control and monitoring systems for environmental and industrial risks. The final aim of the system was to support the provision of appropriate services both to citizens and businesses, especially in those high-risk areas lacking modern and efficient IT and communications systems.

Results: The project reached its scientific objectives, producing several scientific publications, participating in conferences, and fostering research networks and collaborations. Moreover, some of the research results were also used by a start-up created in connection to the project activities. It currently has 20 employees and approximately EUR 1 million in turnover. Starting from some ideas developed by the SIGMA project, it has continued the development of products with application in the context of smart cities and the integration of the cloud with Internet of Things. Finally, some prototypes were developed because of the project, and, following other research activities and investments, a software solution has been developed and is currently adopted in several cities.

Source: Prognos AG, CSIL, Technopolis (2021)

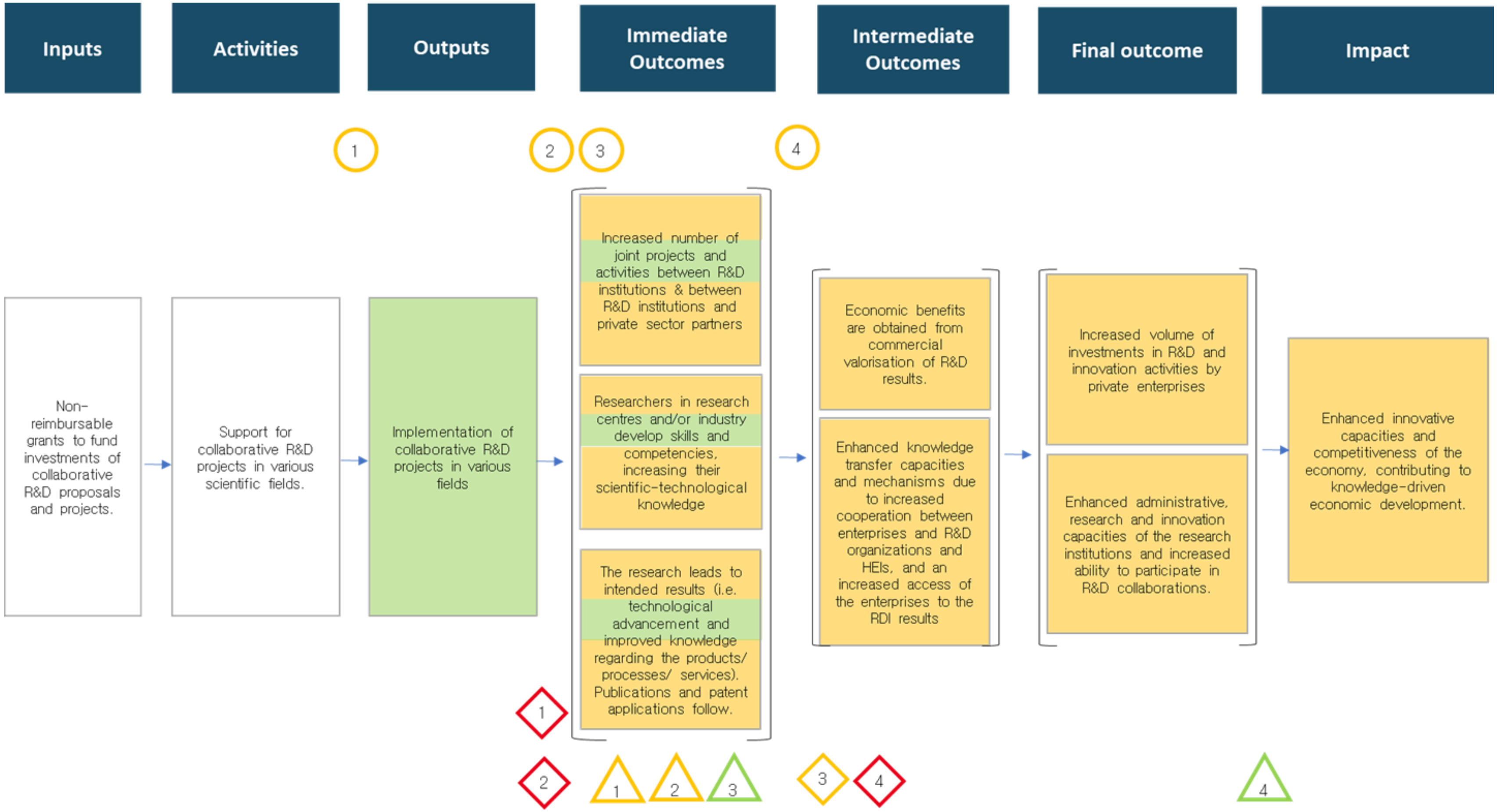
3.1.3. Final outcomes and impacts

As for longer-term outcomes, this type of policy helped increase the volume of investments in R&D and innovation activities by public and private enterprises, which allowed for continued long-term funding of research endeavours. Moreover, beneficiaries developed enhanced administrative, research, and innovation capacities because of the supported projects, thereby increasing their ability to participate in international R&D collaborations.

Finally, the long-term impact strengthened a region’s innovative capacity and competitiveness, contributing to knowledge-driven economic development.

The figure below outlines the tested Generalised Theory of Change for policy interventions focused on collaborative R&D projects. It illustrates the causal chain of such a policy, tracing the path from the initial input to longer-term impacts. In so doing, it depicts to what extent the change or effect took place (upper half of the box) and what the causal relationship (lower half of the box) with other elements of the theory of change was. The colour spectrum ranges from green (indicating the achievement of effects to a full extent or a strong causal relationship) to red (indicating that effects were not achieved or no causal relationship was identified). Moreover, the figure includes preconditions, supporting factors and risks or threats associated with the policy intervention and describes to what extent these contextual factors played a role. The colour spectrum of these factors ranges from green (preconditions and supporting factors existed and risks did not materialise) to red (preconditions and supporting factors did not exist and risks materialised). In the following section, we highlight and discuss a selection of these contextual factors that have demonstrated to be consequential and thus can be considered as key ingredients for effective policy instruments focused on collaborative R&D projects.

Figure 4 - Generalised Theory of Change for Collaborative R&D Projects



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Legend:

Pre-conditions:

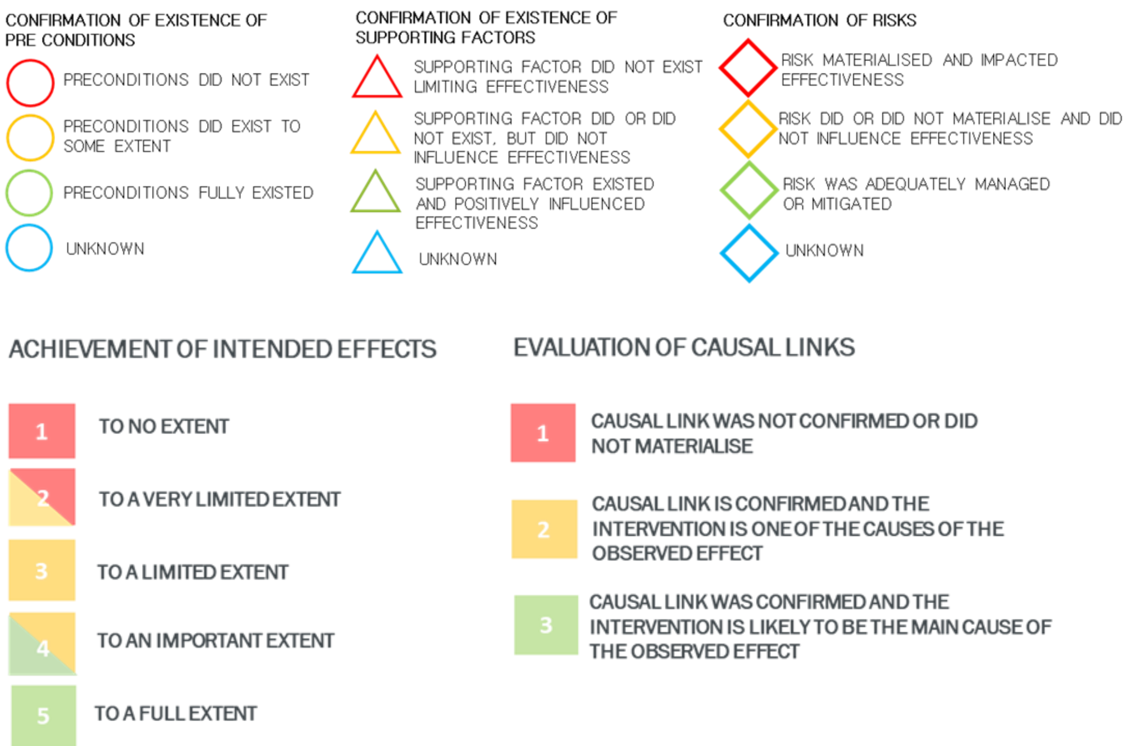
1. Quality projects are selected by a competitive procedure that has a transparent and clear evaluation and selection criteria.
2. Funds are disbursed timely and according to smooth procedures
3. Projects are carried out in compliance with procurement and State Aid rules and procedures.
4. Prospective application of the R&D results in the industry is plausible and stems from a real market need.

Supporting factors:

1. Partners have previous experience of collaboration.
2. The beneficiaries have the necessary economic and financial stability to cover obligations and contribute to implementing the research project and costs. They also have the requisite capacities in terms of organisation, management, human resources and infrastructure.
3. Synergies and complementarities with other (i.e. regional OPs) support measures are exploited.
4. Public support for collaborative R&D is sustained over time.

Risks and threats:

1. Macroeconomic stability and economic consequences (lack of access to credit).
2. Research project risks (i.e. implementation delays or cancellation).
3. Lack of coordination within collaborations, especially larger ones.
4. Beneficiaries adopt opportunistic behaviours, or enterprises disengage from collaboration or do not apply research results for various reasons.



3.2. Key ingredients (contextual factors): preconditions, supporting factors and risks when planning and implementing collaborative R&D projects

In review, when considering the effective implementation of collaborative R&D projects as a policy intervention, the evidence collected throughout this evaluation suggests that there are **key contextual factors** to consider. The setting in which funding mechanisms are implemented depends on several identified preconditions, such as the **administrative and institutional capacity** of the Managing Authorities or regulations regarding membership of collaborative groups. Moreover, supporting factors, such as beneficiaries having the **necessary economic capacity and intent** to remain in collaborative ventures, proved to be significant. Furthermore, potential risks, such as the **2008 Economic and Financial Crisis**, significantly impacted the policy intervention. These salient factors are discussed in some more detail below:

- **Administrative and institutional capacity** influenced how projects were implemented. Deficiencies in the project selection procedure, for instance, resulted in projects being selected even though they were not suitable, which led to a significant number of project terminations. Moreover, the timely distribution of funds was not always ensured caused projects to be delayed. Moreover, in some settings, state aid regulations prevented or constrained partnerships between science-industry partners, severely limiting their close collaboration and influencing the commercial valorisation of R&D results.

- **The necessary economic capacity and intent to sustain collaborative R&D projects and transfer results into industry application were** not always given. In some cases, financial constraints (see next point) prevented private-sector partners from remaining in collaborative R&D endeavours and pursuing such knowledge transfer. In other cases, the R&D results were not commercialised due to exceedingly tedious regulatory procedures to acquire patents and intellectual property rights or were, in other settings, not anymore desired due to changes in business strategy. The collaboration constraints between science-industry partners due to the legal constraints described above may have influenced these developments.

- **Economic shocks:** in the period under inquiry, the 2008 Economic and Financial Crisis materialised as a significant shock in almost all settings. In more general terms, economic recessions can have significant impacts on public budgets and serious financial consequences, such as reduced access to credit. This can cause project terminations due to the inability to secure bank guarantees for pre-and co-financing. Economic downturns also influence private sector partners' willingness to invest in R&D projects and spend on commercialising project results.

4. Policy Intervention 3: Individual R&D Projects

4.1. Generalised Theory of Change for Individual R&D Projects

The funding of **individual R&D projects** sought to support innovative research projects in various fields that would strengthen the scientific and technological capacity of the region. This type of policy intervention consisted of **support for existing fields of research, in which applications were investigated and more "exploratory" or "foundational" research**, which targeted areas that had great potential for innovation but were as yet untapped. Furthermore, the intervention sought to improve the knowledge and technology transfer into the industry, which would involve the economic valorisation of new scientific or technological products and processes.

This kind of R&D support was a central feature of the Lisbon National Reform Programmes (2006) since large disparities between the EU Member States and regions were observed and a persistent gap compared to competitors at the global level existed. Investment into R&D was regarded as the main priority for the Cohesion Policy Programmes of 2007 – 2013. Early-stage (foundational) and exploratory research often do not have specific predetermined commercial applications and rather serve to generate new knowledge and further develop innovative skills in research institutions, which are crucial for long-term, rather than immediate, R&D results. The fact that this type of research has high risks and is therefore of reduced interest to private sector investment is well-documented in the literature.[2] The uncertainty relating to the return of investment and the sunk costs involved in ensuring a critical mass in terms of knowledge and skills-accumulation, which is frequently a precondition to any meaningful R&D results, would induce underinvestment in such forms of research and innovation and thus underscores the significance of sufficient public investment in these areas.

4.1.1. Inputs, activities, & output

The input or activity of this kind of policy took the form of **funding for individual R&D projects provided in non-reimbursable grants to fund investments** – ranging from 75% to 100% of the eligible costs. Eligible to apply for these grants were, among others, higher education institutions (HEIs), non-university research institutions and R&D centres, as well as an associate or state laboratories. The specific nature of the projects funded ranged from application-oriented research in various scientific fields, including existing areas of excellence, to projects more exploratory in nature, which sought to identify new and original areas of inquiry that had the innovation potential. The funding provided research institutions with human and material resources in an effort to increase their scientific and technological capacity. Outputs included a significant expansion of research in various scientific fields, resulting in individual R&D projects. Relatedly, an increased number of jobs for researchers became available.

4.1.2. Immediate and intermediate outcomes

The funding of R&D projects helped further **develop researchers scientific and technological knowledge**, thereby developing new as well as increasing existing skills and competencies in the scientific fields of interest. Investments increased or helped maintain

[2] European Commission. 2017. "The Economic Rationale for Public R&I Funding and Its Impacts

operational R&D jobs, which promoted knowledge accumulation and skill development among the participating research groups. These more immediate outcomes (knowledge-generation and skill-development) were followed by developing industrially relevant and applicable results, such as new products, technologies, or processes in specific fields, resulting in new publications, patents, and intellectual property rights.

These outcomes are regarded in the **literature** as the **rationale** for providing **public funding** for these research areas.[3] Martin (1996) explains that the useful economic output of basic research is codified information, which has the property of a "public good", as it is costly to produce and virtually costless to transfer, use and re-use. Therefore, it is efficient to make the results of basic or fundamental research freely available to all potential users. Moreover, the skill-development of researchers is also of economic value since trained graduates entering industry positions come equipped with advanced levels of training, knowledge, and expertise. They are also 'plugged into' international networks of scientists and have experience in tackling complex problems.

Box 3 – Examples from the ground: outcomes of support for individual R&D projects

New industry-science relationships emerge as a result of funding measures in Sachsen, Germany

- The Helmholtz Centre for Environmental Research GmbH in Leipzig improved networking between the non-university research institutions and the Sachsen industry. Although contacts with Sachsen companies already existed before implementing the funded research project, the centre reported that after the projects took place, it was approached significantly more frequently by companies with cooperation requests.
- At the Fraunhofer Institute for Cell Therapy and Immunology, new R&D orders from international pharmaceutical companies were generated based on the funded construction and research projects. In addition, a research contract was initiated by the Californian Institute for Regenerative Medicine (CIRM).
- Through the funded equipment investments and research projects at the Biotechnological-Biomedical Centre of the University of Leipzig (BBZ), new cooperation partners were established and thereby, new local and regional networks were formed that could constitute future regional growth cores. The centre deemed this as an opportunity to implement larger joint projects in the future.
- A significant increase in R&D contracts from industry partners was registered in individual research institutions, such as the Fraunhofer Institute for Electronic Nano Systems. According to the institute's directors, this opened up further opportunities to position themselves on the market as specialised service providers. For example, companies in the automotive, machine tool and plant engineering sectors were interested in testing new materials, such as new plastics as substitutes.

R&D funding beneficiaries in Portugal underscore increased scientific capacity

- The results of a survey (Mateus & Associados, 2018) carried out with RTD entities funded under the COMPETE OP SAESCTN - Support to Entities of the National Scientific and Technological System, the instrument under which RTD individual projects in all scientific fields were supported - reported that 89% of beneficiaries said that there was an increase in their capacity for RTD activities in the future; 79% considered that projects facilitated their entry or reinforced their presence in international research networks; 90% reported that there was the production of new

[3] Martin, Ben. 1996. "The Relationship between Publicly Funded Basic Research and Economic Performance: A SPRU Review."

knowledge with potential for economic valorisation; 85% said they were better prepared to provide technological and consulting services to external organisations.

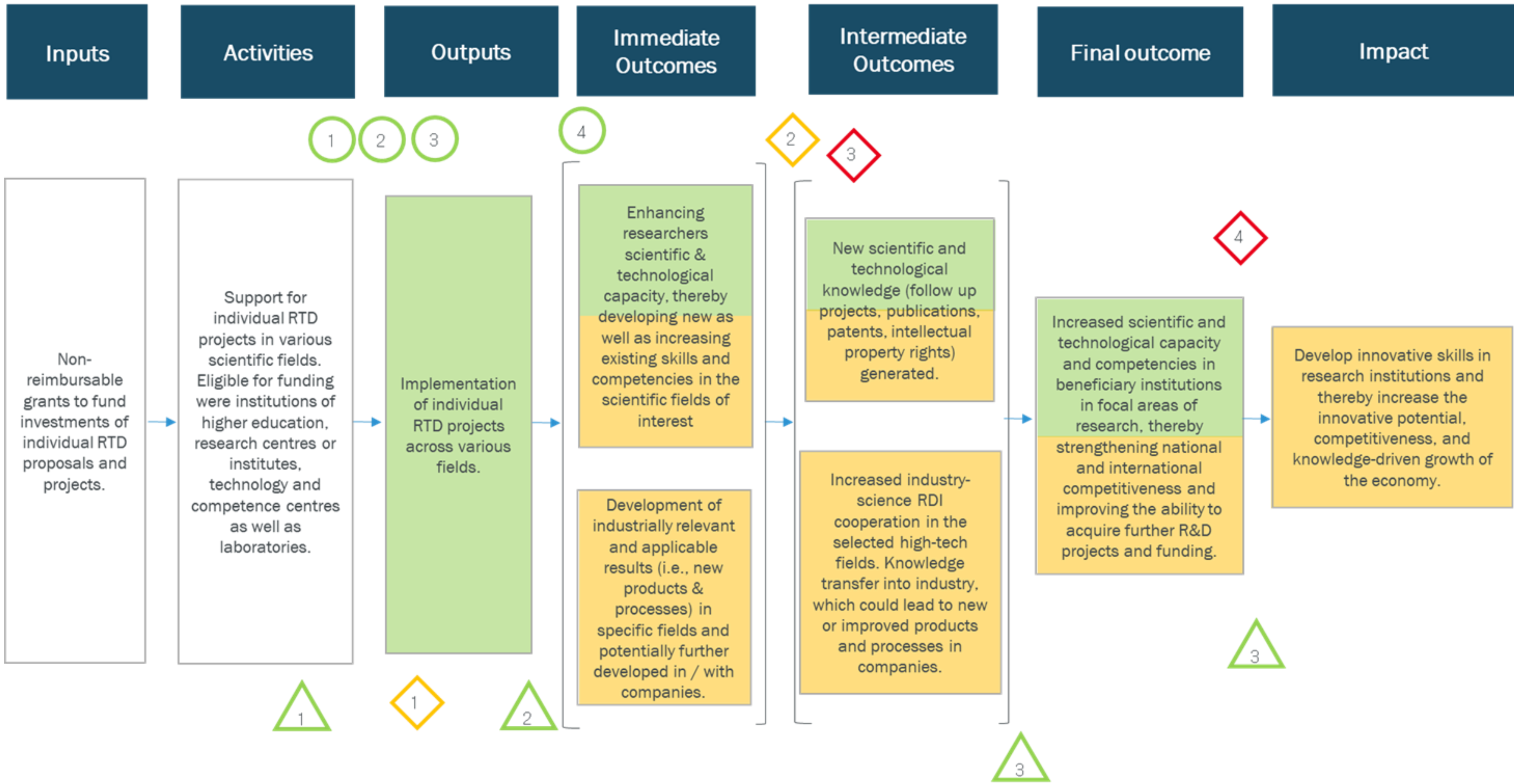
Source: Prognos AG, CSIL, Technopolis (2021)

4.1.3. Final outcomes and impacts

This funding helped increase scientific and technical capacity within research institutions. As such, one long-term outcome was that research organisations enhanced their competencies in focal research areas, thereby strengthening their competitiveness and national and **international standing**. This, in turn, led to an **improved ability to acquire further R&D projects and associated funding**. The long-term impact manifested itself in the **enhancement of innovative skills in research institutions** or other HEIs. This contributed to increasing the innovative potential of an economy by **promoting knowledge-driven growth** and increasing its competitiveness, thereby laying the foundation for the sustainable strengthening of its economy.

The figure below outlines the tested Generalised Theory of Change for policy interventions focused on funding individual R&D projects. It illustrates the causal chain of such a policy, tracing the path from the initial input to longer-term impacts. In so doing, it depicts to what extent the change or effect took place (upper half of the box) and what the causal relationship (lower half of the box) with other elements of the theory of change was. The colour spectrum ranges from green (indicating the achievement of effects to a full extent or a strong causal relationship) to red (indicating that effects were not achieved or no causal relationship was identified). Moreover, the figure includes preconditions, supporting factors and risks or threats associated with the policy intervention and describes to what extent these contextual factors played a role. The colour spectrum of these factors ranges from green (preconditions and supporting factors existed and risks did not materialise) to red (preconditions and supporting factors did not exist and risks materialised). In the following section, we highlight and discuss a selection of these contextual factors that have demonstrated to be consequential and thus can be considered as key ingredients for effective policy instruments focused on individual R&D projects.

Figure 5 - Generalised Theory of Change for Individual R&D Projects



Note: the visual representation is to be interpreted as follows. Each element of the intervention chain (outputs, outcomes, impacts, etc.) is divided into the achievement of effects (top half) and the causal relationship (bottom half). The range for the achievement of effects is 1 (to no extent), 2 (to a very limited extent), 3 (to a limited extent), 4 (to a significant extent) and 5 (to a full extent). The range for the causal relationship is 1 (causal link was not confirmed or did not materialise), 2 (causal link is confirmed and the intervention is one of the causes of the effect) and 3 (causal link is confirmed and the intervention is likely to be the main cause of the effect). The colour codes are presented on the following page, as are the interpretations for the preconditions, supporting factors and risks.

Legend:

Preconditions:

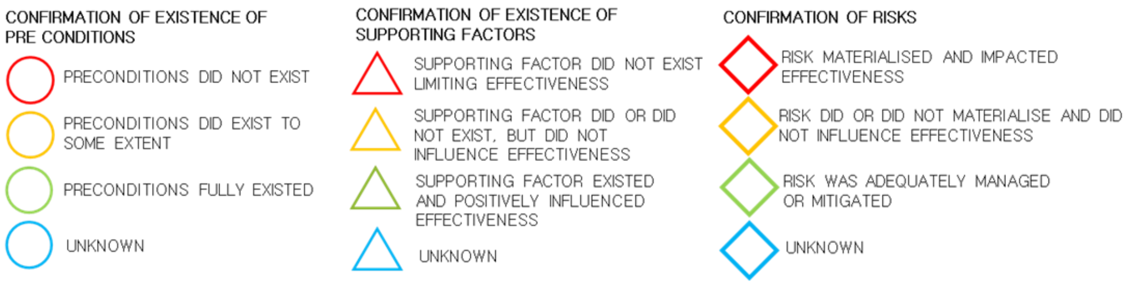
1. Potential applicants are aware of the call, and they have the interest and capacity to apply.
2. The beneficiary institution can finance parts of the projects with its resources or justify the need to secure total financing.
3. Applicants were prepared to manage the project from a technical, organisational, and institutional perspective, ensuring that the necessary human resources and infrastructure or technical equipment were available to carry out the project.
4. Funds are distributed on time, and thus, the projects have sufficient means to pursue their research.

Supporting factors:

1. The transparent and effective implementation of the application process and a good working relationship with the Managing Authority.
2. Alignment of the intervention with other R&D support mechanisms (at the regional, national, European level).
3. Public support for R&D activities is sustained over time: follow-up R&D investment is available through continuous access to public support measures that focus on R&D.

Risks and threats:

1. Limited resources to complete the research project.
2. Findings would deviate from expected results, reducing the possibility of transferring new technologies to the industry.
3. Transfer into industry does not occur or to a limited extent due to limited demand from potential beneficiaries (companies) for R&D projects or other reasons.
4. Increased innovative potential of R&D institutions does not translate to sustained, observable knowledge-driven economic growth.



ACHIEVEMENT OF INTENDED EFFECTS

1 TO NO EXTENT

2 TO A VERY LIMITED EXTENT

3 TO A LIMITED EXTENT

4 TO AN IMPORTANT EXTENT

5 TO A FULL EXTENT

EVALUATION OF CAUSAL LINKS

1 CAUSAL LINK WAS NOT CONFIRMED OR DID NOT MATERIALISE

2 CAUSAL LINK IS CONFIRMED AND THE INTERVENTION IS ONE OF THE CAUSES OF THE OBSERVED EFFECT

3 CAUSAL LINK WAS CONFIRMED AND THE INTERVENTION IS LIKELY TO BE THE MAIN CAUSE OF THE OBSERVED EFFECT

4.2. Key ingredients (contextual factors): preconditions, supporting factors and risks when planning and implementing individual R&D projects

When considering the effective implementation of individual R&D projects as a policy intervention, the evidence collected throughout this evaluation suggests that various factors have important influences. The context in which funding mechanisms are implemented depends on several identified preconditions, such as the **organisational capacity** of the beneficiary institution and the **institutional capacity** of Managing Authorities. Moreover, supporting factors, such as the **effective alignment of the policy intervention in the broader regional or national context of R&D funding**, proved to be significant. Furthermore, potential risks, such as the limited transfer of knowledge to industry partners, took place to some degree in certain contexts, partly due to the **limited previous relationship between the scientific and industrial communities**. These salient factors are discussed in some more detail below:

- **Organisational and institutional capacity** both at the level of the research institution and the responsible Managing Authorities. The evidence suggests that beneficiary institutions with dedicated departments identify funding measures and provide consequent support to allow for an effective application process. Furthermore, supportive Managing Authorities that show a high level of commitment and assistance and effectively coordinate the needs of the scientific community prove to be crucial. In this context, transparent and effective funding application rules facilitate a smoother process.

- **Broader research and innovation support system:** The effective alignment with other R&D funding mechanisms at the regional and national level proves to be key to ensuring that various programs do not compete with one another but rather complement each other to offer a comprehensive funding framework for research institutions.

- **Relationship between scientific and industry partners:** In order to ensure that new products, processes, and technologies find long-term commercial applications, an effective science-business collaboration system needs to exist. On the one hand, this will allow for the funded research findings to be more effectively communicated and thus better understood by industrial partners. On the other hand, it will ensure that the scientific community is more aware of industry needs. The cultivation of a strong association between the two parties is essential for an effective transfer of knowledge.

- **Continued growth and development of the scientific and technological system:** Increased scientific and technological capacity depends on developing the R&D environment in a region or country. In this regard, continued public investment in research institutions is key, as it allows for follow-up projects to take place that strengthens existing capacities and allow for the development of new ones. Such long-term investment enables research institutions to strengthen their international standing and competitiveness, thereby increasing their ability to attract third-party funding sources and increasing the likelihood of strategic collaborations with industry partners. Moreover, sustained support also allows for an increase in human capital, essential for any R&D system.

5. Policy Intervention 4: ICT-based Infrastructure Investments

5.1. Generalised Theory of Change for ICT-based infrastructure investments

The **investments into ICT-based infrastructure** aimed at creating or improving the conditions for the production of high-quality scientific research by improving ICT-based infrastructure. Frequently infrastructure gaps between a country's regions or the other EU Member States were identified as negatively affecting their R&D activities. In frequent cases, ICT infrastructure was deemed outdated or not according to modern education and research standards. Low levels of investment in research and academic infrastructure were recognised as major problems that limited the quality of education for students, the production of quality scientific research results and knowledge transfer through collaborative R&D projects. Thus, this kind of policy aimed at creating or improving existing educational and research infrastructures. In doing so, it sought to increase the quality of education and R&D through ICT, thereby creating an environment for more effective R&D.

5.1.1. Inputs, activities, & output

The input or activity of this type of policy took the form of funding **non-reimbursable grants to fund information infrastructure** for R&D and build, modernise and /or equip information and communication networks and technologies of higher education institutes. The projects funded the construction or modernisation of educational and research infrastructure. They provided outputs such as the installation of the latest and most developed high-performance computational systems, increased access to ICT infrastructures, and the modernisation of classrooms or labs. These efforts also resulted in increased access to ICT infrastructure for students and researchers.

5.1.2. Immediate and intermediate outcomes

The investments helped develop or modernise educational and research infrastructure, which improved the research and working conditions in focal research areas and the quality of education and training. The investments also contributed to an increase in networking activity between research teams across faculties and universities. These more immediate outcomes were complemented by longer-term outcomes, such as strengthened focal research areas of the beneficiary universities (e.g. through improved competitiveness and cooperation). Moreover, the improved working conditions and the improved quality of education, combined with increased networking opportunities for research teams, allowed for new project proposals and greater follow-up funding to emerging. Moreover, the technical skills and competencies of students and young researchers were also strengthened.

5.1.3. Final outcomes and impacts

As for longer-term outcomes, investments into ICT infrastructure helped induce new industry-science RDI cooperation (especially with SMEs) in the universities focal research areas. In consequence, this, together with the increase in follow-up funding, led to increased third-party funds received by universities. While this was not foreseen as a direct outcome of the ICT-based infrastructure intervention, it was regarded as an important long-term objective. Moreover, through the strengthened skillsets of students and young researcher's, skill gaps in the labour market were reduced, and employability increased. The long-term impact thus helped foster competitiveness and innovation as well as improved research capacities, contributing to stronger knowledge-based economic development.

Box 4 – Examples from the ground: longer-term impacts of improved ICT-infrastructure

Below are some examples of industry-science collaborations that took place, in part, due to improved ICT infrastructure available in Thüringen, Germany.

Schmalkalden University of Applied Sciences

Project name: Powermoulds - application of embedded diagnostic systems in the injection mould (EUR 508,000)

Focal research areas: Materials engineering, electrical engineering

Project description: There are many cooperative relationships with external companies in applied plastics technology at the Schmalkalden University of Applied Sciences, which directly and indirectly benefit from the universities' improved ICT infrastructure. Specifically, the scientific activities of the 'Powermoulds' project were emphasised in this context. The research project aimed to apply embedded diagnostic systems in injection moulding tools. Using a permanently installed embedded diagnostic system, including integrated signal processing, machine learning methods are used to derive targeted decision aids for the machine operator in the event of a malfunction. In addition, the quality characteristics of the manufactured plastic products are examined through 3D scanners and other measuring devices and are used to teach computer-aided evaluation algorithms.

Impact ICT infrastructure: The interviewees pointed out that by building on the newly available resources in terms of network infrastructure, the project 'Powermoulds' represented the start of the university's research activities into digitisation and industry 4.0 topics within the field of applied plastics engineering. From this initial spark, supported by the high-performance network infrastructure, several separate funded research projects have been developed, which, according to the interviewees, will continue to have a budget and impact until 2022.

Technical University Ilmenau

Project name: Thuringian Innovation Center: Mobility - ThIMo (EUR 22.5 m)

Focal research area: Automotive engineering, materials engineering, information engineering, electronic engineering

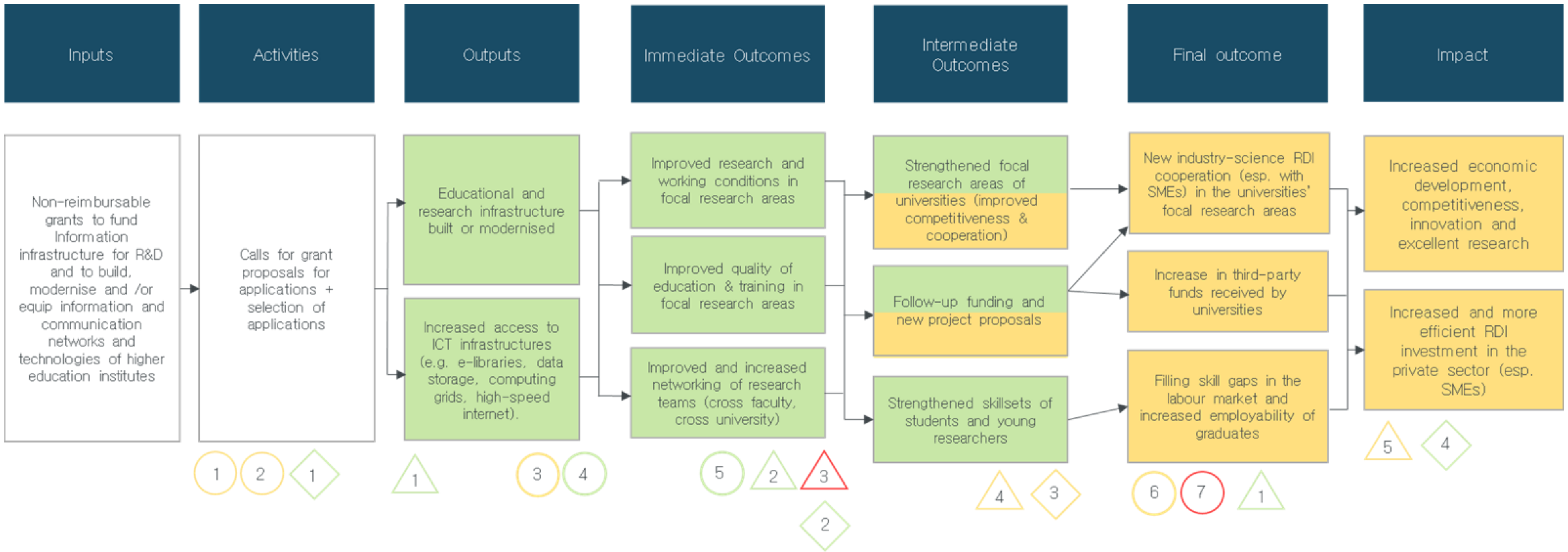
Project description: The ThIMo was founded in 2011 at the TU Ilmenau. ThIMo is an interdisciplinary centre with an international profile, focusing both on research as well industrial development. The vision of ThIMo is to find scientific solutions for challenges associated with mobility. Environmental responsibility, intelligence, digitised solutions, and complex mobility networks are the focus of their research. The centre has more than 200 active collaborations with national and international partners from research and industry. The different partners have access to state-of-the-art research equipment and benefit from the large network and competences gathered within the centre.

Impact ICT infrastructure: Since the innovation centre has buildings at two different locations (3km away), one of the key requirements was connecting both buildings via a performant network to enable them to share simulation and measurement results in real-time. The interviewees of the TU Ilmenau emphasised that this requirement, amongst others, could only be fulfilled due to the different ICT infrastructure projects implemented during the 2007-2013 ERDF funding period. One concrete example in this regard is the virtual driving simulator, which was set up (and partly funded by the ERDF 2014-2020) in 2018 at the ThIMo. This simulator is coupled in real-time with different simulation systems and test benches, some of which are located kilometres away from the simulators' location.

Source: Prognos AG, CSIL, Technopolis (2021)

The figure below outlines the tested Generalised Theory of Change for policy interventions focused on ICT-infrastructure investments. It illustrates the causal chain of such a policy, tracing the path from the initial input to longer-term impacts. In so doing, it depicts to what extent the change or effect took place (upper half of the box) and what the causal relationship (lower half of the box) with other elements of the theory of change was. The colour spectrum ranges from green (indicating the achievement of effects to a full extent or a strong causal relationship) to red (indicating that effects were not achieved or no causal relationship was identified). Moreover, the figure includes preconditions, supporting factors and risks or threats associated with the policy intervention and describes to what extent these contextual factors played a role. The colour spectrum of these factors ranges from green (preconditions and supporting factors existed and risks did not materialise) to red (preconditions and supporting factors did not exist and risks materialised). In the following section, we highlight and discuss a selection of these contextual factors that have demonstrated to be consequential and thus can be considered as key ingredients for effective policy instruments focused on ICT-based infrastructure investments.

Figure 6 - Generalised Theory of Change for ICT-based infrastructure projects



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Legend:

Preconditions:

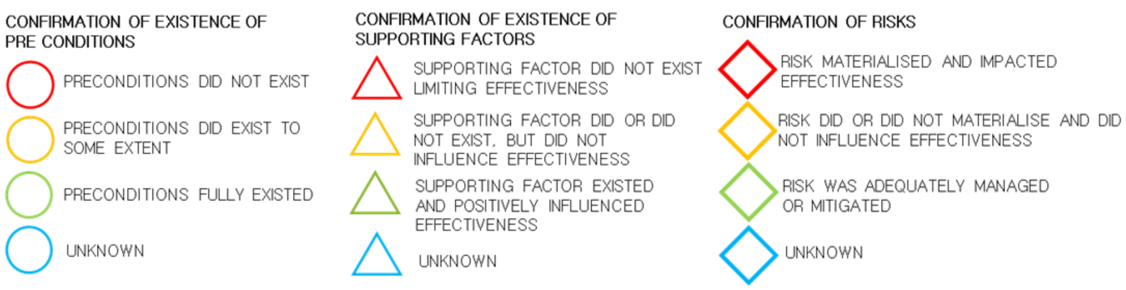
1. The applicants have the necessary resources and capacities in organisation, management, human resources and infrastructure to carry out the project and foreseen activities.
2. Sufficient organisational, staff and expert capacity on the side of the Managing Authority to successfully administrate projects, stability of the implementation structure, smooths and timely procedures of funds distribution.
3. Projects are carried out in compliance with procurement and State Aid rules and procedures.
4. The beneficiary institution is prepared to manage the project from a technical, organisational and institutional perspective.
5. Relevant technical skills available in the organisation to develop and operate the infrastructures. New and modernised infrastructure is successfully incorporated into training programmes and curricula.
6. Skillsets being developed and fields of training being strengthened are in line with the needs of the labour market.
7. New and modernised infrastructure is successfully incorporated into the university's R&D schemes

Supporting factors:

1. Alignment of the instrument with other R&D and infrastructure support mechanisms (regional, national, European level).
2. Existence of strong ICT infrastructure at the regional and national level (i.e. high-speed internet networks)
3. New / modernised infrastructure is given alternative use (e.g. for collaborative R&D and research services)
4. Activities aimed at enhancing the level of attractiveness of priority fields of studies for students.
5. Access to other support measures targeting industry-science RDI cooperation.

Risks and threats:

1. Uncertainty, instability of the interpretation of rules, long-lasting and complex controls of tenders of public procurements process
2. Rapid technological, social, regulatory or economic changes may render some technological solutions irrelevant.
3. Brain-drain and demographic changes
4. Insufficient demand and motivation of companies for using the capacities and services of the university / RTO



ACHIEVEMENT OF INTENDED EFFECTS

1. TO NO EXTENT
2. TO A VERY LIMITED EXTENT
3. TO A LIMITED EXTENT
4. TO AN IMPORTANT EXTENT
5. TO A FULL EXTENT

EVALUATION OF CAUSAL LINKS

1. CAUSAL LINK WAS NOT CONFIRMED OR DID NOT MATERIALISE
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3. CAUSAL LINK WAS CONFIRMED AND THE INTERVENTION IS LIKELY TO BE THE MAIN CAUSE OF THE OBSERVED EFFECT

5.2. Key ingredients (contextual factors): preconditions, supporting factors and risks when planning and implementing ICT-based infrastructure projects

In review, when considering the effective implementation of ICT-based infrastructure projects as a policy intervention, the evidence collected throughout this evaluation underscores **salient insights and key contextual factors** to consider. Supporting factors, such as **complementarities** with projects funded through the other sources and interconnection of investments with a **regional development strategy**, proved significant. Furthermore, factors such as **structural problems in the labour market** can limit the impact of the intervention. These salient factors are discussed in some more detail below:

- **Complementarities with projects funded through alternative sources**. The evaluation has shown that there can be a complementary mix of policy instruments supported across different ERDF OPs and that strong synergies can exist among these different policy measures and OPs. However, for this to occur, effective coordination among regional and national actors proved to be essential.

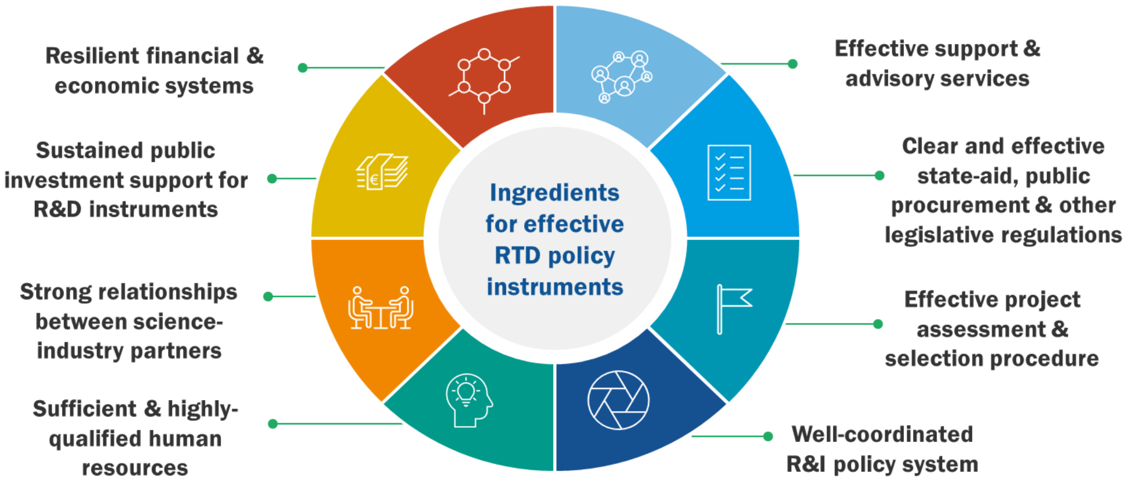
- **Coherence of investments with a regional development strategy** and dedicated regional/local stakeholders proved to be a vital supporting factor that helped multiply the effects of invested sources not only within the investigated projects under this evaluation. An example of such coherence involved universities coordinating the preparation of project proposals to eliminate overlaps among thematically similar oriented faculties and thereby jointly collaborating on the development of a regional innovation system.

- **Structural problems in the labour market** can impede the policy interventions positive effect on the employability of graduates. Increases in the skill levels of students and young researchers may not translate into increases in employability when graduates' acquired skills differ from those required by the labour market.

6. Conclusion: Key ingredients for an effective RTD policy

In light of the assessment of the above policy interventions in the 2007 – 2013 programming period and the respective theories of change, we offer below a review of some of the **most important ingredients for effective ERDF supported RTD policies**. These factors do not necessarily relate to specific policy interventions themselves but are more general contextual factors that have proven to be consequential in determining the effectiveness of the policy. They can be regarded as essential ingredients to complement and supplement various RTD policies along their life cycle.

Figure 7 – Important ingredients for effective ERDF supported RTD policies



Source: Prognos AG, CSIL, Technopolis (2021)

These factors are embedded in the **twelve guiding questions** below, which seek to accompany policy-practitioners in developing their ERDF-supported policy intervention. Complementary to the questions, related key elements have been identified to be considered when answering the questions. The questions are structured along with preconditions, supporting factors, and risks and threats since each of these groups of factors should be assessed and prepared for appropriately. Selected country examples are included to demonstrate the real-life significance of these factors. Together, the following can be considered a decision-aid tool for policymakers in developing ERDF supported investments in RTD infrastructures and activities.

Initial activities to desired impacts: 12 guiding questions for your ERDF-supported RTD policy intervention

I. Salient preconditions to ensure the viability of R&D policy interventions

1. **Are support and advisory services equipped with sufficient dedicated staff that are well trained?**

a. **Staff**: administrative and managerial capacities of Programme Management Units (and beneficiaries) are crucial for effective public spending.

b. **Attitude**: a high level of commitment and willingness to assist in beneficiary application processes.

c. **Coordination**: effective coordination of the needs of the innovation community, which may include the swift development of administrative capacities, such as the restructuring of Ministries to establish dedicated structural funds units, as occurred in newer MS.

2. **How can we ensure a transparent, effective, and timely project assessment & selection procedure?**

a. **Timely calls**: preparing calls for proposals on time in order to prevent implementation delays.

b. **Project assessment**: ensuring experienced and dedicated staff with sufficient time and resources to assess project proposals adequately.

c. **Selection procedures**: competitive selection procedures are imperative to reduce beneficiary withdrawals, project suspensions and projects of low innovative potential.

Figure 8 – Deep dive: example on the ground of a salient precondition

Project assessment & selection procedure

Portugal – Policy Instrument: Strategic RTD projects in areas of public interest

Rigorous assessment of RTD institutions	The Ministry of Science, Technology and Higher Education pursued a comprehensive and demanding (resource intense) assessment of all RTD organisations, which discerned whether institutions were equipped with a strategic research agenda, had the capacity to pursue rigorous R&D and possessed the potential for internationalisation. Only entities labelled as "very good" or "excellent" were eligible to apply for funding.
More effective outcomes & improved long-term funding opportunities	As a result, support was concentrated among the best and most suitable RTD actors, which received relatively high amounts of funding. Compared to other measures that had a more broad support framework, this selective approach generated more effective outcomes among beneficiaries, significantly strengthening their R&D capacity and making them more competitive internationally. In turn, it proved to have a sustaining effect as the funded institutions were better able to compete for further funding.

Source: Prognos AG, CSIL, Technopolis (2021)

3. **What steps can be taken to provide clear guidance on state aid rules and simplify complex and long-lasting public procurement regulations?**

a. **State aid rules**: effective and clear communication of state aid rules are critical to ensure that enterprises are eligible and willing to seek public funding and collaborate in R&D projects.

b. **Administrative burdens**: public procurement procedures should be coherent and concise to ensure a smooth implementation of projects without undue delays.

4. **What mechanisms are put in place to ensure the timely disbursement of funds to beneficiaries?**

   a. **Timely payments**: timely access to funds is especially important during economic shocks and specifically for SMEs with limited access to alternative funding sources.

   b. **Simple procedures**: ensuring that administrative procedures for fund disbursement are simple and swift reduces delays.

   c. **Staff**: having sufficient staff to verify reimbursement requests and make payments is vital for timely project implementation.

II. Important supporting factors to strengthen R&D policy interventions

5. **Does our region have sufficient & highly qualified human resources to employ new R&D infrastructure or participate in R&D projects?**

   a. **Qualified staff**: sufficient and highly qualified and trained R&D and ICT staff to employ new infrastructure are essential.

   b. **Administrative matters**: ensuring that financial and administrative regulations within public research organisations allow for the swift hiring of additional specialised personnel.

   c. **Adequate pay**: providing sufficient pay and other framework conditions for staff members helps attract suitable profiles and prevent departures.

6. **What is the current relationship between science-industry partners in our region, and how can we foster an environment that helps further enhance their collaboration?**

   a. **Science-industry relationships**: knowledge-transfer depends on ties between science and industry partners. Important to develop Technology Transfer Offices as well as permanent collaboration platforms such as competence centres or clusters.

   b. **Capacity building**: a key enabling factor is promoting and maintaining mutual trust, awareness of individual needs, and the capacity to exchange ideas and know-how (i.e., R&D results and application possibilities).

7. **Have the various RTD support programmes in our region & country been coordinated to ensure their effective alignment and complementarity?**

   a. **Innovation framework**: important to seek to embed ERDF supported policy instruments within the national strategic innovation framework to foster synergies.

   b. **Coordinated R&I systems**: funding mechanisms at the regional, national, and EU levels are effectively coordinated to complement each other and offer a comprehensive funding framework for beneficiaries.

Figure 9 – Deep dive: example on the ground of an important supporting factor

Effective alignment of intervention in R&I system

Sachsen, Germany – Policy Instrument: Application-oriented research projects

Funding for individual, application-oriented R&D projects in Sachsen, Germany supported universities and research institutions in pursuing early-stage, foundational research. This funding was complemented by a host of other regional and national support programs, such as:

- **State Excellence Initiative:** Concentrated support to five universities in Sachsen pursuing specific areas of research.
- **State support for collaborative R&D projects:** Support for collaborations between private enterprises and application-oriented research organisations, which the ERDF funded policy instrument did not specifically address. Of 327 entities supported by the ERDF, 192 benefitted from this measure, underscoring its complementarity.
- **Hightech-Strategy 2020:** National funding focused on five areas (Climate/Energy, Health/Nutrition, Mobility, Security, Communication) and on specific fields of technology. Differentiation to ERDF support, which does not specify technology to be used.

Conclusion: the ERDF supported policy fits well into the existing R&I funding framework and does not compete with existing support measures. Rather, it is complemented by other regional and national funding opportunities. A continuous dialogue between policymakers at different governing levels and a clear R&D roadmap is of importance in this regard.

Source: Prognos AG, CSIL, Technopolis (2021)

8. **How can one ensure that public investment in R&D is sustained over the long term? Relatedly, how can private R&D expenditure be incentivised?**

   a. **Connect better**: when developing a new research infrastructure, ensure that research teams have budgets to utilise it.

   b. **3rd party funding**: enhance the capacity of and create incentives for beneficiaries to acquire third-party funding.

   c. **Long-term funding**: develop a clear and strategic R&D policy roadmap with a long-term commitment to public investments and effectively communicate this to relevant actors.

III. Significant risks and threats posed to R&D policy interventions

9. **Are state aid rules for the use of R&D investments communicated and understood?**

   a. **R&D collaboration**: rigidity regarding the involvement of commercial partners in joint R&D projects strongly reduces the likelihood of collaboration between science-industry partners and jeopardises the future willingness of private sector engagement.

   b. **Use of infrastructure**: strict limitations regarding private sector access to funded R&D and ICT infrastructure prevents a more diversified use of the infrastructure and inhibits beneficiaries from engaging in more proactive knowledge transfer.

Figure 10 – Deep dive: example on the ground of a significant risk

State Aid Rules

Examples from Poland, Estonia and Romania

Science-industry collaboration jeopardized	In Poland, legal barriers related to state aid rules prevented private companies from being eligible to collaborate with research institutions from 2008 to 2011. While knowledge transfer could still take place, since scientific organisations could transfer their findings to commercial partners (through licensing agreements or by making them publicly available), the increase in collaborative efforts between research organisations and industry partners was limited.
Limited use of R&D and ICT infrastructure	In various countries, such as Romania, Estonia and Poland, there were strict limitations (in some cases use rate of 20%) in regard to private sector use of publicly funded research infrastructure and equipment. This played a key role in limiting the capacity of the intervention to a) enable a more diversified use of the developed and renewed infrastructure, b) generate additional revenue through these alternative uses, and c) allow beneficiary institutions to use the infrastructure as a means to engage in more pro-active knowledge transfer and cooperation with the private sector.

Source: Prognos AG, CSIL, Technopolis (2021)

10. How can demographic changes (incl. brain drain) be addressed in the long run? What systemic changes need to occur?

a. **Emigration dynamics**: demographic change can limit the longer-term impact of R&D investments. Emigration of students and researchers due to unfavourable framework conditions (poor academic prospects) for PhD study.

b. **Capacity building**: retention of highly qualified R&D personnel a persistent challenge: results in migratory “brain drain” phenomenon. Non-competitive pay due to legal constraints (public wage policy) plays an important role.

11. How can collaborative efforts between research institutions and enterprises be protected and sustained?

a. **Limited collaboration**: limited collaboration (also due to legal constraints) results in reduced knowledge transfer due to declining involvement of enterprises and reduced interest in research results.

b. **Coordination and trust**: a lack of coordination and trust within a team can lead to limited results. Miscommunication or changes in enterprise strategy can play a role. Financial limitations and unclear commercialisation pathways (prospective returns) reduce long-term private sector engagement.

12. Do we have resilient economic & financial systems that sustain public investment during economic shocks? How do we ensure financial resilience in terms of continued access to credit?

a. **Private sector**: economic and financial crises severely affect private enterprises’ access to credit, jeopardising approved projects. Enterprises often reduce R&D and innovation expenditure in cost-cutting measures.

b. **Public sector**: national budgets are also affected by budgetary constraints during economic crises. Decreased public resources available to stimulate innovation and competitiveness.

***

The findings of the ex-post evaluation underscore the importance of contextual factors in pursuing R&D instruments. The broader system of enabling conditions necessary to improve regional competitiveness proves to be a vital factor to consider. As such, the above questions encourage rigorous thought about the conditions in which ERDF instruments can be most effective. Since regional circumstances will vary and are complex, the questions and key ingredients of the Cookbook should not be seen as a formula but rather regarded as accompanying guidance to consider when planning future ERDF supported R&D instruments thoroughly. In so doing, common pitfalls in the design and implementation of RTD policy can be avoided, and lessons learned can be applied. Moreover, critically thinking about and diligently preparing for contextual factors and relevant enabling conditions ex-ante can help improve the success rate of the policy in the long term.

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