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

Italy

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LIST OF ABBREVIATIONS

APQ	*Accordi di Programma* Quadro (Framework Programme Agreements)
APRE	*Agenzia per la Promozione della Ricerca Europea* (Agency for the Promotion of European Research)
CA	Contribution analysis
CNR	*Consiglio Nazionale delle Ricerche* (National Research Council)
CSIL	*Centro Studi Industria Leggera* (Centre for Industrial Studies)
DAC	*Distretto Aerospaziale Campano* (Campania Aerospace District)
DPEF	*Documento di Programmazione Economico-Finanziaria* (Document of Economic and Financial Policy)
DTA	*Distretto Tecnologico Aerospaziale* (Aerospace Technology District)
EC	European Commission
ECEI	European Cluster Excellence Initiative
EMSO	European Multidisciplinary Seafloor and water column Observatory
ENEA	*Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile* (Italian National Agency for New Technologies, Energy and Sustainable Economic Development)
ERA	European Research Area
ERC	European Research Council
ERDF	European Regional Development Fund
ESA	European Space Agency
ESCA	European Secretariat for Cluster Analysis
ESFRI	European Strategy Forum for Research Infrastructures
ESIF	European Structural and Investment Funds
ESF	European Social Fund
EU	European Union
FAS	*Fondo per le Aree Sottoutilizzate* (Fund for Lagging Behind Areas)
FIRST	*Fondo per gli investimenti nella ricerca scientifica e tecnologica* (Fund for investments in scientific and technological research)
FP	Framework Programmes
FP7	Seventh Framework Programme
GDP	Gross Domestic Product
H2020	Horizon 2020
HEI(s)	Higher Education Institution(s)
IAMC	*Istituto per l'ambiente marino costiero* (Institute for the Coastal Marine Environment)
ICOS	Integrated Carbon Observation System
ICT	Information and Communication Technologies
IMM	*Istituto per la microelettronica e microsistemi* (Institute of Microelectronics and Microsystems)
IPCB	*Istituto per i Polimeri, Compositi e Biomateriali* (Institute for Polymers, Composites and Biomaterial)

ISI	International Scientific Indexing
ISTAT	*Istituto Nazionale di Statistica* (Italian National Institute of Statistics)
IT	Information Technology
MA	Managing Authority
MIUR	*Ministero dell'istruzione, dell'università e della ricerca* (Ministry of Education, University and Research)
MiSE	*Ministero dello Sviluppo Economico* (Ministry of Economic Development)
MS	Member State(s)
PNR	*Programma Nazionale della Ricerca* (National Programme for Research)
NSF	National Strategic Framework
OECD	Organisation for Economic Co-operation and Development
OLAF	European Anti-Fraud Office
OP(s)	Operational Programme(s)
OP R&C	Operational Programme Research and Competitiveness
p.p.	Percentage point(s)
PAC	*Piano di Azione e Coesione* (Cohesion Action Plan)
PCT	Patent Cooperation Treaty
PVC	Polyvinyl chloride
R&D	Research and Development
RDD	Regression Discontinuity Design
RTD	Research and Technological Development
RTO(s)	Research and Technology Organisation(s)
S3	Smart Specialisation Strategy(ies)
SERC	Spatial Economics Research Centres
SMEs	Small and Medium Enterprises
STAR	Southern Europe TBS source for Applied Research
SVIMEZ	*Associazione per lo SVIluppo dell'industria nel MEZzogiorno* (Association for the Development of Industry in the Mezzogiorno)
TIGEM	Telethon Institute of Genetics and Medicine
ToC(s)	Theory(ies) of Change(s)

EXECUTIVE SUMMARY AND KEY FINDINGS

This document is one of seven case studies included in the ex-post 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. It focuses on Italy, in particular on the Operational Programme for Research and Competitiveness (OP R&C), which absorbed more than 80% of the ERDF resources for RTD invested in Italy during that period. It also provides a deep dive on three specific policy instruments implemented under this OP:

- Collaborative science-industry R&D projects implemented by firms, universities and research organisations under Measure I.1;
- Collaborative R&D projects in clusters under Measure I.3 (Action I.3.1 High-technology districts);
- Infrastructure investments in public universities and research organisations under Measure I.4.

This case study investigates whether the ERDF policy mix for RTD achieved its intended objectives and matched or responded to the country's policy challenges. It also looks at whether the selected interventions for RTD infrastructure and activities were effective and according to which mechanisms.

The methodology used is a Contribution Analysis (CA), which builds on the reconstruction of the underlying Theories of Changes (ToCs) of selected policy instruments, testing their validity based on evidence collected. This approach implies disentangling the complex causal relationships between different stages of implementation and the production of results.

The evidence basis includes hard data and information from strategic and programming documents, project implementation reporting, statistical data, and indicators from the monitoring system and other literature. The data is complemented by 32 interviews with representatives of policymakers, programme managers, beneficiaries, other stakeholders, and individual experts. The analysis was carried out during the period of May-July 2020. It builds on the evidence available from a previous task, including a comprehensive mapping and classification of projects and beneficiaries funded in 53 Operational Programmes in 18 Member States under the codes of expenditures 01 and 02 (Research infrastructure and activities, see the First Intermediate Report for more details).

OVERVIEW OF KEY FINDINGS AND CONCLUSIONS

Analysis of the policy context at the national level

At the beginning of the 2007-2013 programming period, Italy was still characterised by a modest economic performance. Beyond the scarcity of human capital and the low R&D intensity of firms, mainly due to the structural deficiencies typical of the Italian industrial fabric, the national public research context was marked by low and shrinking public spending for R&D and universities.

Along with generalised economic and structural weaknesses at the national level, the country suffered from strong regional disparities, further sharpened by the outbreak of the 2008 Great Recession. Convergence regions (i.e. Campania, Calabria, Puglia and Sicilia) underperformed in most variables expressing the research system's performance. Compared to northern regions, they had an overall lower capacity to attract and retain researchers, successfully participate in highly competitive calls for proposals for scientific projects at the national and European levels, and engage with private actors in research activities.

On the spur of the Lisbon Strategy, research and innovation had finally become a strategic objective in the country towards the end of the 1990s. The importance of giving a higher priority to R&D investments was corroborated by adopting new legislative acts developing a framework for research and innovation policies. The most significant of these was the

reform of the National Research System[1], which guaranteed for the first time the programmatic coordination of research activities and initiatives, coherent with a strategic approach to be defined and included in the triannual National Programme for Research (Programma Nazionale per la Ricerca - PNR).

In light of the importance of the collaborative nature of research, the strategic approach pursued by the 2005-2007 National Programme for Research, in force at the beginning of the 2007-2013 programming period, focused on fostering the link between RTD and industrial policies, and on promoting regional territorial aggregations.

In the 2007-2013 programming period, the ERDF allocated EUR 2.1 billion in RTD investments through the national convergence OP for Research and Competitiveness and 14 regional OPs (four convergence OPs and ten competitiveness OPs), with the former absorbing more than 80% of the total ERDF contribution for RTD in the country.

Relevance

ERDF support in Italy responded to the identified challenges and needs of the Italian RTD system. Absorbing 92% of the total ERDF contribution for RTD in the country, convergence regions were the main target of ERDF to reduce regional disparities. Despite being highly relevant for the context's specificities, this strategic objective posed a challenge when it came to selecting projects based on their research and innovation merit in territories characterised by less mature RTD ecosystems.

Convergence and competitiveness regions showed a similar RTD policy mix, with a **predominance of individual and collaborative R&D projects** and a more marginal role of infrastructure investments for research. According to the mapping and classification proposed under Task 1, the former accounted for 85% of the ERDF RTD resources in the OP R&C. In the southern convergence regions. However, the predominance of collaborative industrial R&D projects reflected a political will. Since the late 1990s, the national RTD policy aimed to promote science-industry collaboration due to low engagement in R&D from the business sector stemming from structural deficiencies such as their overall limited dimension. The rationale of infrastructure investments drew from the need to maximise potential joint effects from collaborative R&D projects; the increased attractiveness of these actors could lay the groundwork for public-private collaborations.

Evidence indicates that RTD support in convergence regions was characterised by a top-down approach. Industrial research instruments and capacities were mainly driven by research supply, thus informed by the availability of, or gaps in, support services and infrastructure. Moreover, there was evidence of a significant, intentional and relevant thematic focus of ERDF on fields and themes with considerable potential or with comparative advantage. Collaborative science-industry research projects were implemented in one of the nine target scientific-technological areas identified as strategic in the Framework Programme Agreements. Similarly, technological clusters and universities and research infrastructures were selected based on the sectors in which they operated. This approach paved the way for the adoption of the Smart Specialisation Strategies (S3) in the following programming period.

Coherence

ERDF programmes were designed in great synergies between the national and regional policies in the field of RTD, with a strategic approach acknowledging the mission of RTD investments to improve economic competitiveness through the promotion of public-private partnerships and territorial aggregations. In convergence regions, there was planning for complementary interventions in national and regional OPs. While the regional OPs supported RTD investments with a strong local significance, the national OP was designed to support larger-scale and more ambitious RTD investments with an interregional perspective and national relevance. To avoid potential overlapping, several criteria were formulated in the 2007-2013 National Strategic Framework (NSF) and in the Framework

[1] Legislative Decree No. 204/1998

Programme Agreements stipulated by the central administration for the four regions of the Convergence objective (Accordi di Programma Quadro – APQ). Overall, the in-depth analysis of the different policy instruments funded by the national OP has shown that selected R&D, as well as infrastructure projects, were of a large financial scale, thus ensuring the maximisation of combined effects.

There was complementarity with other European objectives and strategies, such as the European Social Fund (ESF) and the national OP for Research and Competitiveness. Under Art. 34 of the Regulation (CE) No 1083/2006, the application of complementarity between ESI Funds allowed ERDF to fund training activities (generally funded by the ESF) directly related to the scope of funded RTD projects up to a maximum of 10% of the EU contribution of the Priority Axis.

There were also elements of connection with the European Framework Programmes for research, despite the lack of specific coordination mechanisms. ERDF investments were, in principle, meant to enable subsequent participation in FP actions. However, an analysis of Cordis and OpenCoesione data showed no evidence of increased participation of ERDF recipients in research projects at European level after the end of the 2007-2013 programming period, especially those funded by convergence OPs.

Efficiency

Financial support provided by the ERDF to support RTD activities and infrastructures made a perceptible difference in RTD expenditure in the convergence regions. National and regional convergence OPs accounted for more than 92% of the total ERDF contribution for RTD in the country and represented between 13.25% (in Sicily) and 32% (in Calabria) of the cumulative public R&D expenditure in the regions. However, this alone was insufficient to reduce regional disparities.

The identification of sectoral priorities in the ERDF 2007-2013 OPs, already influenced by the pioneering design of regional Smart Specialisation Strategies, facilitated a concentration on strategic scientific and technological areas. Finally, the significant financial scale of the project suggests a concentration of funds at the project level able to make some difference in the research agenda of recipients.

All of the above would suggest an efficient allocation of financial resources. However, the case study shows how crucial is the administrative capacity to ensure efficiency during the implementation. A responsive and agile administration must ensure smooth administrative procedures and quick fund absorption, facilitating project implementation by beneficiaries. Unfortunately, to date, the OP is still not closed from a financial and administrative point of view, and it records high underspending and suspended or revoked projects.

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

This case study shows that, with EUR 2.1 billion of total allocated budget (both national and EU co-financing), the ERDF support to RTD in convergence regions in the period 2007-2013 played a pivotal anti-cyclical role concerning the harmful effects of the economic crisis and the ongoing cuts in public expenditures in R&D. In particular, the national OP certainly helped prevent a possible dramatic drop in R&D investments, especially private ones: instead, evidence shows that the share of business R&D expenditure over GDP increased during the period 2007-2017, although less than in some of the competitiveness regions. This finding echoes a previous result of the ex-post evaluation of ERDF programmes on the Support to SMEs[2], where the Italian case showed that the ERDF helped

[2] European Commission, 2016, Support to SMEs – Increasing Research and Innovation in SMEs and SME Development. Final Report Work Package 2. Ex post evaluation of Cohesion Policy programmes 2007-2013, focusing on the European Regional Development Fund (ERDF) and the Cohesion Fund (CF). Authors: CSIL in partnership with CSES and ZEW

targeted SMEs withstand the crisis by coping with the credit crunch and supporting the accumulation of fixed capital.

However, compared to initial ambitions, the OP had limited if no effects in terms of output additionality, since it neither achieved its primary objective of contributing to narrowing the gap in terms of RTD performance with the rest of the country and other European countries, nor promoted a competitive repositioning of the territory. Cluster analysis results show that convergence regions' performance remains 'modest' in 2017, with most of the RTD-related variables recording no improvements since 2007. In this respect, ERDF interventions proved to be insufficient, all alone, to improve the competitiveness of convergence regions. Specific contextual conditions, such as a less favourable business environment, financial constraints related to underdeveloped capital markets, a lack of high-skilled people due to, among other reasons, brain drain and limited lifelong learning, were not conducive to the materialisation of wider impacts. In addition, overall public spending in research and development and education has been reduced, preventing the set-up of a long-term policy framework from sustaining RTD investment[3].

This more general conclusion also applies in the context of the three policy instruments analysed in more depth using the contribution analysis approach. Although, in all cases, ERDF support contributed to the achievement of short-term results (implementing research projects, setting up cluster organisations, and modernising research infrastructures), they did not translate into a structural improvement of the convergence territory. Some softer evidence has been collected from interviewees suggesting behavioural benefits, with research providers and firms experiencing fruitful cooperation around a number of prioritised scientific-technological areas.

The policy instrument for **collaborative science-industry R&D activities** supported ambitious industrial research projects, favouring a knowledge exchange process between firms and research providers and contributing to the consolidation of existing partnerships. Evidence is more limited to the effects in terms of innovation in products and processes. Beneficiaries did not structurally become more likely to invest in R&D activities. However, they maintained the level of R&D investments despite the negative effects of the economic crisis.

Support provided **to technological clusters** managed to contribute to the strengthening of regional R&D capabilities by boosting the reinforcement of existing clusters and creating a few new clusters. This was evident in the overall good results by research projects in terms of innovation production. There was less evidence of long-term impact. Despite more than ten years of public support, only a few technological clusters preserved or strengthened their role as facilitators of collaborative research. A lesson learned is that an enduring political vision and leadership and managerial capacity of clusters organisations are key success factors.

Investments for the construction or modernisation of research infrastructures managed to increase the research capacity and attractiveness of funded infrastructures. There was limited evidence that funded beneficiaries could manage the new or modernised research infrastructure or be involved at the national and European level in research projects of proven excellence. Therefore there was a little contribution to the overall economic development of the convergence territory. For this to happen, a more stable and significant public financial support to public research providers could be decisive for engaging in a long-term and ambitious research agenda.

Drivers of and barriers to success

A combination of factors can explain the limited longer-term impacts. Implementation problems mainly related to **administrative capacity issues** with the Managing Authority are a crucial factor. Long and cumbersome selection processes led to late project approvals and errors in eliminating evaluators' conflicts of interest. In addition, payment delays

[3] See also COM(2018) 411 final, Recommendation for a COUNCIL RECOMMENDATION on the 2018 National Reform Programme of Italy.

imposed critical financial stress, especially on smaller firms already facing the economic crisis's consequences. This finding highlights the importance of developing and maintaining entrepreneurial capacity within the public administration responsible for managing large and ambitious spending programmes with appropriate staffing and skills. Scheduling capacity, client-orientation and problem-solving attitudes are determinant to guarantee a credible and successful implementation plan.

Leadership capacity and commitment to a long-term strategy, both in public and private actors, are other critical success factors. Developing research and innovation capacity is a long-term journey requiring vision, perseverance, and strategic approach consistency. Research collaborations involving large firms were generally successful, thanks to their economic stability, capacity to organise towards a long-term agenda, and ability to coordinate with a network of SMEs. Such clusters, supported by regional administrations, achieved long-term success. By contrast, the development of a cluster's role in regional research was hampered in the absence of strong management and the lack of a long-term national political vision.

Finally, **structural problems** typical of convergence regions (including in infrastructure and public administration) have also been a significant factor exacerbated by the economic crisis's effects. But a key determinant of the missed opportunity was that the ERDF represented for convergence regions the primary source of support in RTD. ERDF support has acted as a substitute for ordinary national and regional funds, rather than complementing them, becoming the main funding instrument of the national RTD policy focusing on public-private research integration. A key finding of this evaluation is the importance of national and regional funds as leverage for Cohesion policy: without them ERDF investments have a reduced potential to move the needle of the regional research system.

Sustainability

The case study shows limited overall sustainability of the results of the three policy instruments. Despite the consolidation of collaborative R&D activities, the delayed disbursement of funds and the limited propensity of small firms to patent generally prevented the translation of research results into commercial applications. Moreover, it is unlikely that technological clusters will keep a key role in the regional research and innovation system, except for those clusters that have been able to evolve and adapt their role to their members' requests and the changes introduced within the national RTD policy framework. Likewise, new or modernised research infrastructures will have difficulties in exploiting their improved research potential and contributing to the economic development of convergence regions if subject to budgetary constraints in current expenditures.

The most long-lasting result is a demonstration effect played by the ERDF policy instruments emphasising the importance of science-industry collaboration, in line with the national strategic indications for RTD policies to boost public-private research integration. This is at the basis of the identified behavioural additionality effects on research providers and firms experiencing fruitful cooperation around a number of prioritised scientific-technological areas, which interviewees indicated as the most relevant strategic legacy of the programme.

EU added value

The evaluation found that the ERDF support for RTD activities and infrastructure generated regional effects more than EU-wide effects. Only in some specific cases, funded research infrastructures were able to improve their research capacity and attract European and international partners' attention. This is the case, for instance, of the four research infrastructures of pan-European interest, which were funded by the programme and later included in the strategic roadmap of the European Strategy Forum for Research Infrastructures (ESFRI).

In light of the low level of ordinary national and regional funds for RTD mobilised in the convergence regions, the ERDF has been crucial for promoting competitiveness by supporting scientific and technological research. Its added value primarily rests on its ability to ensure continuity and sufficient resources to support a sustainable structural change. In most cases, the in-depth analysis of policy instruments revealed that investments would not have been undertaken without EU support. Only when large firms were involved in collaborative R&D activities did the additionality effect of the ERDF appear to be lower. Even in those cases, the ERDF has at least increased the intensity of investment and/or implementation pace. One of the main achievements of the ERDF support to RTD investment in Italy's convergence regions was to keep high the priority to investments for research and technological development in the public investment agenda, in a moment of generalised cut in public spending.

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 billion, or about 85% of the EU total for the relevant themes) provided during this programming period.

The case study has 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 between different stages of implementation and the 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 by addressing the specific conditions influencing the policy rationale (further explored in the cross-case analysis), the interplay of different stakeholders, as well as their expectations, and the observed effects resulting from the policy instruments.

The selected policy instruments were the following:

- Collaborative science-industry R&D carried out by firms, universities and research organisations under Measure I.1 'Strategic scientific-technological areas';
- Collaborative R&D in clusters implemented under Measure I.3.1 'Technological clusters and related networks';
- Infrastructure investments for research in public HEIs and RTOs under Measure I.4.1 'Structural reinforcement'.

The case study provides an assessment of the implementation of ERDF in the field of RTD of the national Operational Programme for Research and Competitiveness (henceforth OP R&C). The latter absorbed 82% of ERDF resources for RTD in the country and concentrated funds on the four convergence regions eligible under the 2007-2013 programming period: Campania, Puglia, Sicilia and Calabria.

The following chapters provide, against the description of the national and regional economic and innovative background, an overview of the RTD policies and ERDF policy mix implemented in the country both at the national and regional level. Then, Chapter 3 is specifically devoted to an in-depth analysis of the national OP R&C.

The case study was developed based on hard data and information from strategic and programming documents, project implementation reporting, statistical data, indicators from the monitoring system and other literature, complemented by interviews with representatives of policymakers, programme managers, beneficiaries, other stakeholders and individual experts. The analysis was carried out during the period of May-June 2020. It builds on the evidence available from a previous task, including a comprehensive mapping and classification of projects and beneficiaries funded in 53 Operational Programmes in 18 Member States under the codes of expenditures 01 and 02 (Research infrastructure and activities; see the First Intermediate Report for more details) and cluster analysis of European regions according to their R&D performance.

Altogether 32 stakeholders were consulted in the preparation of this report, including representatives of the managing and implementing authorities and direct and final beneficiaries. The stakeholders' consultation was done through phone interviews and carried out by the CSIL team from mid-May to the end of July 2020. Experts preparing this report were able to reach out to most of the identified stakeholders and discuss their experience during the period of 2007-2013, except for some potential interviewees no longer employed by the focal organisations. However, while beneficiaries provided some relatively good data at the project level, the Managing Authority could not give the evaluation team access to more detailed data on projects (e.g. technical reports) or up-to-date information on the OP results. The main reason is that the OP is not administratively closed, and administrative controls are still in progress for some projects.

Aggregate quantitative indicators have also been considered in the evaluation context despite their limitations, for example, regional indicators on R&D expenditure, patent applications, or the employment rate in science and technology sectors. Although available at the level of the entire programme and not broken down into individual support measures, monitoring indicators were also taken into consideration. When available, evaluation reports carried out in the context of the OP evaluation plan or by independent experts were also used to strengthen the case study's analytical reliability further.

2. ANALYSIS OF THE POLICY CONTEXT AT THE NATIONAL LEVEL

This chapter presents the policy context in which ERDF support was provided during the 2007-2013 programming period in the field of RTD. To begin with, Section 2.1 provides an analysis of the national context and the main RTD needs and strategies. Section 2.2 is devoted to describing the role of ERDF with respect to national and regional RTD strategies and other European RTD policies and analyses how intended articulations were meant to act as drivers of effectiveness. Finally, Section 2.3 describes the institutional structure for ESIF programming and management at the MS-level and the total OPs implemented in the country, with an overview of RTD expenditure across all OPs to present the ERDF RTD policy mix.

2.1. National RTD objectives and strategies

2.1.1. National RTD context

At the dawn of the 2007-2013 programming period, all European Member States' competitive position was affected by emerging countries, such as China or India, showing considerable growth rates fuelled by technological innovation in goods and services. However, Italy was one of the oldest EU countries most suffering from the erosion of its economy's competitive position. Among the main reasons explaining the country's economic decline, the overall **poor national research and innovation system** stands out, along with the sharp territorial polarisation between northern and southern regions.

At the beginning of 2007, the **national public research context** was characterised by low public spending for R&D and universities, scarcity of human capital and moderate use of technology transfer processes (Nascia and Pianta, 2018). Although universities and research centres already constituted a large and solid basis for excellence in 2007, the dialogue between businesses and the research sphere was still limited. Moreover, there was a problem linked to researchers' lower skill levels compared to other industrial countries. Not only did the system lack the ability to produce and attract skilled human capital, but it also suffered from difficulties in absorbing higher education graduates (Coletti, 2007). The mismatch between the offer of the educational institutions and the labour market demands resulted in a problematic 'brain drain' phenomenon in that period (Nascia and Pianta, 2018).

Regarding the **business research system**, firms showed low R&D intensity mainly due to the structural deficiencies typical of the Italian industrial fabric. These include the reduced size of companies, the consequent low propensity to invest in R&D and accessing finance, and the productive specialisation in low-tech industries. In 2007, micro firms (from 1 to 9 employees) represented 94.8% of all firms, and 4.6% were of small size (from 10 to 49 employees)[4]. However, in the same year, 70.1% of the total intramural R&D expenditure was concentrated in large companies of at least 500 employees (ISTAT, 2009). The sectors with the highest share of the total value added were social and personal services, manufacturing and real estate (Pierantozzi, 2008).

In this context, the **scarce mobilisation of financial resources for research** characterising the period sharpened the national research system's overall poor performance (Poti et al., 2009). The ratio of R&D expenditure over GDP shows that, in 2000-2006, the country lagged behind older Member States, with an average R&D expenditure of 1.05% of GDP, which is 0.76 p.p. lower than the EU average over the same period. The picture appeared even worse when comparing the different research funding shares (i.e. business R&D, government R&D and higher education R&D). In this respect, business R&D over GDP in 2005 stood at 0.53%, far below the European average (1.1%) and that of all Western countries and even some EU13 Member States (e.g. Slovenia and Czechia)[5].

[4] ISTAT data, Statistical Archive of Active Companies (year 2007).
[5] EUROSTAT data (code: rd_e_gerdtot).

Along with the generalised economic and structural weaknesses at the national level, at that time, Italy was also characterised by **sharp regional disparities** (see Figure 1). On the one hand, some technologically advanced areas in northern Italy, such as Lombardy or Emilia-Romagna, were among the most competitive areas in Europe and the most active in developing research policy initiatives and in innovating. On the other hand, southern regions, especially the four convergence regions (Calabria, Puglia, Campania and Sicilia) were undergoing a profound competitiveness crisis.

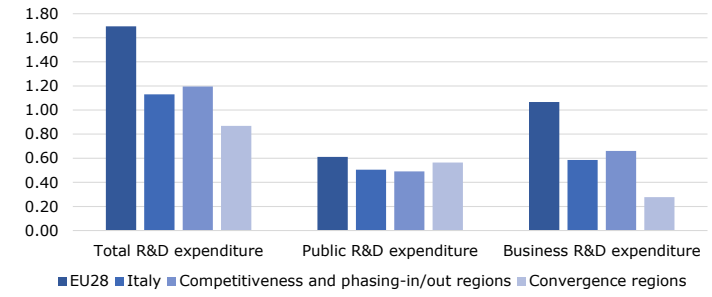
Figure 1. Eligibility of Italian regions under the Convergence and Competitiveness objectives

Source: DG Regio

Compared to the rest of the country, convergent regions underperformed with respect to most of the variables characterising the research system.

In 2007, in all regions, except Campania, R&D expenditure was far below the Italian and the EU average. The lowest level was in Calabria, where R&D expenditure amounted to 0.46% of GDP. The level of R&D expenditure in both the public and business sectors was also lower for competitiveness regions (see Figure 2).

Figure 2. Total, public, and business R&D expenditure over GDP in convergence and competitiveness regions compared to the EU and national average (year 2007)



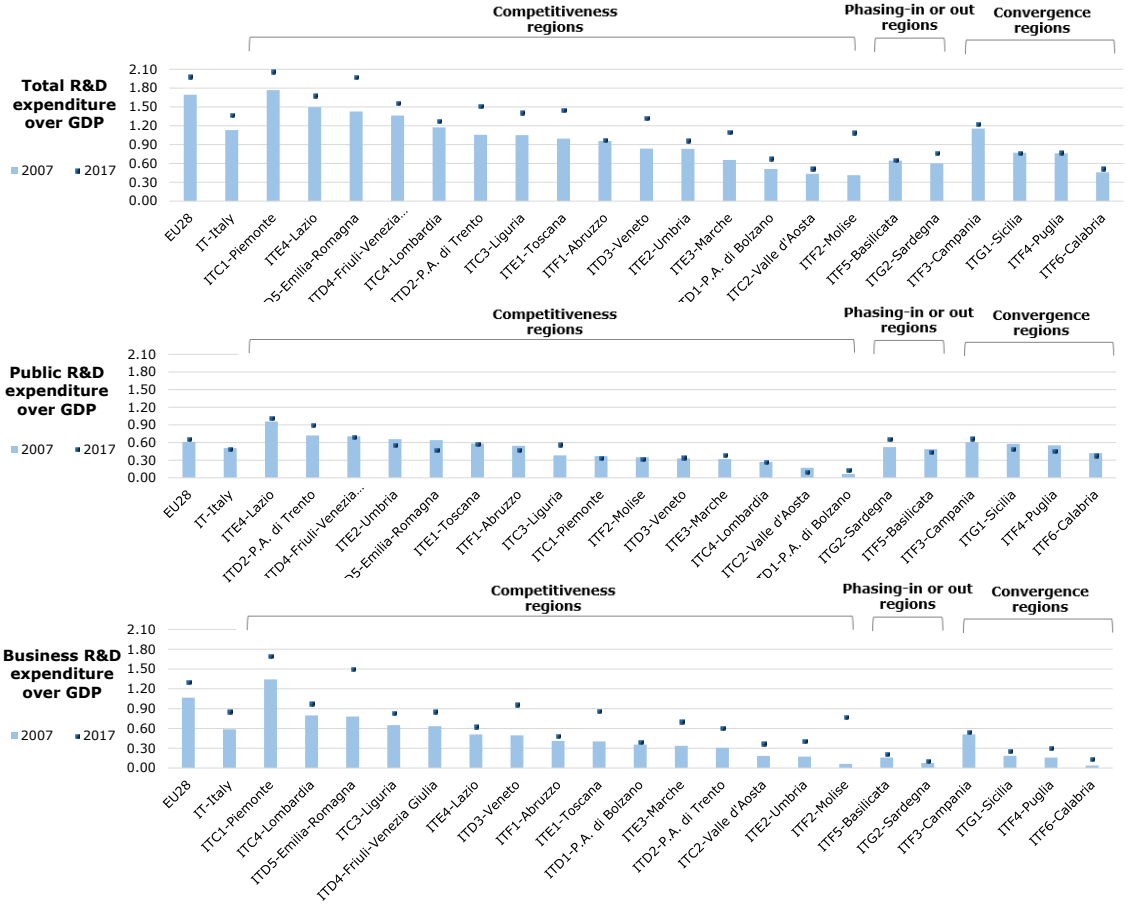
Source: own elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of GDP

Despite a significant and uniform presence of universities in the local system, as well as of public research organisations (MIUR, 2005), convergence regions had an overall lower capacity to attract and retain researchers, to participate in highly competitive tenders for projects successfully, both at national and European level, and to engage with private actors in research activities.

The **2008 Great Recession** affected the country in a significant way by **further sharpening regional differences**. Still, it did **not** have **a particularly negative impact on the R&D expenditure** at the national and regional level. Overall, competitiveness and convergence regions maintained their relative position compared to the others. As shown in Figure 3, an increase in the total and business R&D expenditure was recorded in all competitiveness and phasing regions, although at a generally slower pace in convergence regions. The austerity policies implemented after the Great Recession had a strong impact on public R&D expenditure[6] (Nascia and Pianta, 2018) which suffered from a considerable decrease between 2007 and 2017 in most of the competitiveness and convergence regions, although with some exceptions (e.g. the Campania region).

[6] Government and higher education sector R&D expenditure.

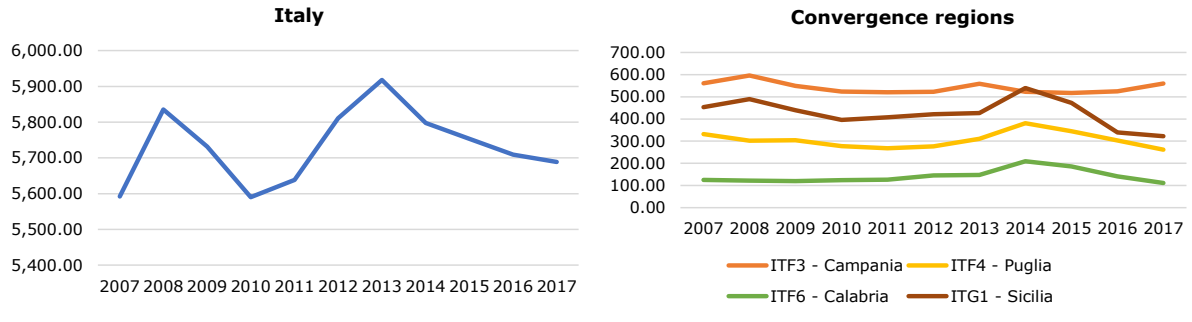
Figure 3. Total, public, and business R&D exp. over GDP, by type of region – 2007 and 2017



Source: own elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of GDP and are ordered within each category of regions in descending order for the three different variables.

The **contraction of public funding for research** had a more substantial **impact** on financing fundamental research and **the scientific performance of universities** and public research organisations (see Figure 4) because of their weak capacity to attract private funding (Fabrizio et al., 2018). As also reported by the media, austerity policies since 2008 determined a loss of funding for universities of over EUR 1 billion[7].

Figure 4. Evolution of intramural R&D expenditure (GERD) in the higher education sector (in Million purchasing power standards), 2007-2017



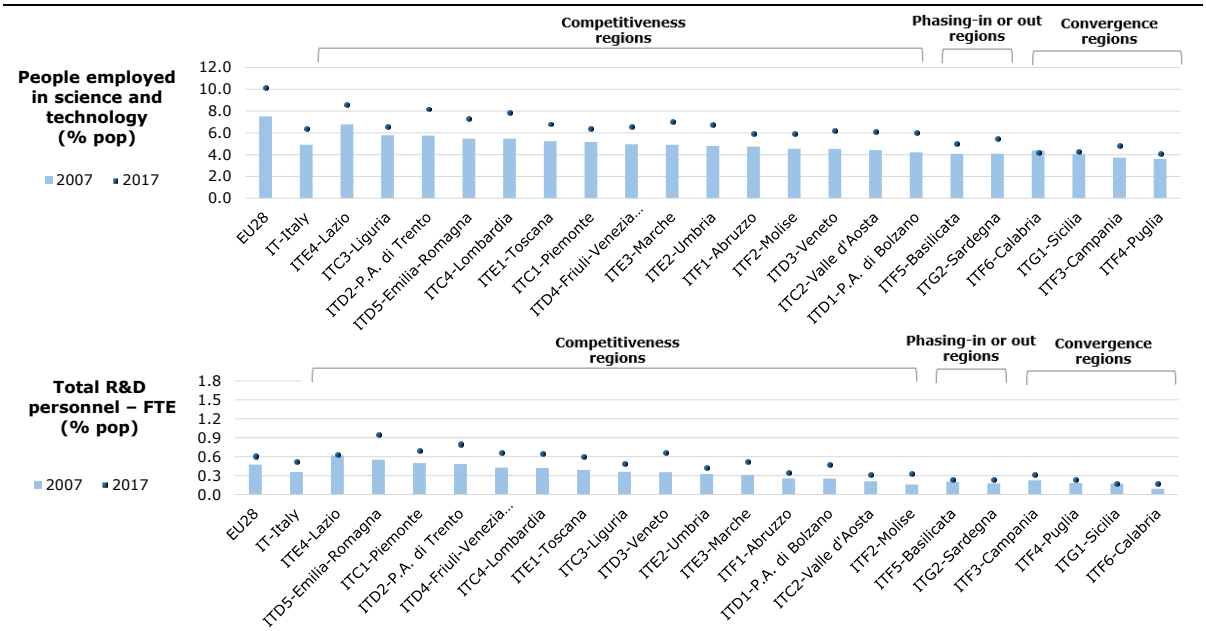
Source: own elaboration based on EUROSTAT data.

The overall increase in total R&D expenditure, especially in business R&D, was also reflected in the **increased percentage of people employed in science and technology sectors and of R&D personnel over the total population** in most regions, especially in competitiveness ones (see Figure 5). The picture is mixed for convergence regions.

[7] Patitucci, D. "Ricerca, l'appello degli scienziati: "Servono più risorse. Dal 2008 persi un miliardo di fondi e 10mila lavoratori". Il fatto Quotidiano, 13th February 2017.

Employment in high-technology sectors increased specifically in Campania and Puglia, reflecting the historical (for the former) and the increased (for the latter) propensity of firms to engage in research activities. The involvement of researchers in the industry sector, although improving, was still far below the Italian average.

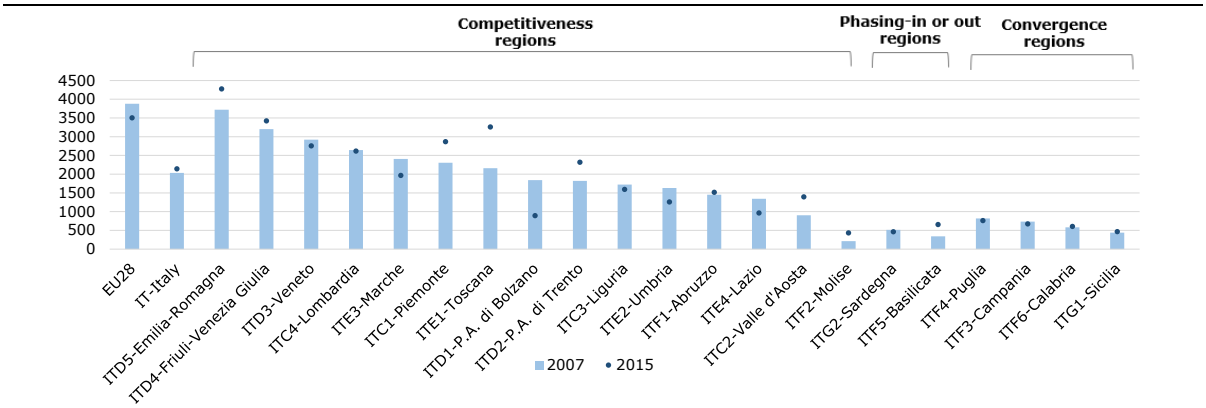
Figure 5. Employees in science and technology and R&D personnel in percentage of the total population, by type of region – 2007 and 2017



Source: own elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of the total population and are ordered within each category of regions in descending order for the two different variables.

The improved propensity to invest in R&D and the slight increase in high-skilled employees' involvement **did not result in a significant increase in innovation outputs** (see Figure 6). Patent applications remained overall stable between 2007 and 2017 in the entire country. In convergence regions, the level of patent applications compared to GDP recorded a decrease, specifically in those regions showing a higher propensity to innovate (i.e. Campania and Puglia). Besides the effect of the economic crisis, such a result could be explained by the limited tendency of both public research organisations and large enterprises to patent innovations[8]and the fact that small-medium companies represented the majority of firms in the convergence territory.

Figure 6. Number of patent applications over GDP, by type of region – 2008 and 2015



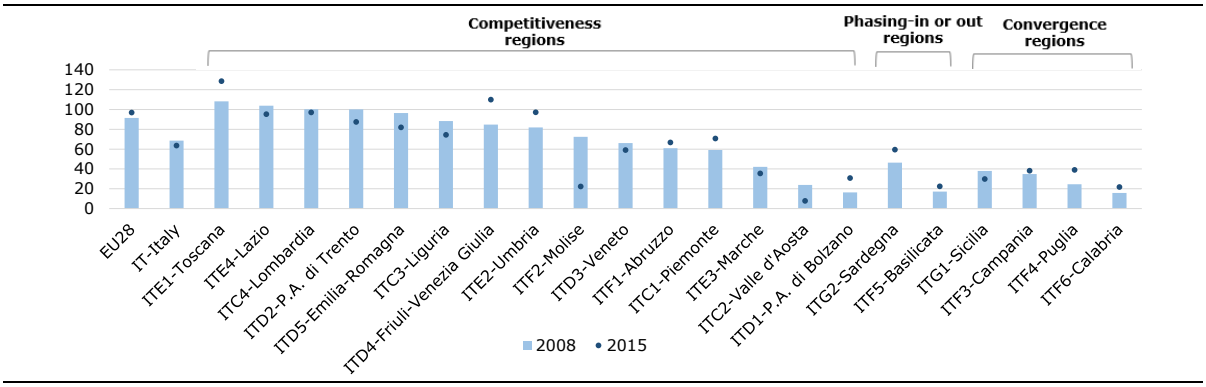
Source: own elaboration based on OECD data.
Note: Values are ordered within each category of regions in descending order.

There were mixed results in the production of public-private co-publications. Between 2008-2015 some regions improved their performance, and others did not (see Figure 7).

[8] 2012 Annual Implementation Report of the OP Research and Competitiveness.

This was true of both competitiveness and convergence regions, but in the latter, the level remained further below the Italian and EU average.

Figure 7. Number of co-publications per million population, by type of region – 2007 and 2017



Source: own elaboration based on CWTS data.
Note: Values are ordered within each category of regions in descending order.

This mixed picture in terms of RTD performance and the still significant polarisation in the country is also confirmed by the results of the cluster analysis carried out under Task 1. While the RTD performance during the period covered by this evaluation increased for some of the most innovative Italian regions, such as Lombardia and Piemonte, RTD performance remained unchanged in the southern and convergence regions. The latter, in particular, lagged behind most of the European regions, especially in terms of patent applications, total R&D personnel, and people employed in science and technology over the total population.

2.1.2. National and regional RTD strategies

From an institutional perspective, **in Italy, RTD policy competences are shared between the national and regional administrative level**. Following the 2001 constitutional reform of Article 117, both central and regional authorities can legislate in the RTD field. Although the lack of a clear division of competences might generate potential conflicts in specific areas, several interventions remain the central State's exclusive competence[9].

The main actors of RTD policy at the national level remain central ministries: the Ministry of Education, University and Research (*Ministero dell'istruzione, dell'università e della ricerca* - MIUR), the Ministry for Economic Development (*Ministero dello Sviluppo Economico* - MiSE) and many other ministries competent in their specific areas (e.g. Ministry for Agriculture, Ministry of Health). With the Law n. 3/2003, regional administrations have acquired more responsibility: they are in charge of promoting applied research, innovation, and technology transfer programmes and projects.

Research and innovation policies gained particular importance in the Italian legislative context between the end of the 1990s and the beginning of the 2000s when new legislative acts developed a framework for research and innovation policies. The National Research System[10] guaranteed the first time programmatic coordination of research activities and initiatives by introducing the triannual National Programme for Research (*Programma Nazionale per la Ricerca* - PNR) coordinated by the MIUR. Updated annually, based on the government budget's decision in the national Document of Economic and Financial Policy (*Documento di Programmazione Economico-Finanziaria* - DPEF), it provides an overall strategic framework for the use of different sources of funding. These include all MIUR funds – for universities, public research organisations, research programmes, etc. - and EU programmes, such as the ESIF and EU Framework Programmes (e.g. 7th Framework programme).

[9] These areas include: support to universities and public research organisations; R&D national mission-oriented Programmes; the creation of large national public-private laboratories; the co-ordination of the national scientific system participation to European and International R&D programmes; the support to national-international research infrastructures.

[10] Adopted with Legislative Decree No. 204/1998

Concurrent with the beginning of the 2007-2013 programming period, the strategic policy document in force was the 2005-2007 National Programme for Research. In light of the **substantial importance attached to the collaborative dimension of research** since the legislative decree 297/1999, a fresh element of the strategic approach pursued by the national RTD policy in this National Programme for Research focused on fostering:

- The link between RTD and industrial policies through the launch of strategic mission-oriented programmes;
- Private-public partnerships in key strategic export-oriented and high-tech areas;
- Regional territorial aggregations in the form of technological clusters, especially in southern regions.

The focus on public-private research integration advocated in this strategic policy document became even stronger during the 2007-2013 programming period. The adoption of the new 2011-2013 NPR reiterated the idea that the efforts of R&D policy in Italy should target the promotion of more significant R&D investments by public-private collaborations (Nascia et al., 2014).

In both the 2005-2007 and the 2011-2013 National Programmes for Research, the strategic approach also takes on the **need to narrow the gap between northern and southern regions** to promote a process of convergence of the underdeveloped areas of the country. In particular, the 2011-2013 National Programme for Research set out the goal to achieve the highest level of integration between university, research and industry in southern regions by favouring the development of a system of large firms and SMEs, public research organisations and universities, clusters, and public-private laboratories. In both strategic policy documents, such objectives were meant to be pursued mainly by the mobilisation of ESI Funds co-financed by the Fund for Lagging Behind Areas (Fondo per le Aree Sottoutilizzate – FAS), rather than by ordinary national and regional R&D funds.

Most of the regions also issued legislative interventions specifically dedicated to research and innovation for the territory's socio-economic enhancement. From a horizontal analysis of Cavallaro et al. (2018), it emerged that **all regional policies tended to focus on specific areas of intervention**, which appeared to reflect the strategic approach of the National Programme for Research.

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

This section describes the role of the ERDF investments for RTD in the national and regional RTD policy mix as well as with respect to European framework programmes.

2.2.1. Linkages between national and regional RTD policies and ERDF support

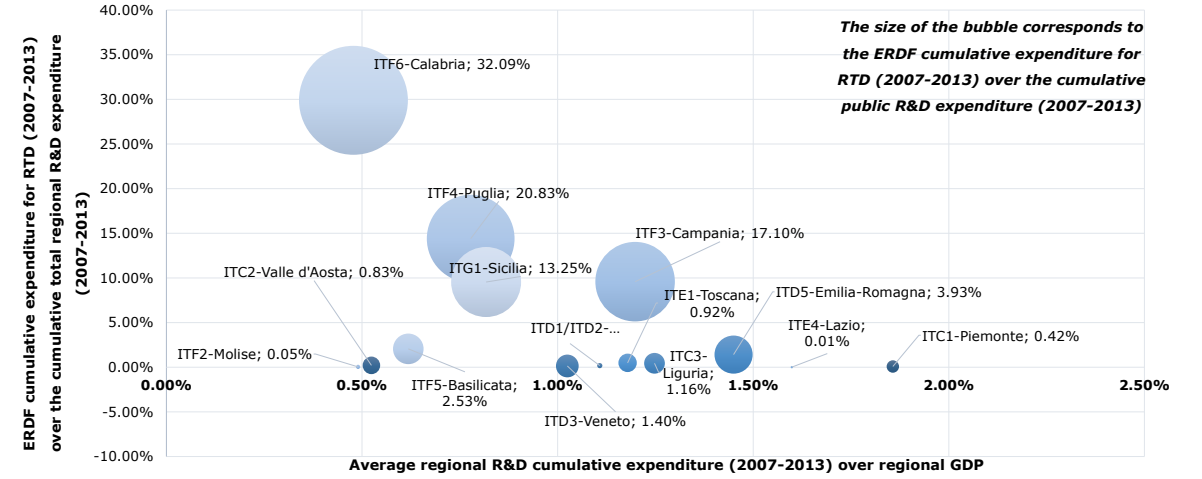
Among the financial resources foreseen in the National Programmes for Research during the 2007-2013 programming period, ESI funds played a key role. As a link between the former and the latter, the **2007-2013 National Strategic Framework** (NSF) set the priority in the RTD field in 'Promotion, enhancement and dissemination of research and innovation for competitiveness'. The priority was to strengthen the entire research system and, in particular, the cooperation networks between the research system and enterprises and raise the level of scientific and technical skills and knowledge.

According to the NSF, the **ERDF was meant to be implemented through different intensities and modalities** between the areas covered by **the Competitiveness and Convergence objectives**. In the former, the ERDF would focus on enhancing research excellence in connection with other EU programmes (i.a. 7th Framework Programme). In convergence areas, the ERDF would respond to more pressing repositioning needs of the production system in terms of economic competitiveness. In these regions, a national OP for Research and Competitiveness was mobilised to promote investments with an interregional dimension beyond intra-regional research activities and infrastructures, which were instead supported by the four regional OPs.

Synergies between the national and regional policies and the ERDF in the field of RTD **can be identified in a strategic approach,** which acknowledges that the RTD policy framework's mission was to improve economic competitiveness through the promotion of public-private partnerships and territorial aggregations, especially in southern regions.

However, synergies in the strategic approaches did not correspond to actual complementarities between national and regional funds and the ERDF, especially in convergence regions. In the 2007-2013 programming period, the **ERDF represented the primary source of support for convergence regions** in the field of RTD (see Figure 8). In contrast, national funds targeted other types of regions, such as competitiveness ones (Cavallaro et al., 2018).

Figure 8. Total R&D expenditure over GDP and ERDF RTD expenditure (code 01 and 02) over the total and public R&D expenditure during the 2007-2013 programming period



Source: own elaboration on ISTAT data (as regards R&D expenditure and GDP) and OpenCoesione (concerning ERDF RTD expenditure, which includes payments under the category of expenditure 01 and 02).

In convergence regions, a sort of **substitution effect between national/regional and European funds** can be highlighted in the context of a decrease in national R&D expenditure due to austerity policies implemented after the 2008 Great Recession. As SVIMEZ[11] (2018) has pointed out, there was a twofold substitution: firstly, due to insufficient ordinary capital expenditure and secondly, due to a lack of use of the national funds as leverage for Cohesion policy. As a result, the ERDF became the primary source of funds, rather than complementing national and regional co-financing. ERDF investments played a crucial role in convergence regions in supporting scientific and technological research for the promotion of competitiveness. While there was full strategic coordination between national and regional RTD policies and the ERDF during the programming period, EU funds did not represent an additional funding source for ordinary funds, especially in convergence regions.

The **role of the regional Smart Specialisation Strategy (S3)** also had an impact. Although these strategies were drafted towards the end of the programming period, identifying sectoral priorities in the ERDF 2007-2013 OPs was already influenced by the pioneering design of regional S3. The full synergy between the ERDF and the S3 was ensured when they adopted coherent sectoral priorities. For instance, in Emilia-Romagna, a network of competence centres was created for selected technological fields, which were the same as the specialisation domains identified by the S3. In 2012, the national OP for Research and Competitiveness was revised to reiterate the objective of increasing and better target investments in R&D – in line with a smart specialisation strategy aligning with each region's context. As a result, some strategic measures of the OP were explicitly

[11] *Associazione per lo SVIluppo dell'industria nel MEZzogiorno* (Association for the Development of Industry in the Mezzogiorno)

designed to target identified sectors, apparent anticipation of many of the features of the 2014-2020 programmes.

2.2.2. Linkages between ERDF support for RTD and FP7/Horizon 2020 and other EU Cohesion Policy funds

Support provided by the ERDF in the RTD field was not designed in isolation but envisaging synergies and connections with other European objectives and strategies.

The national OP for Research and Competitiveness complemented **the ESF policies** by funding training activities directly related to the scope of funded RTD projects in line with the principle defined in article 34 of Reg. (EC) 1083/2006. The latter allowed ERDF to fund activities falling within the areas of intervention established by the ESF up to a maximum of 10% of the EU contribution of the Priority Axis, provided it was necessary for the correct execution of the operation and directly linked to it.

Elements of connection were also expected with the **European Framework Programmes (FP) for research**. Both programmes were considered highly relevant for ensuring long term investment in R&D in Italy, as recognised by the 2005-2007 National Programme for Research and by the national and some regional OPs. However, no specific mechanisms of coordination were identified. As a result, the ambition of the 2007-2013 OPs was limited to the so-called **up-stream synergies**: ERDF investments should have enabled subsequent participation in FP actions, but there was no objective to implement projects in continuity (Potì et al., 2009). This may be because the two funds still followed quite different logistical and implementation mechanisms (e.g. modality of selecting the interventions, the object of these interventions).

An example of closer alignment was offered by the regional OP Emilia-Romagna, which included activities that supported the preparation of proposals for FP7 and Horizon 2020. An explicit alignment between the regional OP Emilia-Romagna and the H2020 was sought and implemented through a specific call for tenders launched in 2014. The call was aimed at funding feasibility studies based on research results already achieved by the technopoles and research labs, which could be further expanded in the context of research programmes eligible under the H2020.

In the national OP for Research and Competitiveness, it was expected that ERDF-funded research projects would improve the research capacity of beneficiaries, including increasing participation in the EU research projects. A specific link to the development of the European Research Area (ERA), the main goal of the FP7, was mentioned since the first versions of the OP. Interventions aimed at strengthening research infrastructures were especially expected to increase public research infrastructures' participation in the European Research Area.

Despite the lack of coordination mechanisms and the different objectives of the Framework Programmes and the ERDF OPs, the analysis of participation data to the FP7, H2020, and ERDF projects funded in the field of RTD[12] provided preliminary indications of whether ERDF investments enabled the subsequent participation in FP actions.

It emerged that during the 2007-2013 programming period, only a small percentage of **beneficiaries of ERDF RTD interventions**[13] (around 22.5%) also participated in FP7 projects. Most of them are enterprises (52%), higher education institutions (19%) and Research and Technology Organisations (12%). This small sample represented 8% of the

[12] Information on FP7 beneficiaries was retrieved from the Cordis database, while information on ERDF beneficiaries in the field of RTD from the OpenCoesione platform. Since the format of the VAT code included in Cordis and in OpenCoesione differs, the information included in the two databases was combined manually based on the name of the beneficiary institution. Therefore, the figures presented in this paragraph should be taken with caution. It is not possible to exclude matching errors.

[13] This sample includes all the beneficiaries involved in projects funded by the ERDF under code 01 and 02 by all Italian OPs. The total number of institutions receiving ERDF funding is equal to 877, of which only 196 were involved in FP7 projects.

total Italian FP7 beneficiaries[14] but **implemented more than 41% of the total number of FP7 projects** carried out by Italian FP7 beneficiaries **for a total FP7 contribution of EUR 1.7 billion** (46% of the total contribution to the country). Therefore, on average, each ERDF beneficiary participated in around 25 FP7 projects and received EUR 9.06 billion compared to the average of 3.16 FP7 projects and an FP7 contribution of EUR 931.8 thousand non-ERDF beneficiaries. Nevertheless, a more in-depth analysis of the sample of **institutions** benefitting from ERDF shows that those **located in competitiveness regions** only, or with branches through the country, were on average more successful in both competitiveness and convergence regions than those located in convergence regions only[15].

Having a look at the participation rate in FP7 projects amongst ERDF beneficiaries, data reveal that this rate is generally lower in convergence regions than in competitiveness regions, despite the more substantial amount of ERDF funding mobilised in the latter.

Table 1. Participation rate in FP7 projects amongst ERDF beneficiaries

	Number of beneficiaries of ERDF RTD investments (a)	Number of beneficiaries of ERDF RTD investments also benefitting from the FP7 (b)	Participation rate (b/a)
Funded by Convergence OPs	647	134	20.71%
Funded by both Convergence and Competitiveness OPs	13	10	76.92%
Funded by Competitiveness OPs	217	52	23.96%
Total	**877**	**196**	**22.35%**

Source: own elaboration based on OpenCoesione and Cordis data.

Moreover, while most recipients received funding from convergence OPs, they accounted for only half of the number of FP7 projects and the total FP7 contribution.

Table 2. ERDF beneficiaries participating in FP7 projects by type of OPs from which they received funding

	Number of beneficiaries of ERDF RTD investments also benefitting from the FP7	Number of FP7 projects	Total FP7 contribution
Funded by Convergence OPs	134 (68.4%)	2,309 (46.4%)	877,317,983.44 € (49.9%)
Funded by both Convergence and Competitiveness OPs	10 (5.1%)	1,325 (26.6%)	464,902,051.73 € (26.5%)
Funded by Competitiveness OPs	52 (26.5%)	1,342 (27%)	415,056,489.21 € (23.6%)
Total	**196**	**4,976**	**1,757,276,524.38 €**

Source: own elaboration based on OpenCoesione and Cordis data.

Overall, it was not possible to quantitatively assess whether the ERDF enabled subsequent participation in FP actions. However, looking at a combination of Cordis and OpenCoesione data on the level of participation of ERDF beneficiaries to FP7 and H2020 projects, there is no evidence of increased participation of ERDF recipients in research projects at the European level after the end of the 2007-2013 programming period[16].

Table 3. ERDF beneficiaries participating in FP7 and H2020 projects

	ERDF recipients benefitting also from FP	Number of FP projects	Total FP contribution
FP7	196	4,976	1,757,276,524.38 €
H2020	138	2,915	1,358,924,663.47 €

Source: own elaboration based on OpenCoesione and Cordis data.

[14] From an analysis of Cordis data, the total number of Italian institutions benefitting from FP7 funding is equal to 2,389. These 2,389 institutions were involved in 11,828 FP7 projects for a total contribution of EUR 3.78 billion.

[15] B ERDF beneficiaries funded by both Convergence and Competitiveness OPs are those beneficiaries which have different branches throughout the country, both in Convergence and Competitiveness regions or which have stable headquarters in Competitiveness regions but have decided to invest in Convergence regions under the OP Research and Competitiveness, in light of the interregional dimension of its investments.

[16] The total number of FP7 projects during the period 2007-2013 amounted to 25,581 for a total contribution of EUR 50.7 billion. Instead, the total number of H2020 projects during the period 2014-2020 amounted to 27,017 for a total contribution of EUR 52.5 billion.

2.3. Implementation of ERDF funds for the 2007-2013 period in Italy

With EUR 30.6 billion allocated for its Cohesion Policy (of which EUR 26.2 billion for ERDF), Italy represented one of the largest beneficiaries of ESI Funds for the programming period 2007-2013, after Poland and Spain. During this period, the country designed 21 Regional Operational Programmes, 5 National Programmes and 2 Interregional Programmes, and the European Territorial Cooperation Objective Programmes.

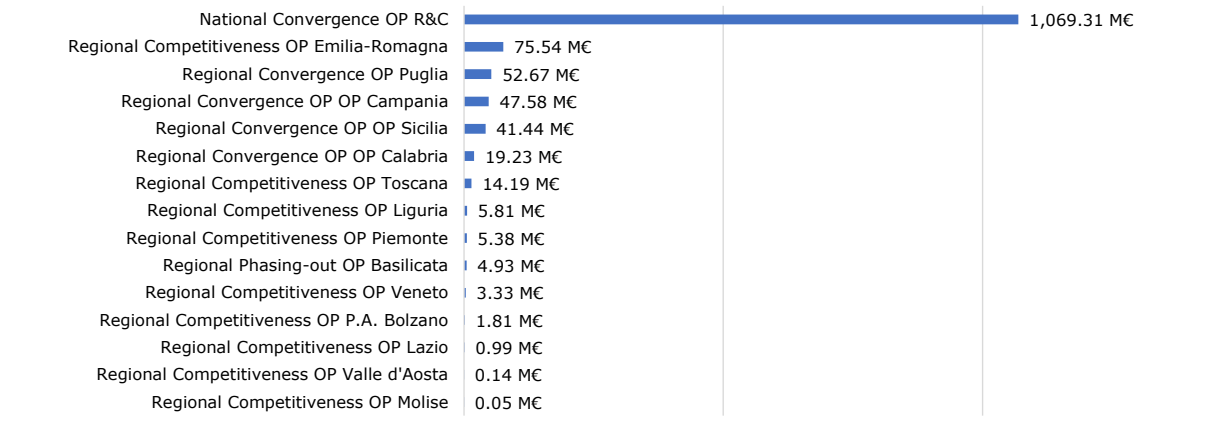
Projects under the categories of expenditure 01 and 02 were funded by the **national OP for Research and Competitiveness** and **14 regional OPs** out of 21[17].

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

The total budget allocated to RTD activities funded under the categories of expenditure 01 and 02 across all Italian OPs during the 2007-2013 programming period, including both the national and the European co-financing, amounted to EUR 2.1 billion, of which 85% was devoted to funding the national convergence OP for Research and Competitiveness[18].

Total certified payments to date correspond to EUR 1.95 billion[19], with the **ERDF contribution** being approximately **EUR 1.3 billion**. As shown in Figure 9, more than 80% of the total ERDF contribution for RTD was concentrated on the national OP R&C targeting the four convergence regions. Considering that the latter also received ERDF funding from the respective regional OPs, the percentage of ERDF funds **in the convergence regions** goes **up to 92% of the total ERDF contribution for RTD**. By contrast, the single region allocating the highest ERDF contribution to RTD investments is Emilia-Romagna, a competitiveness region and one of the most active areas in terms of research and innovation.

Figure 9. Distribution of ERDF funding spent on RTD support in Italy by OP



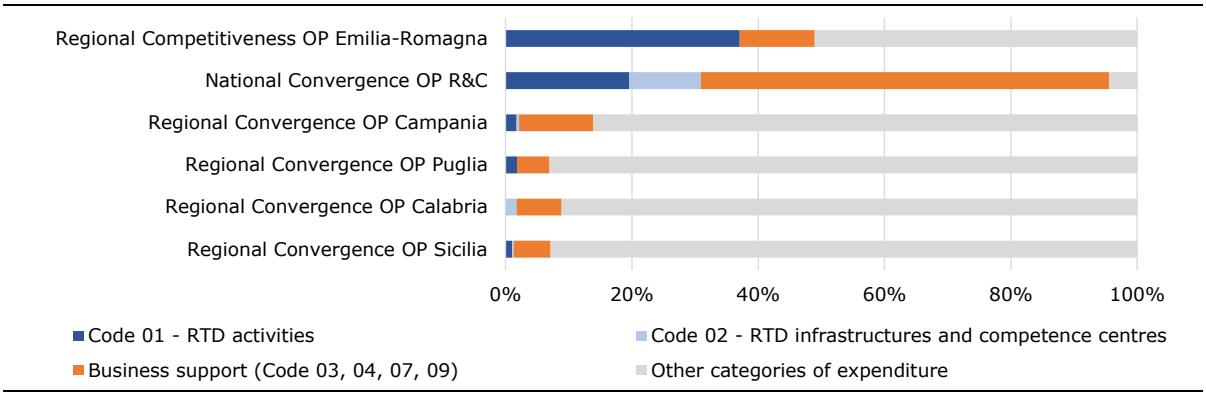
Source: own elaboration based on OpenCoesione data.
Note: financial figures presented correspond to actual payments (latest update on 28th February 2020).

Although the main focus of the present case study is on RTD investments, it should be highlighted that intervention from business support also played a role, particularly in the national OP R&C. Similarly, with regional convergence OPs, the ERDF policy mix sees the

[17] Valle d'Aosta, Piemonte, Liguria, Veneto, Provincia Autonoma di Bolzano, Emilia-Romagna, Toscana, Lazio, Molise, Puglia, Campania, Basilicata, Calabria and Sicilia.
[18] Source: European Commission (2015b).
[19] Source: expenditure data collected in the context of Task 1. Data provided by the Managing Authority on 20th October 2020 show that total certified payment up to July 2020 corresponds to EUR 1.3 billion (including both the national and the European co-financing). However, this figure is slightly below the allocated budget since the OP Research and Competitiveness is not yet administratively closed and payments of final balances for some projects are still in progress following the procedure of suspension of payments. The total amount of payment suspended is of EUR 39.5 million.

predominant role of business support to the detriment of RTD interventions (see Figure 10).

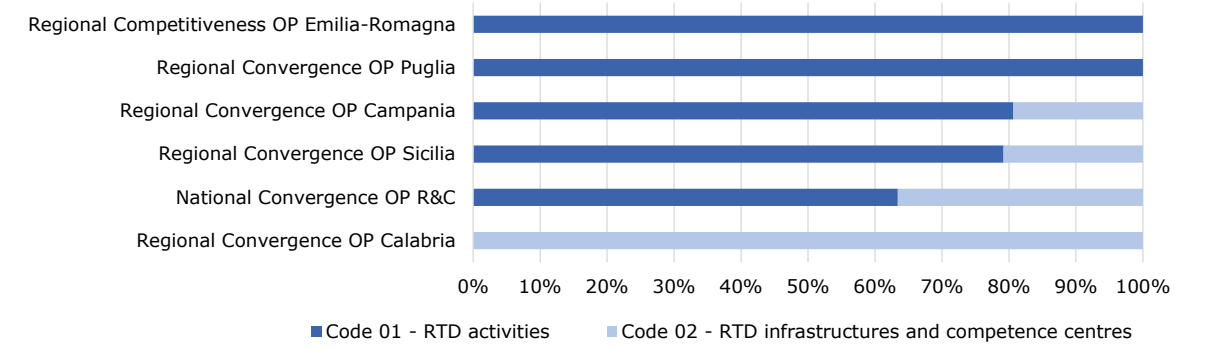
Figure 10. Share of themes in ERDF funding in Italy by OP



Source: own elaboration based on OpenCoesione data.
Note: Values are expressed as a percentage of the total ERDF contribution in the country. OPs are ordered in descending order based on the percentage of 01 and 02 ERDF contribution over the total contribution.

From a preliminary analysis of RTD expenditure, the allocation between RTD activities and RTD infrastructure varies across the national and the regional OPs (see Figure 11).

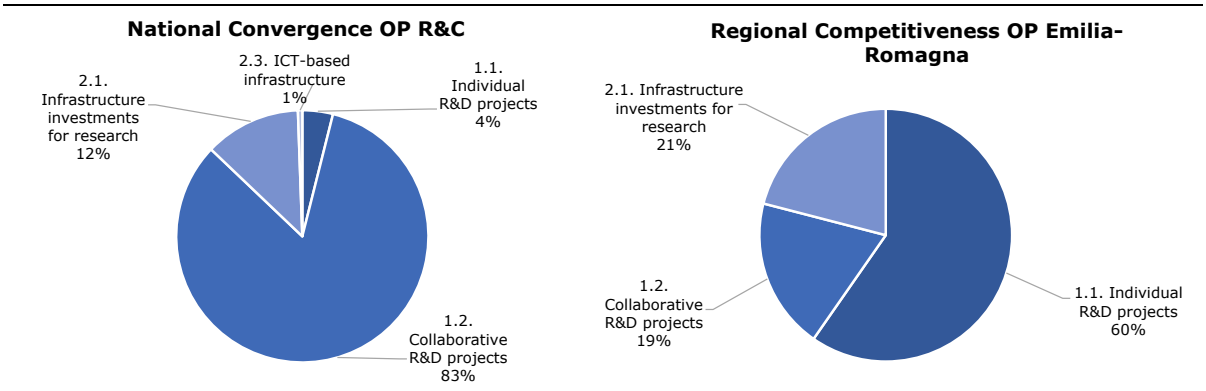
Figure 11. Share of RTD themes in ERDF funding for RTD in Italy by OP



Source: own elaboration based on OpenCoesione data.
Note: Values are expressed as a percentage of the total ERDF contribution to RTD themes in the country. OPs are ordered in descending order based on the percentage of 01 ERDF contribution over the total contribution for the category of expenditure 01 and 02.

The in-depth analysis of Task 1 data on the OPs absorbing almost 90% of the total ERDF RTD contribution (i.e. the national OP R&C and the regional OP Emilia-Romagna) shows that most of the ERDF resources were allocated to individual and collaborative research activities and only to a lesser extent to infrastructure investments for research (see Figure 12). This differs from what is observed in the other Member States, in particular in convergence territories.

Figure 12. Share of ERDF RTD funding across types of intervention (level 2)[20] for the OPs analysed under Task 1



Source: own elaboration based on Task 1 data.
Note: ERDF RTD funding amounts to EUR 1.07 billion for the OP R&C and EUR 75.5 million for the OP Emilia-Romagna.

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

As declared by the strategic approach of the ERDF set out in the 2007-2013 National Strategic Framework in the context of RTD investments, the role of the ERDF consisted of a strong nationally coordinated effort, specifically targeting those regions experiencing the strongest structural weaknesses in the economic and research system, with only a residual part concentrated on more competitive areas presenting some specific problems.

Despite the different rationales at the basis of ERDF support **under the convergence and competitiveness objectives, a similar RTD policy mix was mobilised** in both contexts. The promotion of public-private collaboration and networking was at the core of nearly all OPs investing in RTD, with a lesser focus on infrastructure investments. As a result, **collaborative R&D projects represented the typical intervention** mobilised to build capacities, both in research centres and in industry, and to facilitate their mutual understanding and interaction.

In the OP Emilia-Romagna, the only regional OP in the scope of the analysis carried out in Task 1, collaborative research projects targeted specific competence centres (the so-called technopoles[21]). Such intervention aimed to provide support for a good, but still insufficient, supply of innovative services for industrial (applied) research. Conversely, in the convergence regions, collaboration was mainly supported by promoting collaborative industrial research projects to strengthen public-private cooperation between science and industry actors and in technological clusters. The rationale for such a response drew from the need to consolidate and adapt the regional system of training and research offer spread throughout the territory to the present and future needs of the market.

To a lesser extent, in both Emilia-Romagna and convergence regions, **infrastructure investments for research were also mobilised**, thus responding to a gap in the infrastructural endowment and the need to maximise joint effects through different policies interventions. Although the distribution of universities and research infrastructures was widespread in both competitiveness and convergence regions, a portion of ERDF funding was allocated to such investments to further increase their attractiveness not only at the international level (coherent with the goals of the European Research Area) but also concerning the industry, to lay the groundwork for public-private collaborations.

The rationale for implementing the national convergence OP Research and Competitiveness beyond the regional convergence OPs of Puglia, Campania, Sicilia and Calabria relied on

[20] Under Task 1, policy interventions were classified following a hierarchical approach, made of two different levels: at the first level, three main types of RTD-related interventions were identified, these being 1. R&D projects, 2. Infrastructure investments, 3. Other RTD-related activities; at the second level, the three groups were further classified into a more specific typology, composed of 10 groups. See the First Intermediate Report for further details.

[21] Technopoles are private research infrastructures of consortiums of universities and research labs, with the goal of doing research related to the industrial specialisation of the territory.

the need to promote interregional cooperation. Although responding to the same RTD needs through similar types of intervention, the two types of OPs were intended to promote research activities at different strategic levels in a complementary way. While the regional OPs supported RTD investments with a strong territorial connotation, the national OP was designed to support larger-scale and more ambitious RTD investments with an interregional perspective. Linkages between the two levels have been explicitly sought since the design of the OPs and were reiterated in the context of project calls related to the national OP. In terms of design, a number of criteria to ensure synergy were formulated in the 2007-2013 NSF[22]. As for implementation, synergies were addressed by specific Framework Programme Agreements (see Box 1) stipulated by the central administration with the four regions of the Convergence objective (Accordi di Programma Quadro – APQ).

Box 1. Main features of Framework Programme Agreements (Accordi di Programma Quadro – APQ)

Framework Programme Agreements are one of the tools provided by Italian legislation to define the different competences and activities of the central administration and the regional administrations in the context of those fields on which they can both legislate, such as RTD policy. Specifically, this tool consists of an agreement between the State and the Regions on objectives, sectors and areas in which to carry out interventions for the development of the regional territory by defining:

- The activities and interventions to be carried out, with the times and methods of implementation;
- The necessary financial resources, out of public funds or obtained through private financing;
- The procedures for monitoring the implementation of the investments.

Source: own elaboration based on desk review.

There is a set of explanations for the similar ERDF policy mix for RTD mobilised in both convergence and competitiveness territories and the relatively lower importance of infrastructure investments in the policy mix of convergence OPs compared to other European convergence regions. The first one is that the promotion of **collaborative R&D projects responded to the research system's specificities in these regions**. On the one hand, there was a widespread system of public research institutions and universities, but with a low propensity to link with the industry sector because of cultural barriers. On the other hand, there was a weak industrial system characterised by structural problems and minimal R&D investments. Another element to consider is that public-private collaboration fitted **into the general strategic approach pursued by the national RTD policy** since the end of the 1990s.

[22] The criteria set out in the 2007-2013 NSF includes: the size of the project, also in terms of optimizing the risk profile to sustain; territorial extension of network projects; intervention tools, with particular reference to the dimensions of the investments, to territorial and/or sectorial production specializations; industrial effects induced on production processes, products or services and on local, regional or supra-regional economic development; programme agreements signed between the parties that define the level of responsibility; identification of specific interregional production chains to be enhanced; the endogenous capacity of the territories to attract foreign investments.

3. CONTRIBUTION ANALYSIS OF SELECTED POLICY INSTRUMENTS

As mentioned in the introduction of this report, three policy instruments funded by the OP Research and Competitiveness have been selected for a deep dive analysis. The selected policy instruments are:

- Collaborative science-industry R&D carried out by firms, universities and research organisations under Measure I.1 'Strategic scientific-technological areas';
- Collaborative R&D projects in clusters implemented under Measure I.3.1 'Technological clusters and related networks';
- Infrastructure investments for research in higher education institutions and research and technology organisations under Measure I.4 'Structural reinforcement'.

The analysis of these policy instruments was conducted based on a CA approach, which in turn has been developed on the basis of a ToC defined for each policy instrument. The aim of this chapter is thus threefold:

- To present the OP under which the three policy instruments were funded;
- To present an overview of the policy instrument ToC developed for this evaluation 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 based on the data collected by the evaluation team (primary and secondary) and to provide an assessment of the observed effects as direct results of the ERDF funding and support for the policy instruments, as well as an analysis of the extent to which the overall ToC materialised as initially expected.

Section 3.1 below presents the national OP for Research and Competitiveness under which the policy instruments have been implemented. This overview outlines the rationale of the OP and the policy instrument and its links to other measures and ambitions established by the programme.

The subsequent sections (3.2-3.4) present a comprehensive analysis of each of Italy's selected policy instruments. Each section includes the subsections outlined below.

- The first subsection section presents the Theory of Change of the policy instrument. Theories of Change were developed by the case study team for the purpose of conducting 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 generate such goals. However, it is worth mentioning that the ToCs presented in each chapter present a snapshot of policy-makers intentions at a given point in time. ToCs generally adapt to the realities of specific territories and the acting agents. As such, the ToCs presented here often underwent gradual changes that the case study team tried to reflect both in the design of the ToCs and the final depiction of the ToC testing.
- The second subsection presents the results of the contribution analysis conducted based on the ToC for each instrument. This section explains what happened when the policy instrument was implemented and why and how this happened. The contribution analysis was carried out by assessing the extent to which the different components identified in the ToC actually took place, as well as the extent to which they influenced the effectiveness of the instrument. As such, the contribution analysis assessed each of the elements given below:
- 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 were reached based on the available data. This section also presents any identified intended or unintended results.
- The extent to which activities were implemented according to the intended plans, rules and procedures.
- The extent to which identified pre-conditions took place: this involved assessing whether the necessary pre-conditions actually 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 limited the instrument's effectiveness.
- The combination of the results obtained for each of the previously described assessments led to establishing a contribution claim for the different results observed and verified by the case study team. On this basis, in the third subsection, it was possible to establish one of the following contribution claims for each type 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 for one of the reasons below:
- The activities were not implemented as originally foreseen, or there were flaws in the design of the 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

  The third sub-section is thus structured around each of these elements and the results of their assessment. A final conclusion is provided on each policy instrument which presents the overall results of the contribution analysis and the underlying explanation of this result.

3.1. Operational Programme for Research and Competitiveness

3.1.1. The strategic approach and the RTD policy mix mobilised under the OP

The 2007-2013 Operational Programme for Research and Competitiveness is the result of several initiatives adopted in the context of the national RTD policy framework:

- The legislative decree 297/1999 which for the first time introduced the possibility of carrying out industrial research projects in collaboration;
- The promotion of technological clusters (i.e. territorial agglomeration of firms, universities, public research organisations and institutions) from the beginning of the 2000s;
- The 2000-2006 OP for Research, which focused on the promotion of science and industry collaboration in the context of research projects in specific strategic sectors[23].

In previous programming periods, RTD interventions' main target was the public research system, both in terms of infrastructure and research projects. However, in 2007 there was a shift towards targeting industry. The aim was to address the issue that the university system and public research were considered self-referential.

The goal of improving the performance of convergence regions in terms of firms and territory competitiveness was pursued by mobilising a wide variety of policy instruments, including RTD activities and research infrastructures and broader support for the development of innovative environments and activities. As a result, the OP involved two central administrations' institutional competences: the Ministry for Education, University and Research (MIUR), in the role of the Managing Authority, and the Ministry of Economic Development (MiSE), in the role of Intermediate Body. While the former was responsible for interventions focused on the upstream phase of industrial research production, the latter dealt with business innovation's support more focused on the downstream stage of experimental development.

[23] This intervention was promoted under Measure I.3 'Research and development in strategic sectors for the South'.

An initial total allocated budget of EUR 6.2 billion was devoted to funding both MIUR and MiSE interventions, of which EUR 2.9 billion was specifically aimed at funding RTD interventions[24]. However, during implementation, the 2012 reprogramming action reduced the OP total budget to EUR 4.4 billion and the 2015 reprogramming action to EUR 4.1 billion, thus decreasing the overall allocation for RTD investments to EUR 2.04 billion in 2012 and EUR 2.01 billion in 2015[25]. The total OP budget reduction was introduced explicitly to redirect resources to the Cohesion Action Plan (Piano di Azione e Coesione - PAC) designed after the economic crisis to accelerate EU funds' absorption (see Box 2). Instead, the reduction of the OP total budget for RTD was linked to a financial restructuring between Priority Axes. Funds were displaced from Priority Axis I and III to Priority Axis II, favouring business support and innovation interventions.

Box 2. The Cohesion Action Plan

The Cohesion Action Plan was designed in November 2011 with the aim of overcoming the delays characterising the use of ESI funds. By defining a strategic action to relaunch southern regions on four priority areas of national strategic interest (i.e. education, digital agenda, employment, railway infrastructure), the Plan gave propulsion to investments that were seriously delayed under ESIF management. The Cohesion Action Plan determined a re-modulation between European and national resources for a total of EUR 12.1 billion. As far as the national OP Research and Competitiveness 2007-2013 is concerned, a total of EUR 1.78 billion was finally transferred to the Plan.

Source: own elaboration based on the OP database http://www.ponrec.it/

In 2013, 2014, and 2015, the OP underwent three other reprogramming actions that were mainly targeted at increasing the ERDF co-financing rate. To date, certified payments amount to EUR 1.42 billion (71% of the total initial allocation) of which EUR 1.07 billion correspond to ERDF co-financing. However, this figure is not definitive since the OP is not yet administratively closed.

As mentioned above, to reduce the gap between competitiveness and convergence regions, **the OP primarily promoted collaborative R&D research projects with an interregional dimension.** These were funded under three different measures targeted at specific types of beneficiaries:

- Measure I.1 'Strategic scientific and technological areas' supported industrial research activities mainly fostering the creation of partnerships amongst businesses as well as between science and industry actors;
- Measure I.3.1 'Technological clusters and related networks' supported the creation of territorial agglomerations of science, industry and institutional actors as well as existing technological clusters by funding research activities;
- Measure II.3 'Integrated actions for the sustainable development and dissemination of the information society' fostered collaboration combining project proposals submitted by individual beneficiaries and responding to specific needs of a local community identified ex-ante, following a logic similar to public procurement.

To a lesser extent, the OP also promoted **infrastructure investments** in public universities and research organisations, supported under Measure I.4 'Structural reinforcement', with the ultimate goal of laying the groundwork for public-private collaborations. Finally, individual R&D activities and ICT-investments accounted for less than 5% of the total ERDF expenditure for RTD.

Evidence indicates that RTD support was characterised by a top-down approach. Instruments were mainly driven by research offer, thus informed by the availability of, or gaps in, support services and infrastructure. However, Measure II.3 was an exception and

[24] These figures include both the national and the European co-financing and are retrieved from the first version of the OP.

[25] Source: 2012 OP revision and Final Implementation Report. The overall allocation to RTD (category of expenditure 01 and 02) declared in the latter amounted to EUR 1.05 billion. However, this figure did not include the amount of payments suspended under Priority Axis I (equal to EUR 960 million).

implemented instead in a bottom-up mode by implementing collaborative R&D projects responding to the specific needs of the territory expressed by local stakeholders.

While the three different policy instruments designed for collaborative R&D were conceived as independent from one another, **joint effects between collaborative measures and infrastructure investments** were advocated in the OP documents. The modernisation of existing public research infrastructures should have increased their attractiveness in an interregional and international perspective and therefore improved their participation in public-private partnerships. Altogether, the measures aimed for consolidated collaboration networks by promoting interregional investments. This completed the actions already pursued by the regional OPs, characterised by the local dimension only.

Building on the experience of previous programming periods, **all types of interventions for RTD also included a training component**, following the experience of the 2000-2006 programming period, which had shown the importance of the link between the promotion of RTD and human capital and skills. As a result, training activities could also be funded by the ERDF through the application of the principle of complementarity between ESI Funds[26] (see Subsection 2.2.2).

3.1.2. The implementation of the OP

The OP's implementation was affected by the emergence of several issues concerning both the designed strategic approach and more operational aspects. They played a crucial role in the selected instruments' performance, as explained later in the contribution analyses.

To begin with, the ambition of the OP to promote RTD policy instruments in different convergence regions called for the establishment of a functioning **multi-level governance approach**. In this respect, Framework Programme Agreements with the four convergence regions were signed in July 2009 to define the division of competences, interventions, and financial resources among the central and the regional administrations. According to interviews, the coordination between national and regional programmes did not always work in an expected way. The result was some overlap of interventions implemented within regional programmes with those implemented at the national level. This was partly due to the unclear division of competences between the State and the regions in the RTD field, already highlighted in Subsection 2.2.1. As a result, there was some confusion among the beneficiaries in terms of types of resources available, as well as a substantial risk of opportunistic behaviour (e.g. beneficiaries selecting the most appealing call for projects based on convenience of timing or aid intensity, rather than the nature and logic of the project).

Administrative capacity issues severely affected the implementation of the OP. The Managing Authority's administrative capacity did not match the ambition of the programme: the MA seemed severely understaffed to meet the significant number of projects and activities tasked to the central administration. According to interviews, the selection and implementation of projects were carried out by affiliated banking institutions during previous programming periods. Following the Commission services' request to keep stronger ownership on the selection procedures, in the 2007-2013 programming period, the entire set of activities for the implementation of projects was internalised within the central administration, without a parallel adjustment to the Managing Authority staffing level. Interviews confirmed that when the programme was under implementation, out of almost one hundred people involved in the day-to-day management of the OP, fewer than 10% were internal staff of the Ministry. At the same time, the remaining were external consultants from Technical Assistance Services. Despite the dominant presence of Technical Assistance experts, the decision-making roles on all administrative acts remained with a limited number of internal staff of the Ministry, creating bottlenecks in implementing demanding procedures for administrative controls and disbursements and contract management.

[26] See art. 34 of Reg. (EC) 1083/2006.

In such a context, several deficiencies in the management and control system, with suspicion of illegalities, were also subject to investigations by the Italian judiciary system (see Box 3).

Box 3. Judicial investigations on RTD interventions mobilised by the OP

Judicial investigations regarding some of the RTD policy instruments mobilised by the OP started after a leak in November 2012. As reported by the media, an anonymous person, probably a permanent official of the central administration, subsequently named 'The crow', sent to a national newspaper a dossier of a hundred pages reporting some irregularities identified in investigations by the State's General Accounting Department. The latter had been launched in November 2011 upon the request of the Minister of Public Education.

The article published in the newspaper immediately raised the Italian judiciary's interest, who started investigating the use of European Funds in convergence regions. The accusations ranged from bid-rigging to abuse of office and fiscal damage. More specifically, investigations related to some of the procedures activated by MIUR:

- The invitation to tender for the submission of industrial research projects (January 2010);
- 14 projects under the invitation to tender for structural strengthening (May 2011);
- two acts of the Technical Assistance contract.

Problems in the procedures for the selection of operations were identified concerning the invitation to tender for the submission of industrial research projects issued in January 2010:

- The selection of experts for the evaluation of funding applications, which did not comply with the principle of transparency set out in the call for applications and the national legislation;
- The assessment of the funding applications was not carried out according to the procedure defined by the call for applications (i.e. on-the-spot visit not undertaken).

Audit authorities identified **irregularities in the framework of the management verifications** in four out of the eight operations. This meant that the projected error rate was about 4.73% (vs 2% foreseen in Annex IV of Regulation (EC) No 1828/2006).

The judicial investigation was followed by an audit report by the European and the Italian Court of Auditors and the European Anti-Fraud Office (OLAF). Audit authorities identified irregularities in the framework of the management verifications in four out of the eight operations. This meant that the projected error rate was about 4.73% (vs 2% foreseen in Annex IV of Regulation (EC) No 1828/2006). The judicial proceedings were finally dismissed and acquitted through the procedure N.56860/14 RGNR, with the verdict's announcement on 23rd May 2017, and the procedure RGNR5756/15, which declared all suspects innocent. However, the sentence could not ascertain whether the administrative documents and controls were valid. As a result, an additional internal control procedure was launched.

Source: Desk review of newspaper articles.

Following the investigations' launch, a Letter of Interruption of Payments of the European Commission accepted the MA's request to suspend payments in light of the deficiencies affecting the procedures for the selection of operations and the management controls under judicial investigations. These deficiencies mainly related to the procedure for the selection of operations and the management verifications. Examples include conflicts of interest, lack of evaluation procedures, and administrative controls identified in the selection procedures of some calls for projects.

Following the judicial inspections, the MA director resigned, and six months elapsed before a new director was appointed. As a consequence of the general atmosphere of inspection, a high degree of caution characterised the MA's activities. For quite some time, implementation was delayed due to the administration's reluctance to sign payment authorizations, derogations from the time-schedule, project changes, etc.

It should also be noted that the Managing Authority of the OP underwent several institutional changes over the 2007-2013 programming period, for a total of 5 different Ministries of Public Education, 3 Directors General within the Ministry, and 3 Directors of the Managing Authority. As a result, political-institutional discontinuity further sharpened difficulties in implementing the OP, slowing down administrative procedures.

As a result, as late as June 2017, the Final Implementation Report highlighted that suspended payments amounted to a total of EUR 960.8 million[27]. The OP suffered from a low absorption of funds and payment delays during implementation. For these reasons, the OP is still not closed from a financial and administrative perspective. As of July 2020, the suspended payments related to RTD intervention still amounted to EUR 39.5 million[28]. According to the Managing Authority, the final closure is expected only once the audit activities have been carried out[29].

The 2013 mid-term evaluation by InnovItalia (2013) provided evidence on the initial implementation phase of the OP. By highlighting the significant effects of the economic crisis, this evaluation mainly identified implementation issues. Although the interventions mobilised were highly appreciated by companies, as evidenced by the high number of applications received, operations suffered from reduced disbursements, payment delays and the limited number of completed interventions.

3.2. Policy instrument: Collaborative science-industry R&D projects under the OP R&C

3.2.1. Theory of change of the policy instrument

Collaborative science-industry R&D projects under the OP R&C were funded through non-reimbursable grants by invitation to tender for the submission of industrial research projects issued in January 2010[30]. The initial total budget of EUR 465 million[31] was intended to subsidise:

- **Industrial research projects**, also including experimental development activities, promoted by firms located in convergence regions either individually or in collaboration with other institutions[32];
- Related training activities[33].

According to the MA, the policy instrument was purposely designed as a shift away from previous RTD support interventions funded during the 2000-2006 programming period, with the main target shifting from universities to businesses. The previous approach privileged research projects promoted by universities in collaboration with industry, but, according to interviewees, research projects reflected more the research interests of research providers (universities) than those of the users (industrial partners). As a result, during 2007-2013, companies became the primary target of interventions, with universities being instrumental only for potential collaboration activities.

Unlike projects implemented by regional programmes, this intervention was intended to support excellent research projects with high scientific ambitions, aiming for the technological upgrading of beneficiaries and target territories, with national or supra-regional relevance and a greater level of risks on a larger financial scale. To trigger these wider effects, **nine target scientific-technological areas** were identified as strategic in the Framework Programmes Agreements (Accordi di Programma Quadro - APQ) signed with the four convergence regions. These areas included ICT, advanced materials, energy and energy-saving, human health and biotechnology, agri-food system, aerospace and aeronautics, cultural heritage, transportation and advanced logistics, and environment and safety.

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[27] Rapporto Finale di Esecuzione (June 2017), page 16.
[28] Data reported by the MA on 20th October 2020.
[29] Although the MA will close all administrative procedures related to certification of expenditures in July 2020, the OP's closure will be approved only once the audit activities have been carried out. As of July 2020, the MA expected the closure of audit activities by the end of 2020.
[30] Decreto Direttoriale n. 1/Ric. (18th January 2010).
[31] Including both the national and the European co-financing.
[32] Of a maximum duration of 36 months.
[33] Of a maximum duration of 12 months.

Support to collaborative science-industry R&D projects was therefore provided based on **three main pre-conditions**, in line with the existing literature: the existence of local demand for research activities, beneficiaries awareness of their R&D priorities and capacity to prepare and submit a research project proposal. R&D projects aiming at technological advances were the direct result of a three-step competitive selection procedure[34]by a selection committee, different for each scientific-technological area, composed of independent scientific experts, such as academics, previously selected by the Ministry[35]. Only project proposals with a minimum final score were admitted to co-financing.

As a result of the multi-level governance that characterised the OP's design and implementation, the budget was pre-allocated across the four convergence regions[36] to ensure a balanced distribution of ERDF resources across the different regions, including weaker ones. Although this was in line with the territorial Convergence objective and reflected each region's potential, some interviewees pointed out that it was somehow in contrast with the ambition of scientific excellence.

Eligible projects were submitted by firms, research centres, consortia, or science and technology parks with a stable location in convergence regions, in collaboration between these or with universities or public research centres. Beneficiaries from non-convergence regions could also submit a proposal but had to commit to locating their organisation in target areas for the project activities and for at least five years after the actual conclusion of the project. Ideally, the research project should have been initiated in the first instance by a private actor, which, if necessary, could also involve public actors in the project. However, no specific requirement was set on the lead beneficiary's nature, which could be either a firm or a university or a research centre. More specifically, **three types of** (non-mutually exclusive) **collaboration** were strongly encouraged by the call:

- Among firms, provided that the partnership included at least an SME[37];
- Science-industry collaboration[38];
- Among convergence regions and also with competitiveness regions[39] in line with the interregional vocation of the OP.

One of the purposes of the instrument was to support the technological upgrades of existing local productive specialisation in the target territories. In this respect, the intervention provided for the possibility to fund the so-called 'constellation projects', groups of independent projects sharing a common technological ambition in a specific sector or supply chain[40]. Beyond favouring collaboration between different actors, these projects were expected, if implemented in connection, to foster more ambitious research investments closer to the technological frontier and able to support in a significant way the upgrading of target sectors of supply chains.

[34] A preliminary phase assessing the completeness of the project documentation; a first evaluation phase assessing the quality of the beneficiaries in terms of competences and of projects in terms of technical and scientific potential and sustainability; a second evaluation phase of the potential results.

[35] The panel of experts was selected according to Article 7 of the Legislative Decree 297/1999.

[36] The budget was split as follows: Calabria EUR 80 million, Campania EUR 145 million, Puglia EUR 150 million and Sicilia EUR 90 million.

[37] Collaboration between firms was promoted through the increase in the intensity of the aid gross grant equivalent. The latter, generally consisting in an intensity up to 80%, was increased by 15% if the project implied collaboration between at least two different private actors.

[38] Science-industry collaborations were promoted through the increase in the intensity of the aid gross grant equivalent as well in the score assigned to the project. The aid intensity, generally consisting in an intensity up to 80%, was increased by 15% if the project implied collaboration between at least two different private actors. The score was instead increased if the project was able to foster collaboration with universities and/or public research centres.

[39] Operations may also provide for the performance of activities carried out outside the convergence territory, for an amount not exceeding 25% of the total cost of the research project.

[40] For constellations projects, the participation of SMEs for at least 35% of the costs estimated and deemed eligible for the research project was mandatory. Moreover, a beneficiary could be involved in no more than two projects within the same constellation and no more than three constellations.

With the ultimate aim **of improving beneficiaries' competitiveness**, the policy instrument was intended to have **three levels of intended results** and related causal chains characterise the expected outcomes from the provision of this support:

- Knowledge creation and innovation;
- Skills development;
- Knowledge transfer and network consolidation.

Knowledge creation and innovation

Collaborative science-industry R&D projects were to be funded with the primary objective of **increasing scientific-technological knowledge/know-how** in beneficiaries so that they could exploit research results by developing innovative products, processes and/or services. In this respect, only the typical research project risks (e.g. project does not lead to new knowledge, or not to a useful extent for further exploitation) could prevent beneficiaries from achieving such an outcome.

R&D activities could help beneficiaries acquire scientific and technological knowledge only if **implemented timely and with result orientation**. To this end, the call foresaw that private beneficiaries received an immediate pre-financing equal to 50% of the total eligible project cost after the conclusion of the contract and the presentation of a bank guarantee[41]. Further disbursements were then granted based on the amounts reported and certified every six months, following the outcome of a set of technical and administrative controls. The achievement of intermediate objectives was, therefore, a condition for the project to continue. In collaborative projects, the advance and subsequent co-financing tranches were disbursed to each co-proposer[42] based on periodic reporting. In this respect, beneficiaries with stronger economic and financial capacity and stability could better cope with intermediate payments and co-financing by relying on their resources. Also, well-managed projects could better cope with the need to show systematic signs of progress towards expected results.

Risks of opportunistic behaviour within partnerships were considered a potential hindrance to the realisation of good quality projects. In light of the higher aid intensity and score granted to collaborative research projects, there was an incentive to include universities or research centres in the project application to maximise the probability of being selected. This risk also concerned the above-mentioned 'constellation projects'. The mandatory participation of SMEs for at least 35% of the total eligible project costs could induce their involvement in partnerships with little consideration of the actual relevance for the project activities.

As evidenced in the literature review included in the First Intermediate Report of this evaluation, collaborative R&D projects suffer from an inherent risk of lack of coordination within partnerships, especially larger ones and in those territories with a less mature tradition of collaboration. The lack of a common research agenda and mutual trust among some partners, for instance, could jeopardise the open and constructive sharing of knowledge required to carry out the research activity according to common objectives.

The intention of the policymakers, if appropriately exploited, was that project results would help beneficiary firms **achieve a technological upgrade and a competitive advantage** in their specific sector of operation, with a level of ambition that would not have been possible without public support.

[41] The amount of the bank guarantee is a function of the total cost of the project (including the cost of industrial research, experimental development and training activities).

[42] The legislative tool implementing the scheme, Law 297/1999, required each co-proposer to enter into an individual grant agreement with the grant provider, instead of a lead partner managing the financial and contractual arrangements on behalf of the entire partnership, as is the case for other grant schemes, for example under H2020. As it will be discussed later, this arrangement introduced an element of complexity and additional burden with implications in terms of smooth implementation.

The beneficiaries' ability to implement follow-up investments with a strategic approach was considered a factor further contributing to the achievement of competitive advantage. However, it was acknowledged that other social, political and economic factors could play a role in this context by either accompanying or hindering the possibility to trigger a broader socio-economic development process.

Beyond the direct effects on beneficiaries, the intervention in conjunction with the other types of intervention mobilised under Priority Axis I[43] was expected to improve convergence regions' competitiveness and society's health and quality of life overall.

Skills development

Another level of expected results concerned skills development. The call for projects was designed in complementarity **with ESF activities**: ERDF was expected to fund also the mandatory training activities expected to absorb between 5% and 15% of the total project cost.

Training activities were conceived to develop specific technical skills in the sector affected by the project and **develop skills and competences related to business problems** (e.g. management of the research activity and transfer of technologies) of the researchers involved in the project. The idea was that trained researchers should contribute to the product, process or service innovation funded by the research project[44].

The ultimate aim was to **increase the number of researchers employed in the industry**. This meant that training activities should be designed to properly combine the labour demand with the labour supply in terms of high-qualified employees and researchers.

Knowledge transfer and network consolidation

By promoting collaborative R&D projects, the call pursued the objective to encourage a **profitable exchange of knowledge** from research centres to firms, from large enterprises to SMEs, and from competitiveness to convergence regions, and improve the propensity to collaborate in the long term.

In this respect, **previous collaboration experiences could favour a knowledge transfer mechanism** in light of the existing mutual trust among beneficiaries who were already used to cooperation. Selected projects were therefore expected to strengthen collaboration networks and promote stable collaboration between partners. However, since no constraint was defined in terms of the partnership's size, there were also problems in managing partnerships, especially larger ones. For instance, some beneficiaries could decide not to share knowledge and competences with other partners, potentially competing in the same market.

The intervention was not supposed to work in isolation. **Synergies and complementarities with other (i.e. regional OPs) support measures** were expected to further contribute to fostering the established stable platforms of collaboration, especially in specific production chains. Provided that funds were available for follow-up investments, firms could further engage in research activities and benefit from the technological upgrading and consequent competitive repositioning.

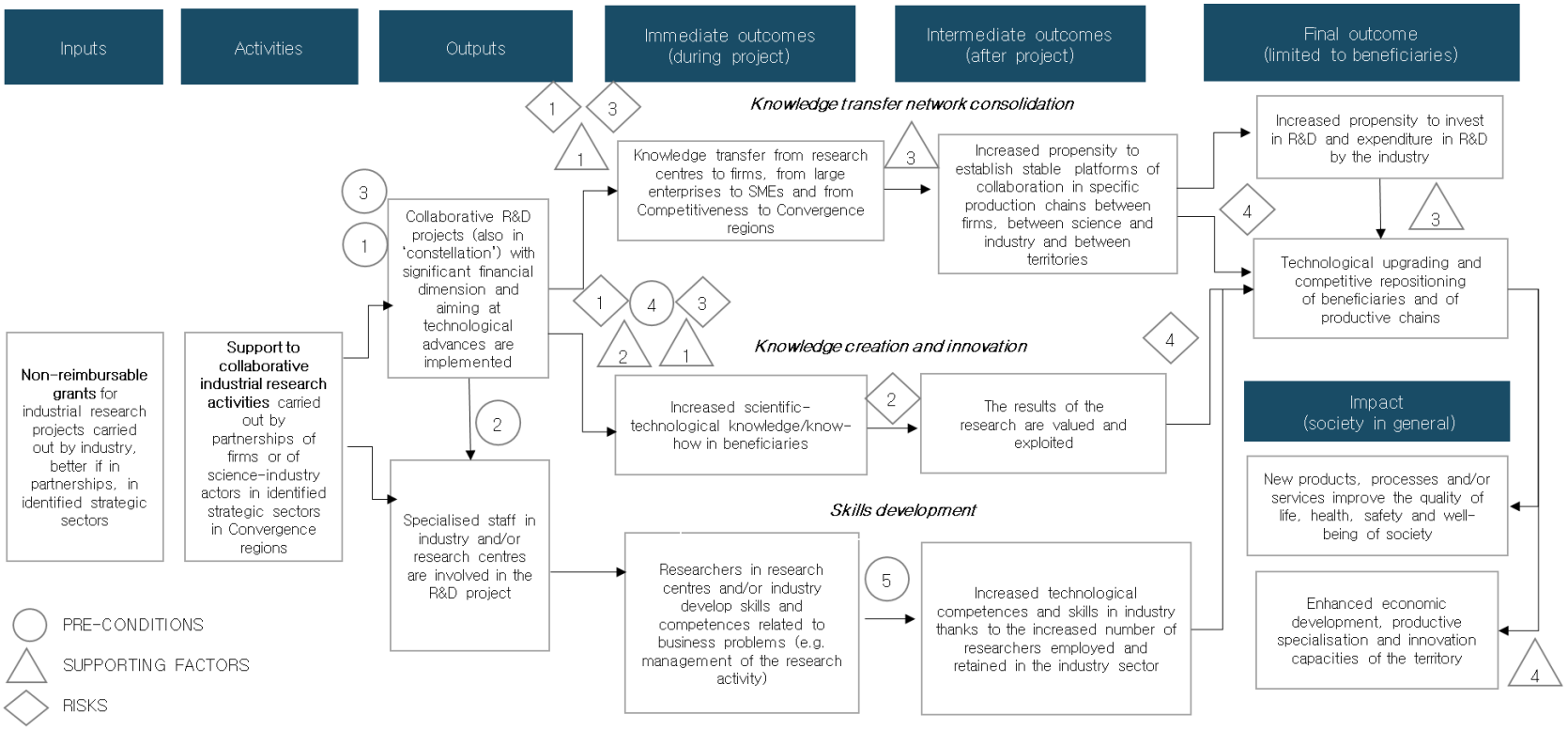
[43] Priority Axis I "Support for structural changes" includes the three policy instruments under assessment as well as policy interventions supporting business innovation.

[44] The training course that was proposed must comply with the characteristics explained by the Ministerial Decree 593/2000 which provides that these paths are structured as follows:

- A module A (equal to 25% of the total cost) for theoretical learning to be compulsorily done at public research facilities;
- A module B for company support;
- A module C for learning programming and strategic management.

The emerging ToC is provided in Figure 13 and illustrates the policy instrument's intended effects, the underpinning pre-conditions, contributing factors, and potential risks and threats, along with the identified three levels of effects. The nature and strength of the causal links illustrated in the reconstructed ToC have been tested as part of the contribution analysis, the results of which are presented in later sections of this case study.

Figure 13. ToC for Collaborative science-industry R&D projects



Source: Own elaboration based on primary and secondary data collected

3.2.2. Contribution analysis

Verification of intended intervention implementation

Although the OP underwent several reprogramming actions, the policy instrument's logic for collaborative R&D projects remained unchanged throughout the programming period. The requirements underlying the rationale and goals set out in the invitation to tender were not altered during the implementation phase.

Funding was distributed through an open call issued in January 2010 aspiring to select innovative R&D projects, especially collaborative, in pre-identified strategic sectors and implemented in convergence regions along with related training activities. The selection process was, however, long and problematic, as already described in Subsection 3.1.2.

The intervention managed to generate a significant number of R&D projects proposals of a large financial scale. After the launch of the call, by April 2010, 533 applications were submitted for a total of EUR 6 billion (over ten times the resources made available by the call for projects) and including 128 projects organised in 33 'constellations' (see above).

As a result of the competitive selection procedure, the first ranking released in May 2011 identified 146 research projects to be funded and an additional 50 projects eligible for financing for a total of more than EUR 1 billion[45]. Since it was possible to increase the total budget of the intervention in case of need, a further allocation of EUR 535 million was approved, in addition to the EUR 465 million initially made available[46].

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

The policy instrument supported a significant number of industrial collaborative research projects with high scientific ambitions. Among industrial players, a crucial role was played by large enterprises, representing almost half of beneficiary enterprises. Not all ambitions were met, however. At the same time, evidence points to relevant immediate outcomes, especially in terms of knowledge creation and skills development; intermediate and final outcome were much more limited.

The determination to support R&D projects for a total of EUR 1 billion has only been partially met, although no specific threshold was defined for the number or budget of collaborative R&D projects. The number of collaborative projects funded to date is equal to 157 R&D projects, of which 15 are components of projects selected during the 2000-2006 programming period but implemented and funded after the administrative closure of the OP for Research 2000-2006[47]. To date, administrative payments for both individual and collaborative R&D projects amount to a total of more than EUR 560.3 million (including both the national and the European co-financing)[48], a figure lower than the total allocated budget. This difference can be attributed to the fact that the OP is not yet administratively closed. As confirmed by the MA, administrative, accounting, and technical-scientific checks on reported expenses are still in progress.

Moreover, it should also be noted that reprogramming actions reduced the total budget allocated to RTD interventions (see Sub-section 3.1.1). However, the difference also stems from a decrease in commitments due to beneficiaries and projects' withdrawal or revocation. Beneficiaries' withdrawals, although not quantified, were highlighted in the Final Implementation Report (June 2017). On project revocation, the Managing Authority

[45] Source: Annual Implementation Report 2012.
[46] Decreto Direttoriale n. 255/Ric. (18th May 2011).
[47] Source: OpenCoesione. The data are not definitive. As confirmed by the Managing Authority, monitoring data may be subject to variation considering that the OP is not yet administratively closed.
[48] Source: expenditure data collected in the context of Task 1 (with a cut-off date of 28th February 2020). Data provided by the Managing Authority on 20th October 2020 show that total certified payment up to July 2020 corresponds to EUR 575.3 million (including both the national and the European co-financing) and that a total of EUR 14.9 million under measure I.1 are still under suspension. The data are not definitive, since the operational programme has not yet been concluded and disbursements are still ongoing.

confirmed that 14 approved projects were suspended during implementation. This figure is not definitive since there is evidence of ongoing legal appeals that may increase non-concluded projects.

In line with the call's objective to promote collaboration between science and industry actors, among the 157 funded collaborative projects, science-industry partnerships represent the primary type of cooperation with a total of 142 projects (see Table 4). In this respect, interviewees pointed out that project ideas were generally the result of interactions between enterprises and research organisations. Although the focus of this specific intervention was on firms, the significant role of science-industry collaboration reflects the importance of research organisations in implementing the research results. As confirmed by interviews, the project idea was generally originated by the research provider's initiative on a topic considered relevant for the industry.

Table 4. Breakdown of funded projects by type of policy instrument and beneficiaries

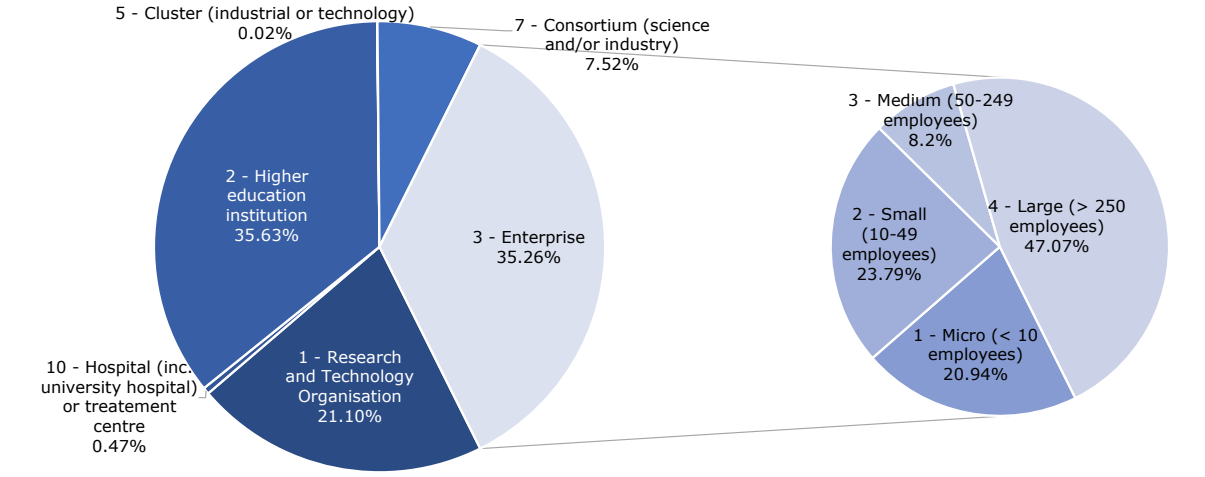
	Number of projects	Sum of ERDF contribution
1.1. Individual R&D projects	**14**	**6,186,778.70 €**
a. In higher education institution	1	118,842.00 €
b. In Research and Technology Organisation	1	
h. Others	1	166,991.90 €
i. In enterprises	11	5,900,944.79 €
1.2. Collaborative R&D projects	**157**	**414,108,844.29 €**
a. In higher education institution	1	619,650.00 €
a/b. In higher education institution and Research and Technology Organisation	1	1,674,901.97 €
d. Science-industry	142	389,151,880.24 €
e. In clusters	4	7,116,666.68 €
f. In science and technology parks	6	7,635,156.92 €
h. Others	1	5,660,124.64 €
i. In enterprises	2	2,250,463.85 €
Total	**171**	**420,295,622.99 €**

Source: own elaboration based on Task 1 data.

The analysis of the types of beneficiaries of collaborative science-industry R&D projects receiving the highest ERDF contribution confirmed the comparative importance of universities, research organisations and enterprises (see Figure 14), especially larger ones such as Fiat Chrysler Automobiles Italy SpA, Selex ES SpA[49], Poste Italiane and ST Microelectronics Srl.

[49] This firm was merged in 2015 into into Finmeccanica S.p.A. (today Leonardo).

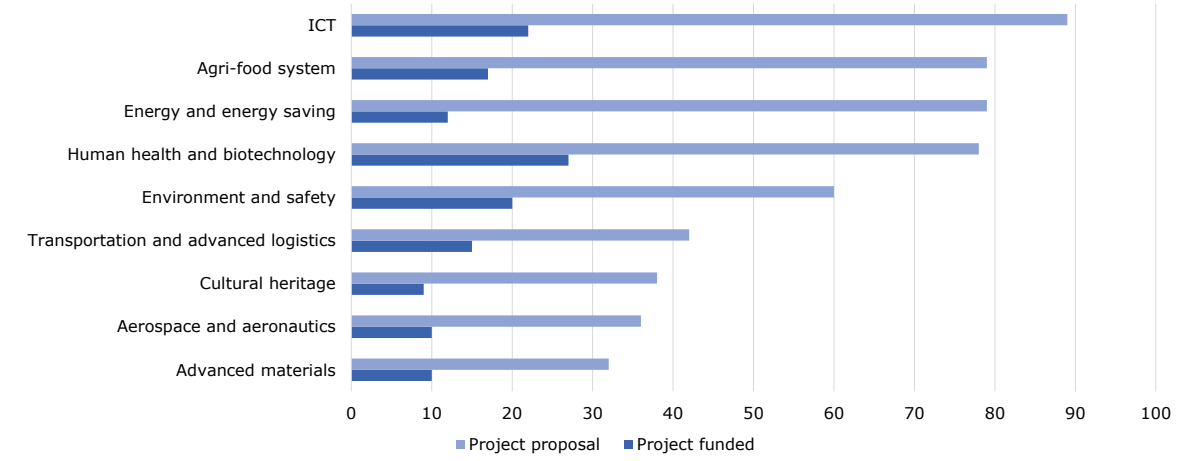
Figure 14. Share of ERDF contribution by type of beneficiary



Source: own elaboration based on Task 1 data.
Note: data refer to the 142 collaborative R&D projects in science-industry.

The objective of funding R&D projects with a significant financial dimension and aiming at technological advances was achieved. The average cost of project proposals was roughly EUR 9 million. This figure may suggest that projects were ambitious in all the nine scientific-technological sectors identified in the call.

Figure 15. Breakdown of project proposals and project funded by type of technological sector



Source: data concerning the project proposal a presentation of the PON R&C website (http://www.ponrec.it/), while data concerning the projects funded stems from the 2014 ranking.
Note: data for projects funded refer to 142 collaborative projects and exclude projects from the previous programming period.

Effects on knowledge creation and innovation

Implemented projects achieved the result of increasing the knowledge of beneficiary companies and research partners in most cases (immediate outcome). Publications and innovation outputs are reported in the final technical and scientific report produced by the beneficiaries and from the technical-scientific experts' monitoring reports[50]. Such results, however, translated into innovative products and processes only in a limited number of cases.

Core and common achievement indicators are available at the Priority Axis level. Nevertheless, considering that a significant portion of the Priority Axis budget for research projects was devoted to the funding of the OP measure under evaluation, a substantial part of the results reported is probably due to the measure itself and can be considered as

[50] The evaluation team had no access to these documents, and no follow-up reports are available on concluded projects.

a starting point for an assessment on achievements (for more details, see ANNEX IV). Interviews with programme managers and direct beneficiaries also provided anecdotal evidence on the effects of some projects and the mechanisms leading to these results' achievement. Moreover, a counterfactual impact evaluation was carried out by Crescenzi et al. (2018), shedding light on the long-term performance of firms involved in the collaborative R&D projects (see Box 4). Finally, aggregate data on regional indicators measure firms' overall research and innovation performance in target regions.

Box 4. A counterfactual impact evaluation

The SERC[51] discussion paper 'Cohesion Policy Incentives for Collaborative Industrial Research. The Evaluation of a Smart Specialisation Forerunner Programme' by Crescenzi, de Blasio and Giua, published in 2018, presents the results of a counterfactual evaluation of the Collaborative Research Programme funded under the OP Research and Competitiveness during the 2007-2013 programming period. By taking advantage of the scoring system assigned to individual applicant firms during the selection procedure of project applications, and the cut-off value defined for accessing financing, the evaluation applies **Regression Discontinuity Design (RDD) techniques** to investigate the causal impact of the intervention on firm performance. More specifically, the sample is represented by firms not receiving additional confounding sources of funding which were ranked above and below this cut-off value, in light of their similar performance.

The evaluation relies on firms-level data extracted from the official database of the intervention (named SIRIO), from CERVED (a database with firm-level budget data), from INPS (National Institute for Social Security) and from ORBIS (firm-level database provided by Bureau van Dijk merged with OECD Patstat), as well as additional project-level data from OpenCoesione. **Three outcome variables** are then considered: investment, value-added, and number of employees, all of them specified as the logarithmic growth rate (over the 2011-2014 period) standardised for the initial (2010) size of the balance sheet.

Robustness of findings is ensured by testing the assumption that treatment near the cut-off value is randomised (through RDD regressions using dependent variables potential co-founding characteristics) and heterogeneity at the threshold using six additional forcing variables.

Key findings are the following: the intervention had limited effects on firm performance, particularly on additional investments, value-added, and employment; besides, partner firms did not benefit overall from collaborations with universities or firms, especially in the context of large partnerships, which negatively affected firm performance.

The findings of this evaluation are relevant for our assessment, but **some limitations** should be highlighted:

- The assessment is focused on collaborative projects only, while individual projects, although a minority within our sample, are not considered;
- Results are valid only for firms very close to the funding cut-off. Although the evaluation attempts far-from-the-threshold extrapolations, it is only possible to provide far-from-the-threshold inference for the outcome variable 'employment' and for a small percentage of observations in the sample.

Source: own elaboration based on Crescenzi et al. (2018)

Achievement indicators at Priority Axis level provide limited evidence of the increased know-how of beneficiaries and the resulting increased number of product and process innovation out of all financed projects: an achievement indicator equal to 0.91 was reported, against the initial target of 1.62[52] (see ANNEX IV).

Interviews with beneficiaries provide a more positive picture: all interviewees noted that their research objectives produced results reported in the final technical reports (see some examples in Box 5). However, the sample of beneficiaries interviewed might not represent the entire set of projects funded and might be biased towards the best-performing ones' self-selection.

By triangulating these pieces of evidence with interviews with the Managing Authority and other experts, this evaluation finds that **the overall effect in terms of innovation in**

[51] Spatial Economics Research Centres.
[52] Source: Final Implementation Report (June 2017).

products and processes is limited. Nevertheless, within the sample, successful projects can be identified.

Box 5. Examples of R&D projects achieving the intended results

OFRALSER[53]

Objectives: The project aimed to promote innovations in the agri-food sector, more specifically in fruit and vegetable processing. The project developed and tested technological solutions that could support product differentiation, improving the content in service while also pursuing an improvement in 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 the adoption of innovative solutions within the business process.

***

DIATEME[54]

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

***

SIGMA[55]

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 system's final aim was to support the provision of appropriate services both to citizens and businesses, especially in those high-risk areas lacking of a 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[56]. 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 developing products with application in the context of smart cities and the integration of the cloud with the Internet of Things. Finally, some prototypes were developed as a result of the project. Following other research activities and investments, a software solution has been developed and is currently adopted in several cities.

Source: interviews with direct beneficiaries.

Despite some positive anecdotal evidence, collected through interviews, of the innovations produced as a result of research activities, the intervention had overall limited effects in terms of the expected final outcome, i.e. technological upgrading and competitive repositioning of beneficiaries and productive chains. This conclusion is confirmed by Crescenzi et al. (2018), which shows that collaborative R&D projects' impact was limited in terms of value-added. It also finds that longer-term effects on value-added mainly concern those firms with a high ex-ante patenting track record, which could capitalise on the potential of previous investments rather than of the intervention itself. Products and processes innovation were not always commercially or industrially exploited, nor were they patented. In this respect, quantitative evidence is available at a more aggregate level only, with regional indicators showing that the four convergence regions' performance in terms of absolute number of patent applications declined during the 2007-2013 programming

[53] http://www.ponrec.it/open-data/progetti/scheda-progetto?ProgettoID=5114#Descrizione
[54] http://www.ponrec.it/open-data/progetti/scheda-progetto?ProgettoID=5001
[55] http://www.ponrec.it/open-data/progetti/scheda-progetto?ProgettoID=5723
[56] See for instance https://www.icar.cnr.it/progetti/pon-sigma-sistema-integrato-di-sensori-in-ambiente-cloud-per-la-gestione-multirischio-avanzata/

period. While in 2007, the number of PCT patent applications per regional GDP in these regions was equal to 642.7, in 2015, this number decreased to 625.6 (see also Subsection 2.12.1.1).

Effects of knowledge transfer and network consolidation

Interviewees pointed out that most collaborative R&D projects, especially science-industry, provided **access to new ideas and competences**. Many companies gained access to new ideas and became aware of new technological solutions. At the same time, research centres were also able to explore the needs of business partners and develop skills needed for industrially-oriented, applied R&D, such as developing demonstrators and prototypes that could then be tested by potential users.

Box 6. Examples of complementary competences

The project objectives: GVS SUD Srl, a large company specialized in the manufacturing of filter solutions with applications in health and safety sectors, jointly designed the **DIATEME** project with the Institute of Polymers, Composites and Biomaterials (*Istituto per i Polimeri, Compositi e Biomateriali* – IPCB) of the National Research Council (*Consiglio Nazionale delle Ricerche* – CNR). The objective was to develop new devices for the biomedical sector.

Sharing competences between business and academia: This project involved several firms and research centres and universities, which incentivized a productive exchange of skills and knowledge between the company and the university sphere. Firms had the opportunity to build on the solid knowledge and research results provided by the IPCB in materials for biomedicine applications. At the same time, firms' industrial expertise became critical for the implementation and, in some cases, the commercialization of the solutions designed as part of the project.

Source: interviews with direct beneficiaries.

Networking has been indicated by several interviewees as a key intermediate outcome of the research projects. Interviews confirmed that the strengthening of public-private collaboration networks is evident in perception and the **follow-up activities of collaborations** activated after the end of the programming period.

Box 7. Examples of follow-up collaborations

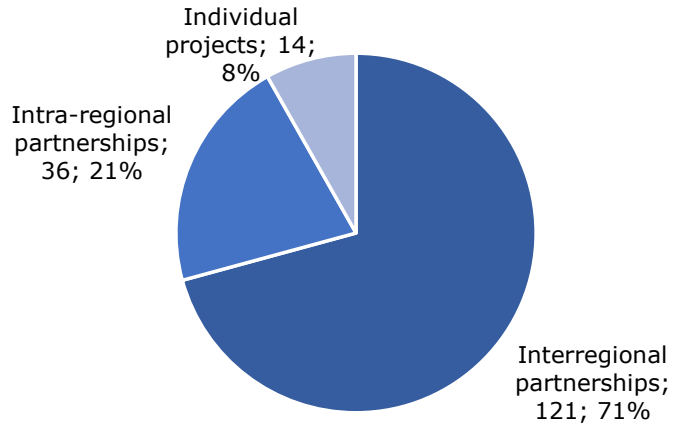
The **OFRALSER** project also led to positive results in terms of consolidation of the network established during the project, translating into a new collaboration between the partners. For instance, a similar team is implanting a new project funded under the National OP 2014-2020, which can be seen as the continuation of the OFRALSER project.

According to evidence collected through interviews, a solid network was also established under the project **DIATEME**, such that most of the partners decided to collaborate on new research activities.

Collaborative activities in the SIGMA project framework consolidated the expertise shared and developed during the project implementation and enabled new collaborations with public administration involved in the same field. This new network for collaborative and applied research also resulted in new collaborative research projects during the subsequent programming period.

Source: interviews with direct beneficiaries.

Figure 16. Breakdown of projects by types of partnerships



Source: own elaboration based on Task 1 data.

Even if networking increased, there is less evidence of the knowledge transfer mechanism between large and small firms and between different territories. Although interregional partnerships represented the majority of funded projects in line with the OP and the call's interregional objective, interviews did not highlight this specific effect. Neither did small firms particularly benefit from collaboration with larger firms. Some interviewees noted that it was not unusual that firms decided not to share research results with other partners, thus limiting the knowledge exchange opportunities embedded in collaborative projects.

Effects on skills development

According to the achievement indicators, the number of training courses and participants was higher than expected. A total of 333 training courses (vs the target of 280) were provided to 3,687 participants (vs the target of 2,800)[57] (see also ANNEX IV). Interviews confirmed that training courses were generally positively implemented, especially when universities were directly involved and coordinated the activity. In the most successful cases, postgraduate courses were specifically designed on the research topics of the supported projects and carried out within the portfolio of teaching courses of the partner university, although with the possibility of inviting experts from other partners or other institutions.

All training activities were carried out in conjunction with the research projects and generally included 'on the job' training with the project's industrial partners. In this way, researchers were able to **develop specific skills and competences** related to the sector and technological field of application of the supported project, as confirmed by all interviewees.

Anecdotal evidence from interviews also confirmed that the placement rate of trainees was overall high (see some examples in Box 8). The shared opinion is that all of them benefitted from a unique training experience. However, not all participants found a job in firms located in the convergence territory, which was the intention of the intervention's logic. Some participants were employed in research centres or universities or even moved to non-convergence regions or abroad. It was also reported that, despite relevant experience in R&D-related activities, not all participants were necessarily employed in R&D sectors or divisions. The final outcome of training activities was achieved partially, even though the high employment rate amongst participants is overall a positive result. This partial achievement might be explained by the fact that the correspondence between the available workforce (number of researchers involved in the project and looking for a job) and the job demand (number of potential employees within the industry) was not always pre-assessed. The instrument, however, contributed to the improvement of the employment opportunities in the R&D sector for young researchers from convergence regions. Data at

[57] Source: Final Implementation Report, 2017.

a more aggregate level showed that the percentage of people employed in science and technology sectors within the industry over the total population slightly increased in the convergence territory, from 3.94% in 2007 to 4.19% in 2015 and 4.37% in 2017 (see also Subsection 2.12.1.1).

Box 8. Examples of training activities and related results

OFRALSER

Training activities: A two-year master's degree was designed as part of the university's offer. Despite a series of organizational and formal problems in sharing training activities between the various scientific partners, the idea was successful. Thanks to the resources available, it was also possible to involve some world-class experts in the area of interest.

Results: Twelve people were trained, while eleven completed the program and obtained a formal degree. As a result, more than 50% of them became employed even before completing the master's degree, in partner companies or external firms, with some researchers becoming recognized experts in the field.

DIATEME

Training activities: A two-year training programme was funded. The program involved twelve researchers through a mixed approach of theoretical lessons and six months of research activities in the project's partner firms.

Results: The project achieved the full employment of the researchers involved. Of these, 60% became employed in the same company where they completed the internship or within these companies' partners. The rest were employed in other private companies operating in the same sector or universities and research centres.

SIGMA

Training activities: Almost EUR 1 million of project resources were dedicated to training activities, accounting for a share of around 10% of the total cost. Two first-level and one second-level master programmes were designed, each involving 20-25 students. The master's programmes included some theoretical lessons (about 500 hours of classroom lessons for each) followed by three months of on-the-job training within the project partner companies.

Results: Despite the lack of official data, interviewees indicated that around 50% of the 70 trained researchers became employed within the six months following the end of the training programme. All the researchers involved are currently employed.

Source: interviews with direct beneficiaries.

Verification of pre-conditions

The limited materialisation of long-term effects compared to expectations can be explained by many pre-conditions that did not materialise. However, there is also evidence that some of the assumed pre-conditions linked to the intended outputs did effectively take place.

The high number of project proposals submitted confirmed that there was local demand for research activities in the convergence regions and that science and industry actors had research design capacity, being aware of their R&D priorities (pre-condition 1). The Final Implementation Report (June 2017) confirmed that all research projects, excluding those dating back to the 2000-2006 programming period, included training activities. In all R&D projects, specialised R&D personnel were involved in implementing activities, as requested by the call. Therefore, the research projects managed to attract talent and scientists to be trained (pre-condition 2).

Funded projects were selected according to quality criteria and were of a significant financial scale, so they could provide a unique opportunity to advance in target technological fields. However, there is evidence that the selection process was unable to detect some selected projects that might have had lower innovative potential than initial expectations or which were possibly too ambitious given the low maturity of the regional innovation ecosystems and the difficult economic situation. **Deficiences in the competitive selection** procedure were highlighted during the intervention implementation (pre-condition 3). The Ministry of Finance inspection requested in

November 2011 by the Minister of Public Education discovered that the time allocated for the evaluation of the funding applications was too short compared to the amount of information included in each file of project documentation. A total of 222 applications for funding were assessed in 3 working days, with an average time of 7.5 minutes per application. Several inconsistencies were identified between the evaluation reports and the final selection decisions. The subsequent investigations by the Italian judiciary (see Subsection 3.1.2) confirmed that the selection decision was not always informed by the result of the selection process: the committee selected projects with a negative scientific assessment, or projects implemented by institutions not complying with economic and financial requirements[58]. At the end of the judicial investigations in 2015, the Managing Authority initiated an additional control procedure to ensure that selected projects were of good quality. Interviews highlighted that this additional quality control indeed identified some low-quality projects with a poor level of innovation and ambition. The occurrence of some errors and inconsistencies in the selection procedure cannot be excluded.

A pre-condition that did not take place explicitly impacted the research projects' effectiveness in terms of innovation. In contrast with what the call had planned, the **timely disbursement of funds** (pre-condition 4) was **not always ensured,** mainly due to administrative capacity issues within the Managing Authority. The latter postponed most of the payments based on the biannual control procedures. The lack of permanent officials responsible for the OP, the massive presence of experts of the Technical Assistance with no decision-making role and the complicated on-going controls on the implementation of the projects (see Subsection 3.1.2) are some of the main factors which affected the implementation of the projects.

Box 9. Bi-annual on-going control procedures: a three-step assessment

On-going controls were planned every six months for 100% of expenditures declared by the total number of beneficiaries and required the three-step procedure outlined below.

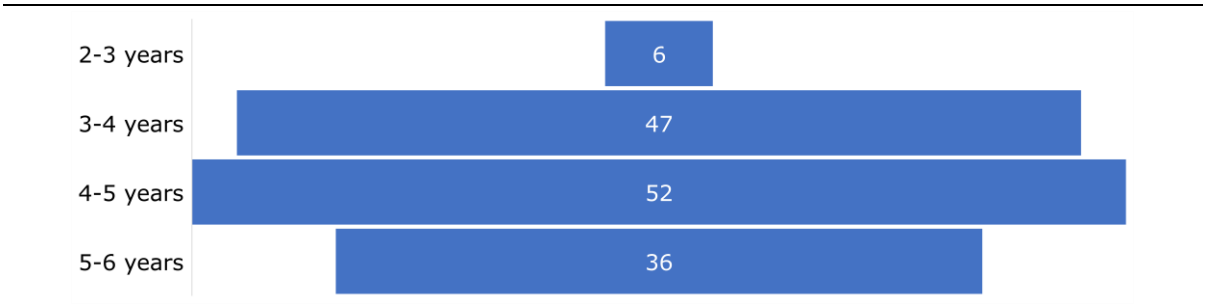
- **On-site inspections by the technical-scientific experts**: the assessment included a field mission to check the status of the project's scientific implementation and compliance by beneficiaries with economic and financial requirements.
- **Compliance check on financial implementation** entrusted to the Technical Assistance Services.
- **Control of invoices and certified expenditures** carried out by the Managing Authority.

Further disbursements were approved only after a positive result of the three controls. In the case of interruptions, the technical-scientific experts and the partner institution assessed whether to cancel the project or cover at least a share of the implemented activities.

Source: own elaboration based on information provided by the Managing Authority.

As a result, implementation of the interventions under assessment was delayed in most cases and generally exceeded the 36 months initially foreseen.

Figure 17. Project duration (in years)



Source: own elaboration based on Task 1 data.
Note: data refer to 144 projects only and exclude projects from the previous programming period.

[58] ANPRI. "Newsletter 8 del 30 aprile 2015". http://www.anpri.it/wp-content/uploads/2015/05/Newsletter-8-2015.pdf

The partial achievement of longer-term effects linked to training activities was also due to limited correspondence between the available workforce (number of researchers involved in the project and looking for a job) and the job demand (number of potential employees within the industry) (pre-condition 5).

Verification of supporting factors

Most of the identified supporting factors partially took place and, in some cases, positively influenced the achievement of intended results.

Previous experience in carrying out R&D activities in a collaborative way was key to the establishment and consolidation of cooperation networks (supporting factor 1). In line with existing literature, interviews highlighted that long-term relationships and mutual knowledge and trust between organizations facilitated negotiations about the types of competences and skills shared among partners. In all interviews, it was reported that project ideas generated based on shared research interests of partners with previous collaboration experience, then involving additional partners who became part of the network. A lack of mutual trust instead can explain a low level of patents. As confirmed by some interviewees, some interesting research results were deliberately not patented and even reported in final technical reports to not inform competitors about innovative results. Interviews also highlighted that **payment, and implementation delays did not always prevent the achievement of research results**. The failure to achieve the research objectives concerned those beneficiaries, especially SMEs, which did not have enough economic and financial capacity to cover projects costs that were not timely covered by the administration. Financial solidity also impacted the private actors' capacity to obtain the bank guarantee needed for signing the contract and obtaining pre-financing. In the 2012 meeting of the Monitoring Committee, the Managing Authority highlighted that, among the approximately 550 private beneficiaries entitled to the advance, only 100 obtained the guarantee. This issue was exacerbated by the post-crisis economic situation, which negatively affected many firms' economic and financial capacity in convergence regions. Conversely, despite the absence of timely funding, large firms and research organisations could rely on their resources to carry out the project (supporting factor 2).

More generally, the intended results were more successfully achieved by those more prepared to engage in research activities and exploit their results, in particular:

- larger or medium firms with a long-term research agenda, a solid network of SMEs as subcontractors, and economic solidity (see the example of Fiat Chrysler Automobiles SpA in the box below);
- research centres or universities with more industrial research experience and the capacity to attract research funding from different sources.

Box 10. The example of Fiat Chrysler Automobiles SpA

9 collaborative projects € for a total contribution of EUR 11.8 million

The ability of Fiat to successfully implement the collaborative research projects funded by the OP derived from a focused company policy in which R&D plays a key role. More specifically, certain activities are internally regulated, as outlined below.

- As the lead beneficiary of most of these projects, Fiat generally involved the supply chain of research centres or suppliers with which collaborative relationships were already in place and were regulated by specific collaboration contracts. The latter defined the areas and activities of competence of the partners and resolved in advance any conflicts in the field of intellectual property. In this way, the firm was more successful in managing and coordinating project partnerships.
- Project proposals were not created ad hoc to participate in the tender. Still, they were inspired by the strategic research plan developed at the company level in which the strategic objectives in the R&D field are defined.

Source: own elaboration based on evidence collected through interviews.

In particular, the capacity to ensure continuity throughout ambitious research and technological development plan was the key to success (supporting factor 3). The exploitation of research results was maximised when following up investments and research activities were possible. Some interviews highlighted that the implementation of collaborative R&D projects in the context of regional OPs and other European programmes also contributed to this mechanism (supporting factor 4).

Verification of risks and threats

Typical **project risks** such as project delays or cancellation (risk 2) played a key role but were exacerbated by the identified problems of delayed payment and implementation. Interviews with beneficiaries highlighted that in some cases, the commercial and/or industrial relevance of project results was affected by delays in the implementation of the intervention, considering that research is 'time-sensitive'. Such delays were determined not only by the implementation issues mentioned above but also by delays in the selection procedure, as evidenced by the first ranking of the applications being released one year and a half after the publication of the invitation to tender.

Specific difficulties in the project implementation concerned collaborative R&D activities (risk 1 and 3) and limited the knowledge transfer and networking mechanism's effectiveness. The risks highlighted in the initial ToC did materialise in the context of some projects, thus affecting their quality, execution and returns.

Results might not have been achieved or were limited in the context of those projects implemented by beneficiaries only for opportunistic purposes (risk 1). As highlighted by the Italian judiciary investigations, there were cases of selected projects in which some of the partners went bankrupt immediately after receiving the advances or where figureheads were used. Interviews with programme managers also pointed out that the higher aid intensity and score granted to collaborative projects induced the establishment of fictitious partnerships, such as universities or SMEs not actually involved in implementing the project activities.

Moreover, lack of coordination within partnerships (risk 3), especially larger ones, was reported by some interviewees as another explanation for the limited achievement of results. The main problems emerging within partnerships included a decline in interest, business financial difficulties, misunderstandings with other partners, a lack of returns, and a lack of mutual trust among partners. For instance, due to the rigidity of the legislative instrument used to implement the call, which allowed limited flexibility for adjustments in the project scope and activities, the withdrawal of just one partner within a consortium had an immediate effect on the project implementation, resulting in postponement and even withdrawal of the project. To solve this limited resilience, only in October 2015 did the Managing Authority approve a decree allowing project variation. Changes were then allowed up to a limit of 20% in terms of content and actors involved in the project[59]. The beneficiaries noted that a clear pre-definition and distribution of tasks across partners could mitigate these issues' manifestation.

This result is confirmed by the counterfactual impact evaluation by Crescenzi et al. (2018) which found that projects implemented by a large number of firms, representing half of the sample, had lower long-term effects in terms of valued added.

[59] Decreto n. 2350 (20th October 2015).

Table 5. Funded collaborative R&D projects by the dimension of consortia

	Number of projects							
Dimension of partnerships in collaborative R&D projects	**a. In HEIs**	**a/b. In HEIs/RTOs**	**d. Science-industry**	**e. In clusters**	**f. In STPs**	**h. Others**	**i. In enterprises**	**Total**
1 partner	0	0	0	1	0	0	0	**1**
2-5 partners	1	1	80	3	2	1	1	**89**
6-10 partners	0	0	50	0	4	0	1	**55**
Over 10 partners	0	0	12	0	0	0	0	**12**
Total	**1**	**1**	**142**	**4**	**6**	**1**	**2**	**157**

Source: own elaboration based on Task 1 data.

3.2.3. General assessment

The policy instrument achieved, to some extent, the expected immediate and intermediate outcomes. In particular, it contributed, with other supporting factors, to increase the scientific knowledge of beneficiaries, develop new skills and competences of selected trainees, and strengthen the consolidation of existing collaborations. The limited results in terms of commercially exploitable innovation and the negative effects of the 2008 economic crisis affected the research projects' potential to increase the competitive position of beneficiaries in particular and convergence territories in general.

The intervention contributed in a necessary way to the observed results as part of a causal package. The observed outcomes would not have been possible without the intervention's inputs, but additional support factors were also necessary. Additional supporting factors, such as the previous collaboration and synergies with other regional OPs, influenced the impact pathways. Some assumed pre-conditions did not take place, especially the fast funds' disbursement. At the same time, risks related to management issues and the adverse effects of the economic crisis hindered the fulfilment of medium and long-term objectives.

The policy instrument funded 171 R&D[60], most of them with a collaborative dimension. They correspond to payments for a total of EUR560.3 million[61], below the allocated budget.

The overall effect of the intervention in terms of innovation in products and processes is limited. Successful beneficiaries are those with research capacity already in place and more solid economic and financial capacity. Payment delays hindered the smooth implementation of projects, but large firms and research organisations' stronger economic and financial stability contributed to safer project implementation.

Interviews highlighted that in some cases, commercial/industrial relevance of project results was affected by delays in the implementation of the intervention, considering that research is 'time-sensitive'. At the same time, aggregate data on the number of patents might underestimate the innovation generated.

There is evidence that support for collaborative R&D projects has favoured a knowledge exchange process. Problems in large partnerships have sometimes prevented the knowledge transfer process and the propensity to collaborate further. The knowledge transfer mechanism between large and small firms and between different territories is less evident. SMEs are indicated to benefit from knowledge transfer mechanisms more in suppliers of high-tech components than as partners. Anecdotal evidence from interviews suggests that concerns around intellectual property rights prevented the full disclosure and sharing of knowledge among partners.

[60] Source: OpenCoesione. The data are not definitive. As confirmed by the Managing Authority, monitoring data may be subject to variation considering that the OP is not yet administratively closed.

[61] Source: expenditure data collected in the context of Task 1 (with a cut-off date of 28th February 2020). Data provided by the Managing Authority on 20th October 2020 show that total certified payment up to July 2020 corresponds to EUR 575.3 million (including both the national and the European co-financing) and that a total of EUR 14.9 million under measure I.1 are still under suspension. The data are not definitive, since the operational programme has not yet been concluded and disbursements are still ongoing.

Follow-up collaboration was generally maintained with those actors with which cooperation was already in place and among science and industry actors. In this respect, regional OPs and other European programmes further contributed to achieving this objective.

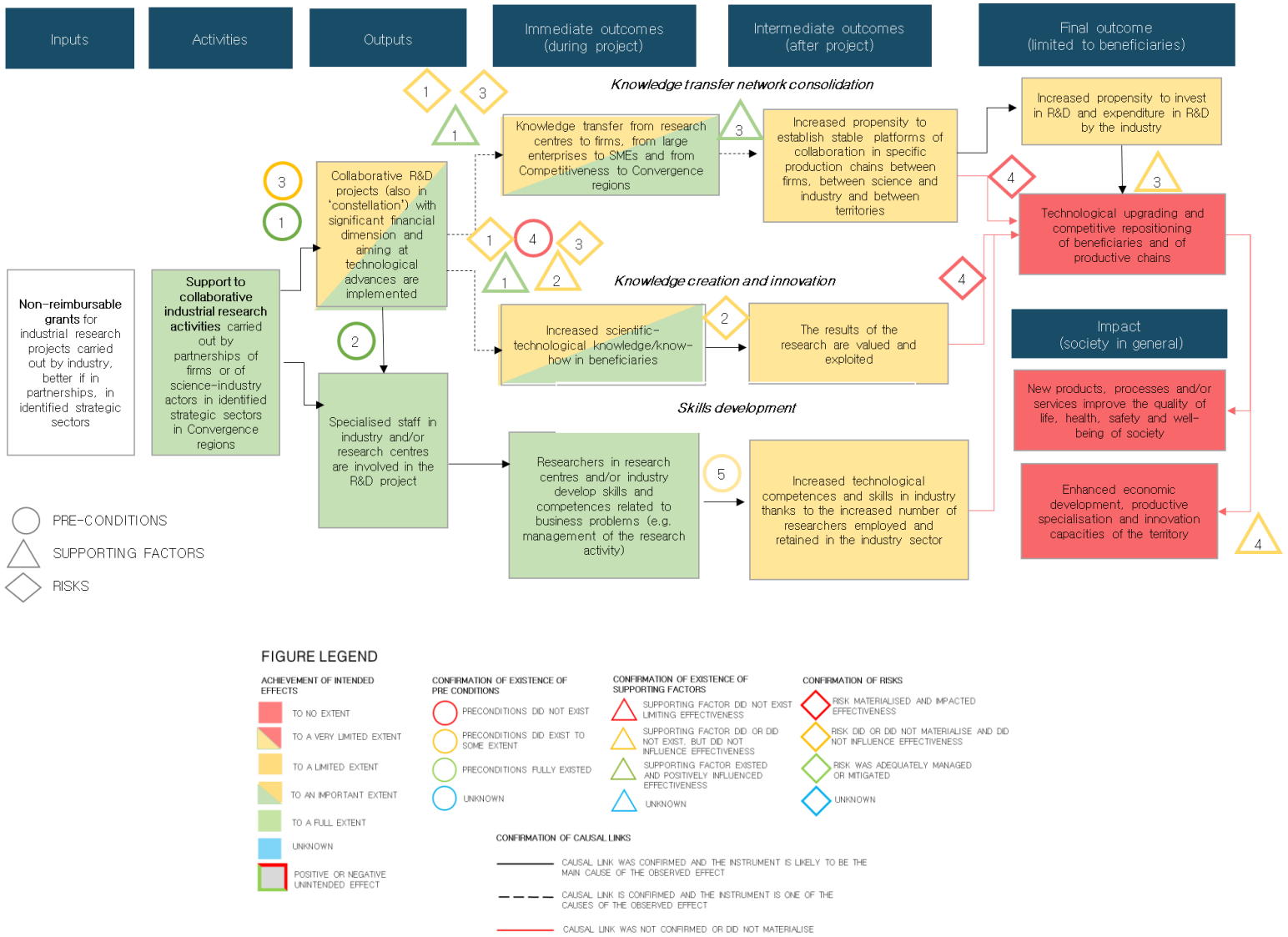
All training activities were carried out in conjunction with the research projects and generally included a period of training 'on the job' so that all researchers involved in projects could develop specific skills related to the sector of application of the project. Although participants' placement rate was overall high, not all of them found a job in firms located in the convergence territory as intended in the intervention's logic.

The limited results in terms of commercially exploitable innovation along with the negative effects of the 2008 economic crisis, affected the potential of the research projects to increase the competitive position of beneficiaries in particular and convergence territories in general. As confirmed by the ex-post counterfactual evaluation by Crescenzi et al. 2018, the intervention did not produce any impact on the beneficiary firms' performance in terms of investments and added value. Interviews highlighted examples of direct economic benefits derived from the exploitation of results of the research projects. However, this seemed to be limited to large firms or research centres and universities implementing follow-up investments.

The increased propensity to establish collaboration was generally limited to science and industry actors who were already used to cooperating in research activities. However, interviews highlighted that most projects had follow-up research activities and collaborated with some of the actors involved in the same partnerships. In this respect, evidence from regional indicators shows that the propensity to invest in R&D has overall only slightly increased and was still below the expected target. Total R&D expenditure over GDP increased in all convergence regions from 2007 (0.79%) to 2015 (0.99%) and 2017 (0.82%) but remained far below the target set out at the beginning of the programming period. However, in the case of private R&D, there was an increase in all convergence regions, reaching the OP's target. In 2007 private R&D compared to GDP amounted to 0.22%, in 2015 reached 0.32% and in 2017, 0.31%.

Thanks to ERDF support, although beneficiaries did not substantially increase their propensity to invest in R&D activities, they at least maintained the level of R&D investments despite the negative effects of the economic crisis. Overall, while not improving as expected, the innovative performance of convergence regions has remained stable over time as shown by context indicators presented in Subsection 2.1.1.

Figure 18. Representation of the results of the contribution analysis for the policy instrument Collaborative science-industry R&D projects



3.3. Policy instrument: Collaborative R&D projects in technological clusters under the OP R&C

3.3.1. Theory of change of the policy instrument

In Italy, policy interventions in favour of technological clusters were introduced at the beginning of the 2000s and were provided during the 2007-2013 programming period only.

Box 11. The history of technological clusters in Italy

In Italy, at the beginning of the 2000s, the political debate on innovation policies shifted the attention from the industrial districts institutionalised in 1991 to the necessity of supporting innovation within districts to better compete at the international level. Technology clusters were defined for the first time in the 2002-2004 and 2005-2007 National Programmes for Research as '"as local aggregations of high-tech activities, made up by public research centres, firms and local governments, geographically concentrated, that aim to fostering firms' innovation capabilities and local competitiveness'".

Based on the **triple helix model** (Etzkowitz and Leydesdorff, 2000), interventions promoting technological clusters were introduced to exploit synergies between firms, universities, research centres and local public authorities of a specific territory as well as to enhance firms' innovation capabilities and the competitiveness of local production systems. This region-oriented policy instrument aimed to act as a tool of governance and coordination of the processes to streamline learning mechanisms appropriate for innovation (Bertamino et al., 2016).

Regional Governments have always played a key role in the identification and creation of the clusters, in strong coordination with other public authorities. However, it was the Ministry of Education, Universities and Research (MIUR) that had the power to legally constitute high-technology clusters after the signing of a legal agreement between the Region and the Ministry (Accordo di Programma Quadro – APQ).

Technological clusters represented the key policy instrument for the implementation of research and innovation policies during the 2007-2013 programming period in Italy, with a substantial amount of resources for strengthening and consolidating existing clusters and public-private laboratories (EUR 389 m) and creating new agglomerations (EUR 526 m) to support the development of convergence regions of Italy.

In line with the objectives defined in the National Programmes for Research and the Horizon 2020 priorities, the Ministry of Education, Universities and Research launched a new national strategy in 2012. This strategy aimed at supporting the integration between national and regional initiatives in the field of innovation while fostering the synergies of the existing clusters with the whole research and innovation chain through **12 National Technology Clusters**, each of them representing the reference point for the development of tailored national policies in the twelve strategic fields of innovation of national interest.

Such actions were also supported during the 2014-2020 programming period, despite more selective criteria as compared to the 2017-2013 programming period. However, the logic behind support to technological clusters changed dramatically, and consequently, the definition of research and innovation strategies have been translated **from a regional to a national dimension**. While during the 2007-2013 programming period, regional authorities were in charge of the definition and coordination of the innovation strategies. In the period 2014-2020, these strategies were designed according to priorities defined at the national level.

National Technology Clusters operate at the national level and coordinate within a unique association, firms, universities, public and private research institutions, and existing technological clusters. The strategy developed in 2012 was to overcome the fragmentation that characterised the system of technological clusters. However, the coexistence of new (National Technology Clusters) and pre-existing (i.e. regional technological clusters) intermediary bodies have added complexity to the system of relationships between industries and the world of research and academia.

Source: own elaboration based on desk research and literature review.

The invitation to tender issued under the OP R&C in October 2010 had a two-fold aim: to consolidate existing technological clusters[62] (allocated total budget of EUR 282 million) and to create new geographically concentrated aggregations of science and industry actors in the form of technological clusters or public-private laboratories (combined allocated total budget of EUR 526 million).

At the end of 2010, the number of technological clusters in the convergence regions created through Framework Programme Agreements (Accordi di Programma Quadro - APQ) amounted to 10 out of 31 at the national level. These clusters were concentrated in sectors considered strategic for territorial competitiveness: materials engineering, mechatronics, agri-food biotechnology, cultural heritage, transport, and nanosystems.

Technological clusters differ from all other forms of public-private collaboration by three specific features[63] given below:

- Strong territorial connotation;
- The existence of a consolidated form of collaboration;
- The presence of a coordinating institution organised with centralised management.

Support to existing and new technological clusters in convergence regions, characterised by an overall low level of concentration of social capital and critical mass due to the structural deficiencies of the business fabric (see also Sub-section 2.1.1), was considered to be propulsive to the **development of stable networks of science and industry actors**. In highlighted by the literature[64], cluster policies aimed at linking the main players in the regional ecosystem (industry, research providers and institutions) to overcome critical mass problems, especially in industries, and facilitate coordination, co-creation and knowledge transfer. The policy instrument had three main objectives:

1. To consolidate coordinating institutions in existing technological clusters through the development of a 5-year strategic development plan and to promote new governance models within the innovative territorial system after the presentation of feasibility studies;
2. To support at least two industrial research projects[65] in existing clusters and industrial research activities in new territorial aggregations;
3. To combine training activities[66] with industrial research projects.

Support was provided based on **several pre-conditions**. In creating new clusters, the development of feasibility studies was possible only if there was local demand for geographically concentrated collaboration in existing or emerging strategic sectors. Existing clusters had to identify the needs of all the different actors, both science and industry, and favour collaboration between them to develop a joint strategic development plan. Industrial research projects, implemented in parallel with the governance consolidation in existing clusters and after the governance creation in new aggregations, had to respond to quality requirements to develop innovation at the frontier necessary for beneficiaries' technological upgrade. Moreover, research projects implemented should attract and train young talent and researchers[67].

To ensure a balanced distribution of ERDF resources, the budget was pre-allocated across the four convergence regions, ensuring weaker regions were not penalised. The selection

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[62] Defined as "*territorial aggregations of firms, universities and research institutions guided by a governance institution and focused on defined strategic scientific and technological areas*". They are different from public-private laboratories, defined as "*integrated systems of fundamental and applied research as well as experimental development in which firms, universities and research institutions are jointly involved*" and which were also targeted by the same instrument. Since the logic of intervention for public-private laboratories is different from technological clusters, the analysis will focus only on the latter.

[63] Based on D'Esposito et al. (2015).

[64] For more details, see Annex to the First Intermediate Report.

[65] Of a maximum duration of 36 months.

[66] Of a maximum duration of 12 months.

[67] The recipients of the training activities must not have been linked by any working relationship with partners involved in the project.

took place in two steps: first, feasibility studies for newly created clusters or five-year strategic plans for already existing clusters were evaluated; second, specific research projects were selected and funded following approval of the plans.

Similarly to the policy instrument analysed in the previous section, support for collaborative R&D projects in technological clusters was intended to have an impact on the economic development, productive specialisation, and innovation capacities of the convergence territory. Unlike collaborative projects, however, support to clusters was meant to develop further **territorial and institutionalised concentration of scientific and productive specialisations** in well-identified production and disciplinary sectors. By adopting a more systemic approach, the instrument aimed at setting up structured organisations that could engage in long-term development strategies combining different policies, programmes and instruments for the benefit of territorial ecosystems. In this respect, **different intended results** and related causal chains characterise the expected outcomes from the provision of this support:

- Governance and network consolidation (for existing clusters) and construction (for new ones);
- Knowledge creation and innovation;
- Skills development.

The proper functioning of governance structure was essential for the entire activity of both existing and newly created clusters. It had to stimulate the involvement and sense of belonging of all the actors, avoiding disaffection or continuous inactivity (Studiare Sviluppo, 2015). Knowledge creation and the enhancement of skills development were instrumental in the clusters' development.

Governance and network consolidation

To consolidate the governance and collaboration networks, the cluster had to develop, in the first instance, a **five-year strategic development aggregation plan**. This plan would respond to emerging needs in the sectors of reference through a combination of processes and actions that would bring advanced knowledge and technologies. The primary condition that had to hold was the presence of a cluster capable of bringing out synergies and helping the actors maintain close collaborative relationships, as confirmed by the existing literature (Uyarra and Ramlogan, 2012).

For long-term sustainability, clusters needed to adapt to the territory's evolving RTD needs and the public and private participants. The synergies and complementarities with the evolving national and regional RTD strategies could also be considered a contributing factor to long term effects. Moreover, follow-up investments stemming from the results of research projects could create further impact for beneficiaries and broader economic development.

Governance and network construction

By establishing new governance models, support was also meant to promote technology clusters that would become active participants in territorial research and innovative systems.

As evidence by the literature, clusters cannot be created from scratch, but they generate the bottom-up self-organising capacities of local actors. The **feasibility study**'s approval was a necessary condition for the formal establishment of the cluster, as a way to underpin the existence of a long-term commitment and a vision to shape the future of the cluster pro-actively. The formal establishment of the clusters took place after the signing of a Framework Programme Agreement 'for the definition of interventions, objectives, mutual financial commitments' by the Managing Authority and the regional administration concerned, and the evaluation of a technical committee.

The created governance structure was intended to favour the establishment of collaboration networks, which should then be strengthened by implementing collaborative research activities. As for existing technological clusters, the capacity to adapt to the evolving RTD needs of the territory and the cluster's public and private partners was a sustainability condition.

Knowledge creation and innovation

The consolidation of the governance was instrumental in facilitating the increase of the scientific-technological knowledge/know-how in beneficiaries to innovate products, processes, and services and exploit research results. The knowledge creation process was meant to occur at two different stages, depending on the intervention type. In existing technological clusters, research projects were implemented soon after the approval of the 5-year strategic development plan. In contrast, in the new ones, they were implemented only after the governance was formally established.

The realisation of funded research projects in both new and existing clusters depended on the materialisation of **two specific conditions**: high quality in terms of innovation potential, as ensured by a selection panel of scientific experts, and timely implementation of the research activity. After the signing of the contract, beneficiaries received an amount equal to 50% of the co-financing. Further disbursements were granted based on the amounts reported and certified every six months, following the outcome of technical and administrative controls.

The exploitation of innovative products, processes, or services resulting from the research projects was intended to contribute to the technological upgrading and competitive repositioning of beneficiaries. In this respect, only the typical research project risks (e.g. project delays or cancellation) could prevent recipients from achieving such an outcome. However, the failure to attain long-term effects could also be linked to other contextual factors hampering the effective implementation of the projects.

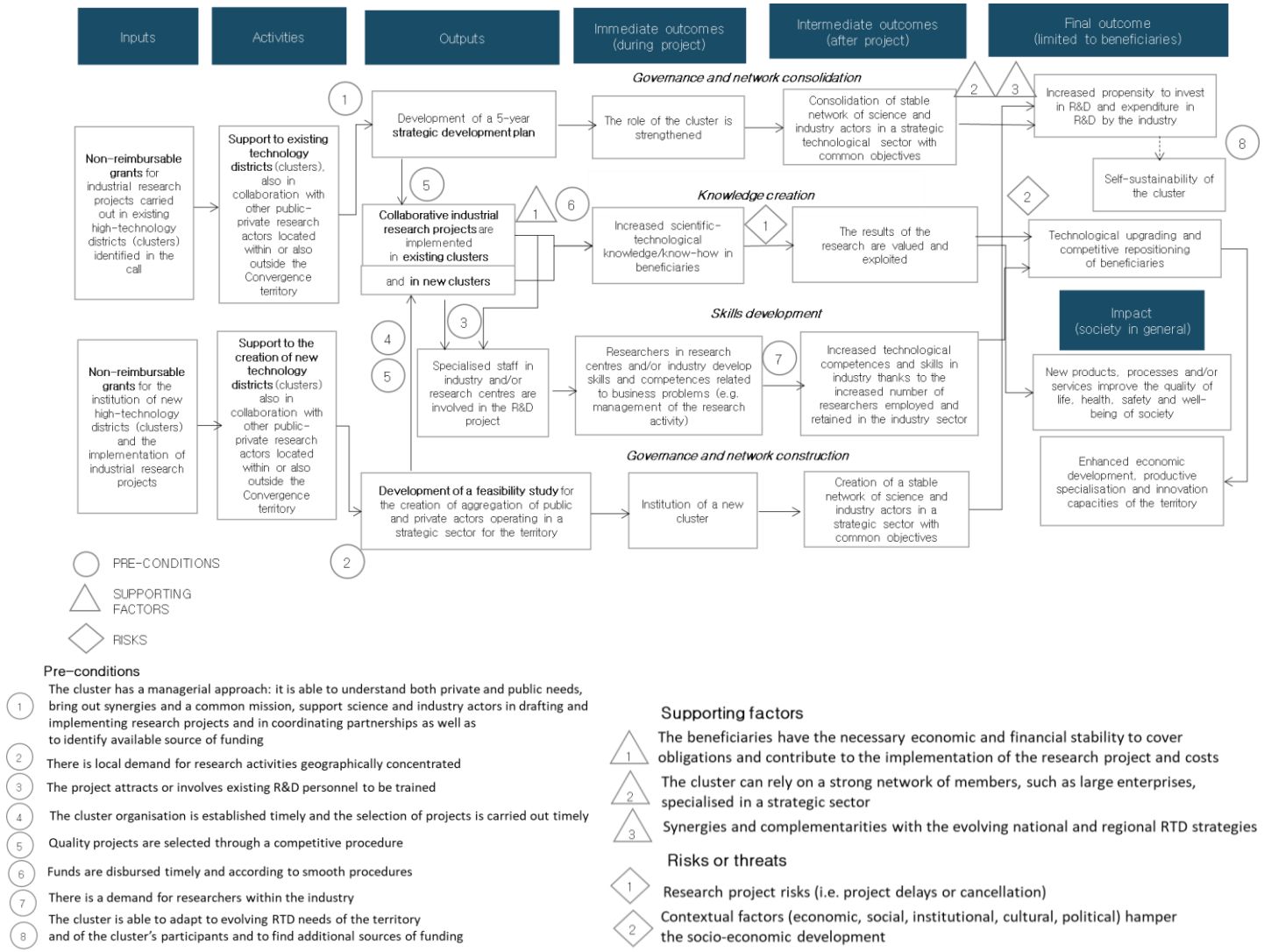
Skills development

Training activities were conceived to develop specific technical or management skills for RTD activities in the project's sector. In the call for projects, training activities were foreseen as mandatory and had to constitute at least 5% and not more than 15% of the project's total cost.

The idea was that trained researchers should contribute to the product, process, or service innovation funded by the research project[68]. The ultimate aim was to increase the number of researchers employed in the industry sector, thus responding to human capital deficiencies and skills characterising both the demand and the supply side. To this end, training activities should be designed to properly combine the labour demand with the labour supply in terms of high-qualified employees and researchers.

[68] The training course that was proposed must comply with the characteristics explained by the Ministerial Decree 593/2000 which provides that these paths are structured as follows:
- A module A (equal to 25% of the total cost) for theoretical learning to be compulsorily done at public research facilities;
- A module B for company support;
- A module C for learning programming and strategic management.

Figure 19. ToC for Collaborative R&D projects in technological clusters



Source: Own elaboration based on primary and secondary data collected.

3.3.2. Contribution analysis

Verification of intended intervention implementation

The implementation of the collaborative R&D support projects in technological clusters took place according to intended plans, despite the OP's several reprogramming actions. As a result, the invitation to tender was not altered in terms of requirements, underlying rationale and goals. Funding was distributed through an open call issued in October 2010.

After the call's launch, 26 applications, including the strategic development plans and 75 research projects, were submitted by the ten **existing technological clusters** for a total cost equal to EUR 771.5 million[69], almost twice the allocated budget[70].

In addition, a total of 196 feasibility studies for the creation of new technological clusters and public-private laboratories were received. The 18 selected new technological clusters and public-private laboratories previously selected were requested to submit research project proposals. One hundred thirteen project proposals were finally submitted[71].

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

The materialisation of the outputs of the call for proposals varies across the different levels of effects presented in the initial ToC.

Concerning governance consolidation and creation, 18 out of 26 strategic development plans for reinforcing existing clusters were selected, along 18 out of 196 presented feasibility studies to create new aggregations. Although no explicit target was explicitly defined ex-ante, the evaluation team found this outcome to be satisfactory, considering that the selected initiatives were meant to go hand-in-hand with research projects funded by allocated resources.

The case of funded research projects was different. In existing technological clusters, the **ambition to select and implement R&D projects** for a total of EUR 282 million **was only partially met**. The final ranking released in April 2012[72] identified 58 research projects eligible for co-financing for a total of more than EUR 532 million[73] and an average project cost of EUR 9 million. Based on the available resources, only 51 research projects were finally selected. To date, a total of 35 research projects have been funded, in addition to 20 research projects which are components of projects admitted to co-financing during the 2000-2006 programming period but implemented and funded after the administrative closure of the OP for Research 2000-2006[74]. More specifically, administrative payments to date amount to EUR 134 million[75], a figure lower than the total allocated budget of EUR 282 million. As was the case with the policy instrument presented in the previous section, the difference between payments and allocations is partly due to reprogramming actions and a decrease in commitments reflected in projects' withdrawal or revocation. Two

[69] Source: Final Implementation Report (June 2017). Data do not only refer to technological clusters but also to existing public-private laboratories.
[70] This includes both existing technological clusters and public-private laboratories. The total allocated budget was EUR 389 million, distributed as follows: EUR 282 million for existing technological clusters and EUR 107 million for existing public-private laboratories.
[71] Source: Final Implementation Report (June 2017).
[72] Decreto Direttoriale n.190/Ric. (23rd April 2012).
[73] Source: Final Implementation Report (June 2017). Data do not only refer to technological clusters but also to existing public-private laboratories.
[74] Source: OpenCoesione. The data are not definitive. As confirmed by the Managing Authority, monitoring data may be subject to variation considering that the OP is not yet administratively closed.
[75] Source: expenditure data collected in the context of Task 1 (with a cut-off date of 28th February 2020). On 20th October 2020, the Managing Authority provided updated data on total certified payment up to July 2020 in the context of the measure I.3.1 (which supported not only existing technological clusters but new cluster aggregations). These data show that total payments correspond to EUR 214.9 million. This figure is in line with expenditure data collected during task 1, which reported under measure I.3.1 total payments for EUR 214.3 million. Therefore, it can be assumed that expenditure data on projects supporting technological clusters only reflect more or less the actual situation.

projects initially selected were moved under national funding, and more specifically under the Cohesion Action Programme (Piano di Azione e Coesione - PAC, see Section 4.1), because of implementation delays

In the same vein, while the Managing Authority aimed at funding research projects **in new technological clusters** and public-private laboratories for a total of EUR 526 million, **this objective's achievement was very limited**. Out of the 81 projects admitted to co-financing[76], the OpenCoesione platform's data reveal that 42 research projects were implemented by new technological aggregations absorbing payments for a total of EUR 79.9 million[77], far below the allocated budget.

As far as training activities are concerned, all research projects ultimately funded, excluding those dating back to the 2000-2006 programming period, included training activities.

Effects on governance and network consolidation

Evidence of the effects of the policy instrument on the governance consolidation in existing technological clusters has been collected by distinguishing the different moments of the implementation of research projects: during and immediately after (i.e. immediate and intermediate outcomes) as well as in the long-term (i.e. final outcomes).

Along with the implementation of research projects, **almost all existing technological clusters have strengthened their role and contributed** to the overall consolidation of science-industry collaboration networks. Funding was distributed across all ten existing technological clusters located in convergence regions, albeit to different extents (see Box below).

Box 12. Distribution of total eligible funding and projects across existing technological clusters

Region Calabria

Logistica Ricerca e Sviluppo S.c.ar.l. (R&D.Log)

- Field: Logistics
- Number of projects: 4 projects (2000-2006)
- Total: EUR 3.85 million

Cultura e Innovazione S.c.ar.l.

- Field: Cultural Heritage
- Number of projects: 1 project (2000-2006)
- Total: EUR 3.25 million

***

Region Campania

IMaST S.c.ar.l.

- Field: Engineering of polymeric and composite materials and structures
- Number of projects: 6 projects (2000-2006) and 6 projects (2007-2013)
- Total: EUR 18.6 million

***

Region Puglia

DHITECH S.c.ar.l.

- Field: High tech and innovation
- Number of projects: 5 projects (2000-2006) and 5 projects (2007-2013)
- Total: EUR 25.3 million

D.A.Re. S.c.ar.l.

- Field: Agri-food industry
- Number of projects: 5 projects (2007-2013)
- Total: EUR 14.2 million

[76] Source: information provided by the Managing Authority in July 2020.

[77] Source: expenditure data collected in the context of Task 1 (with a cut-off date of 28th February 2020). On 20th October 2020, the Managing Authority provided updated data on total certified payment up to July 2020 in the context of the measure I.3.1 (which supported not only existing technological clusters but new cluster aggregations). These data show that total payments correspond to EUR 214.9 million. This figure is in line with expenditure data collected during task 1, which reported under measure I.3.1 total payments for EUR 214.3 million. Therefore, it can be assumed that expenditure data on projects supporting technological clusters only reflect more or less the actual situation.

MEDISDIH S.c.ar.l.

Field: Mechatronics

Number of projects: 3 projects (2007-2013)

Total: EUR 14.9 million

DI.T.N.E. S.c.ar.l.

Field: Renewable energy

Number of projects: 2 projects (2007-2013)

Total: EUR 4.4 million

***

Region Sicilia

Agrobiopesca

Field: Agri-food industry

Number of projects: 6 projects (2007-2013)

Total: EUR 14.3 million

Trasporti navali, commerciali e da diporto

Field: Maritime transport

Number of projects: 5 projects (2007-2013)

Total: EUR 15.3 million

Micro e nano sistemi

Field: High-tech

Number of projects: 3 projects (2007-2013)

Total: EUR 17.6 million

Source: own elaboration based on a desk review and OpenCoesione data.

Most of the clusters received total funding (comprehensive of national and European co-financing) between EUR 14 and 25 million. The only exceptions were the DI.T.N.E. in Puglia, which received a more limited budget, and the two technological clusters located in Calabria. Here, the OP R&C funded only those projects related to the 2000-2006 programming period but implemented after the 2000-2006 OP for Research administrative closure. This situation finds an explanation in the change promoted by the RTD regional policy since 2010 when attention shifted from technological clusters to innovation poles (Studiare Sviluppo, 2015). The latter is defined as 'groupings of companies and research centres that operate as intermediaries specialised in a particular sector and provide innovation diffusion services, scientific-technological services and access to research equipment and infrastructures'[78]. As outlined in the regional OP 2007-2013, the decision to focus Calabria's innovation strategy on innovation poles stems from the aim to rationalise and enhance the regional RTD system's research offer, constituting various organisations such as technological clusters competence centres and technological laboratories. On the grounds of this strategic change, since 2010, operating technological clusters took on a specialised function in the context of the network of innovation poles[79]: the cluster *R&D.Log* started managing the Innovation Pole Transport, Logistics and Processing and *Cultura e Innovazione S.c.ar.l.* the Innovation Pole Cultural Heritage.

The level of consolidation of existing collaboration networks varied across clusters and also regions. Interviews highlighted that consolidation of established cooperation networks was generally more successful in the Campania and Puglia regions. In these regions, innovation found more fertile ground; clusters, also supported by the regional administrations, had a clear mission and were generally more able to coordinate science-industry partnerships.

The ex-post evaluation carried out a year after the publication of the final ranking by INNOVA S.p.A. (2013) as part of the OP's evaluation plan, also supports this conclusion.

Box 13. Overview of the methodology of the ex-post evaluation by INNOVA S.p.A. (2013)

'The intermediary structures between scientific-technological organisations and businesses for the promotion of innovation and the competitive strengthening of the economy in the convergence regions.'

The evaluation studies the performance levels achieved by selected **intermediary structures.** The latter is defined as 'different types of knowledge intermediary organisations of a public-private nature, activated by regional and central administrations, which implement collaboration strategies between the world of research and companies, operating in favour of promoting innovation and competitive strengthening of the regional economy'.

[78] Source: Operational Programme FESR Calabria 2007-2013.

[79] Source: Calabria Smart Specialisation Strategy 2014-2020, https://calabriaeuropa.regione.calabria.it/website/portalmedia/userfiles/file/DGR%20N_294%20Allegato.pdf

Beyond the above mentioned **ten existing technological clusters**, public-private laboratories, scientific and technological parks, competence centres and innovation poles were also analysed in certain areas and effectiveness parameters. To measure their performance, five Performance Areas[80] divided into 15 measurement parameters were selected (see Annex IV for more details on the methodology and the study results). Each of the 15 parameters was then associated with a measurement scale to measure the structure's target (from 0 - non-existent parameter to 3 - high level of the parameter). Each parameter was then assigned a weight equal to 1 or 2 depending on the importance of the aspect measured for the role of knowledge intermediaries recognised for these types of structures. The weight represents the structure's ability to play an active and effective role of intermediation of knowledge with tangible effects on the reference territory. The multiplication of the target by weight defines the parameter's indicator, which can vary from 0 to 6. Based on this final score, the intermediary structures were then classified into three categories: '**Performers', 'Followers'** and **'Early-stage groupings'**.

Source: own elaboration based on INNOVA S.p.A. (2013)

The Performance Analysis implemented by INNOVA S.p.A. classified as '**Performers**' only two out of the ten technological clusters, namely IMaST S.c.ar.l. and D.A.Re S.c.ar.l. These clusters proved to be consolidated structures with good results and objectives in different performance areas. They operated mainly as knowledge integrators, enhancing the results of the joint research activity on the market. Concerning the clusters' ability to promote collaborative R&D projects and establish collaborative networks, the final evaluation grid presented in ANNEX V shows that the ten existing clusters' performance is overall similar: only the two 'Performers' - IMaST S.c.ar.l. and D.A.Re S.c.ar.l. – have a higher score for the number of networks/clusters. This confirms their stronger ability to interact with systems and networks at the national and international levels and create synergies and virtuous collaboration relationships.

Other sources of evidence also confirmed such achievements. For instance, the European Secretariat for Cluster Analysis (ESCA[81]) has awarded the agri-food cluster D.A.Re. S.c.ar.l. in the Puglia region the ECEI Bronze Label until the beginning of 2016. The latter 'documents the intention of a cluster management organisation to strive for excellence by improving its management capabilities and performance levels'[82]. Moreover, the case study evaluation by Studiare Sviluppo (2015) revealed that in Puglia, the agri-food technological cluster D.A.Re. had a decisive role in promoting collaborations thanks to the services offered. The questionnaires and interviews carried out in the context of the 2015 ex-post evaluation highlight an increase in the degree of cooperation, which appears particularly positive in relations between businesses and universities. Universities and research centres have enabled companies to make up for deficiencies in internal capacity and equipment.

Box 14. Ex-post evaluation by Studiare Sviluppo (2015)

'Evaluation of Research and Innovation policies' by Studiare Sviluppo (2015)

This study evaluates collaborative R&D activities carried out in Italy and financed by the Cohesion policy. The first chapters are devoted to a literature review on factors favouring collaboration and methodologies for evaluating R&D policies. The bulk of the study examines three collaborative research case studies implemented within as many technological clusters located in the convergence regions Puglia (D.A.Re), Sicilia (Agrobiopesca) and Calabria (R&D.log) in addition to a fourth case study on a collaborative research project implemented in the Marche region.

Source: own elaboration based on Studiare Sviluppo (2015).

[80] P1. Evaluation and monitoring systems of the activity carried out; P2. Interaction with firms; P3. Economic model and sustainability; P4. Technology transfer, innovation and integration of skills; P5. Networking and internationalisation.

[81] The European Secretariat for Cluster Analysis (ESCA) was created in the context of the European Cluster Excellence Initiative initiated by the European Commission in 2010. ESCA heads a European network of cluster and coordinates a network of around 200 cluster experts from more than 30 countries who implement a three-step quality audit for cluster and network organisations. To date, more than 850 organisations from 40 countries have submitted themselves to the audit. Moreover, ESCA advises funding agencies, ministries and political decision-makers in developing cluster policy.

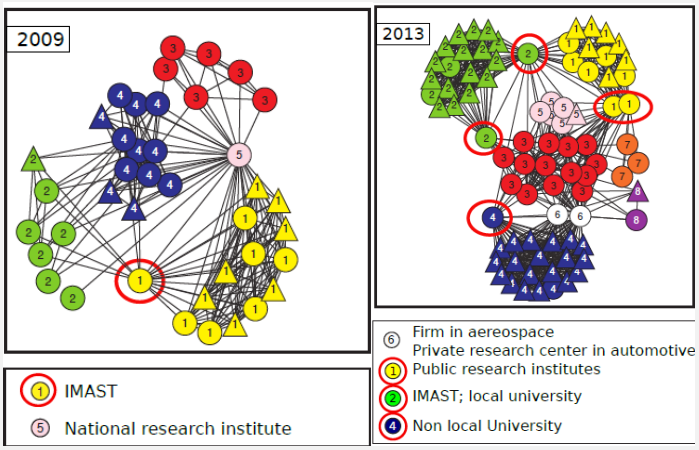
[82] Source: https://www.cluster-analysis.org/benchmarked-clusters

Regarding IMaST S.c.ar.l., the paper by D'Esposito et al. (2015) highlighted the increasing intensity of collaboration between local organisations over time and the evolution of the cluster in terms of types of cooperation established (see Box 15).

Box 15. An example of a successful network consolidation: the case of IMAST

'Analysing Structural Changes in Collaboration Networks through Social Network Analysis' by D'Esposito et al. (2015)

D'Esposito et al. (2015) studied the evolution of collaboration networks within the cluster IMaST S.c.ar.l. during a period covering eight years (2005-2013) using social network analysis. The study results showed how, in the initial period, collaborations took the form of a typical core-periphery configuration characterised by a single, small bridging core of research organisations, namely the main local university and the national research institute. Gradually, the composition of this bridging core changed also to include firms while developing inter-cluster collaborations. As a result, the network's topology evolved from a single bridging core towards a large cohesive nucleus connected to global partners through an increasing number of local and global bridging ties. A visual representation taken from the paper is presented below.



Representation of collaboration networks in 2009 compared to 2013. Circular nodes represent the cluster's associated members; triangles are partners from a different geographical region or nation. Numbers indicate clustering partitions. Red circles around nodes indicate bridging through inconsistencies.

Source: own elaboration based on D'Esposito et al. (2015)

The Performance Analysis by INNOVA S.p.A. of the DHITHEC in Puglia, R&D.Log and Cultura e Innovazione S.c.ar.l. in Calabria instead defined these clusters as '**Followers**'. The latter consisted of medium-structured networks that mainly acted as knowledge catalysts by aggregating subjects, skills and resources and promoting joint research and innovation plans to leverage public finance schemes. Despite having a worse performance than IMaST or D.a.R.E, those clusters have also consolidated their collaboration network, as the shareholding structure's evolution reveals. The cluster DHITHEC has experienced an increase in the number of participants: from the 7 partners in 2007[83] to the current 21[84]. In Calabria, the clusters have attracted many enterprises (five more respectively in R&D.Log and Cultura Innovazione S.c.ar.l.). However, as confirmed by the interviews carried out in the context of the study by INNOVA S.p.A (2013), this result was achieved after the creation of the two innovation poles. Therefore, it cannot be entirely attributed to the instrument under evaluation.

The remaining five clusters were instead included in the '**Early-stage groupings**' or networks still in the start-up phase: *DI.T.N.E. S.c.ar.l., Trasporti navali, commerciali e da diporto, Agrobiopesca, MEDISDIH S.c.ar.l. and Micro e nano sistemi*. Evidence of the

[83] Università del Salento, Consiglio nazionale delle ricerche, Avio Spa, Engineering ingegneria informatica spa, Fiamm spa, Leuci spa, ST Microelettronic srl (Source: https://www.lagazzettadelmezzogiorno.it/news/notizie-nascoste/59875/lecce-che-cos-e-il-distretto-tecnologico-dhitech-scarl.html)

[84] Università del Salento, CNR – Consiglio Nazionale delle Ricerche, INFN – Istituto Nazionale di Fisica Nucleare, Università degli studi di Bari A. Moro, IIT – Istituto Italiano di Tecnologia, Politecnico di Bari, Provincia di Lecce, Engineering Ingegneria Informatica Spa, STMicroelectronics Srl, Exprivia Spa, Tozzi Green Spa, Nuovo Pignone Srl, GE Avio Srl, CLIO Srl, Links management and technology Spa, Ospedale San Raffaele Srl, Ghimas Spa, Altea Spa, ESI Italia Srl, Confindustria Lecce, DW Informatica Spa (Source: http://www.dhitech.it/ecosistema/)

consolidation of their governance and network is overall mixed. The case study evaluation by Studiare Sviluppo (2015) found that in the Agrobiopesca cluster, funding stimulated only to a limited extent the collaboration of research centres with companies, especially small ones, which otherwise would probably not have been involved in research activities. The shareholding structure composition has remained unchanged since 2009[85], with a total number of 26 members. More unstable has been the evolution of the number of partners of the DI.T.N.E. S.c.ar.l. cluster. During the implementation of the projects funded by the OP under evaluation, the structure expanded in the first instance to shrink after the 2007-2013 programming period to the participation of only large companies[86]. The success of the technological MEDISDIH S.c.ar.l. cluster was highlighted in the working paper by Florio et al. (2014). The cluster was able to strengthen collaboration between its members and even with other research centres, companies, industrial or technological clusters, business representative associations, and universities on a regional and national scale, as confirmed by the increase in the cluster's membership[87].

In terms of the policy instrument's long-term results, Studiare Sviluppo (2015) and interviews noted that **the reinforcement of collaboration has generally been key for impact in terms of input additionality** in the three clusters under evaluation. Still, no quantitative data support this argument for the others. Total and business R&D expenditure increased in the convergence regions only at a more aggregate level, as already seen in the previous policy instrument's context, although not up to the target initially defined.

In terms of the **self-sustainability of clusters in the long-term**, a desk review and information collected through interviews showed that all the ten technological clusters still operate. Moreover, seven clusters are currently involved in one of the twelve technological clusters identified at the national level and supported during the current programming period 2014-2020 (see Box 11).

Table 6. Participation of regional technological clusters to National Technology Clusters

Regional technological clusters	Region	National Technology Cluster
R&D.Log	Calabria	/
Cultura e innovazione		/
IMaST	Campania	Cluster Transport Cluster Intelligent Factory
DHITECH	Puglia	Cluster SmartCommunitiesTech
D.A.Re.		Cluster Agrifood
MEDISDIH		Cluster Intelligent Factory
DI.T.N.E.		Cluster Energy
Agrobiopesca	Sicilia	Cluster Agrifood
Trasporti navali, commerciali e da diporto		/
Micro e nano sistemi		Cluster Energy Cluster SmartCommunitiesTech

Source: own elaboration based on web desk research.

Nevertheless, while the support provided in favour of existing clusters gave them an initial boost, in the long-term, not all of them have been able to find their vocation and to ensure their self-sustainability (with some exceptions). In this context, **the change introduced in the national RTD policy** favouring National Technology Clusters further intensified the difficulties of these clusters in adapting their role. In 2012, the Ministry of Education, Universities and Research launched a new national strategy to support National Technology

[85] See http://www.cnr.it/sitocnr/IlCNR/Innovazione/PartecipazioniScheda.html?id=15114 and http://www.agrobiopesca.it/Curriculum.pdf

[86] See: https://por.regione.puglia.it/documents/43777/94808/Seconda+Parte+-+Allegato+6+-+Monitoraggio+dei+Distretti+Tecnologici.pdf/809b09e3-1e3c-d3e7-3daf-30736810c346?t=1556795465380, http://www.ager.puglia.it/web/sviluppo-economico-e-innovazione/news/-/journal_content/56_INSTANCE_BHWJO9d6pKqJ/3728079/10356433;jsessionid=6A16D9A64CCEC94A0841FC5003B175B8?p_p_state=pop_up&_56_INSTANCE_BHWJO9d6pKqJ_viewMode=print) and https://www.ditne.it/il-ditne

[87] See: https://por.regione.puglia.it/documents/43777/94808/Seconda+Parte+-+Allegato+6+-+Monitoraggio+dei+Distretti+Tecnologici.pdf/809b09e3-1e3c-d3e7-3daf-30736810c346?t=1556795465380

Clusters. The latter, funded by the national fund for investments in scientific and technological research (*Fondo per gli investimenti nella ricerca scientifica e tecnologica* – FIRST), further support public-private collaboration, especially in southern regions. However, their introduction dramatically changed the intervention's logic and created a discontinuity in the RTD policy framework. The lack of continuity in the political support weakened the initial boost to regional technology clusters and created a fragmented and uncertain situation. Regional clusters had to find their source of funding and reshape their mission and role, but not all of them succeeded.

Some of them have preserved their role and still guide public and private members in their collaboration activities. For instance, IMaST in Campania is still able to promote collaborative research projects actively and expand its network, as evidenced by the number of initiatives in which it is currently involved[88]. Others have changed their approach by adapting their functions based on the requests of the partners. An example is the DI.T.N.E. in Puglia, which has evolved based on its member companies' innovation needs. Compared to the beginning, when the research was the main function of its services, the cluster currently provides consultancy and support services to its members and the market in general and, to a lesser extent, coordinates research projects.

Another example is represented by the two technological clusters in Calabria, which are now in charge of managing the regional innovation poles. Still, others have not evolved and are currently experiencing some difficulties maintaining their role and coordinating collaboration networks. For instance, Agrobiopesca in Sicilia has not maintained its role since the attention shift of RTD policy from regional to national technology clusters, and the need to look for alternative sources of funding has emerged.

Effects on governance and network construction

The admission to co-financing of 18 feasibility studies for the creation of new technological clusters as well as public-private laboratories finally led to the creation of four technological clusters[89], as evidenced by the data retrieved from the monitoring platform OpenCoesione: one in Puglia, two in Campania and one in Calabria[90].

Box 16. New technological clusters created by the policy instrument

Matelios (Calabria)

Background: The cluster was established to incentivise a collaborative approach between public and private entities to achieve internationally recognised scientific results in the sector of industrial applications of renewable energy and beyond.

Field: Renewable Energy

Total: EUR 5.08 million for two projects

Distretto Tecnologico Aerospaziale della Campania S.c.ar.l. – DAC (Campania)

Background: The cluster was established in 2012 in a region where the aerospace sector plays a pivotal role in industry and research expertise. This cluster aims to stimulate collaboration among research centres, universities, and firms in the Campania Region to create real business opportunities and continuous occasions of growth and innovation, especially in aerospace and aviation sectors. Moreover, the cluster supports education and training activities for young generation engineers and researchers in aerospace applications.

Field: Technologies for Aviation

Total: EUR 10.15 million for 6 projects

Distretto Tecnologico Aerospaziale S.c.ar.l. – DTA (Puglia)

Background: This cluster was created in 2009 in the Puglia region, one of the areas showing the highest economic impact of the aerospace sector, thanks to the long industrial tradition and relevant synergies between large companies, SMEs, local administrations and research centres. The

[88] See for instance: https://www.imast.biz/it/risultati/network

[89] This information has not yet been confirmed by the Managing Authority and it may therefore be inaccurate.

[90] It should be noted that the cluster Matelios, although not already created, was already mentioned in the first version of the OP Calabria 2007-2013, before the change introduced in 2010 by the RTD regional policy which shifted the attention from clusters to innovation poles.

final aim was to foster knowledge and improve the level of technological equipment in the aerospace sector in the region, to increase the innovation rate of product and services. The cluster promotes the collaboration between the aerospace sector's excellence in the region, supporting the implementation of industrial projects in collaborations between local firms, research centres, and universities while also promoting training activities for young professionals in this context.

Field: Technologies for Aviation

Total: EUR 11.74 million for 6 projects

Stress S.c.ar.l. – Sviluppo di tecnologie e ricerca per l'edilizia sismicamente sicura ed ecosostenibile (Campania)

Background: STRESS is the first technological cluster in sustainable construction. It was created to enhance competitiveness and innovation in the construction sector by establishing an active network between businesses, universities and research centres operating in the Campania region. In 2012 the Italian Ministry of Research and Education designated STRESS S.c.ar.l. as the implementing body of the cluster, based on 15 years of previous experience in this field and the networks established with universities in the region.

Field: Sustainable Construction

Total: EUR 5.9 million for two projects

Source: own elaboration based on a desk review and OpenCoesione data.

Interviews highlighted that, despite the long time necessary for establishing the governance, **newly created clusters have been able to contribute to the development of collaboration networks**. Interviews confirmed that the Distretto Tecnologico Aerospaziale S.c.ar.l. (DTA) in Puglia, as well as the Distretto Tecnologico Aerospaziale della Campania S.c.ar.l. (DAC), have acted as aggregators and promoters of the creation of an adequate system of skills to pursue long-term objectives. In both clusters, the network of members has expanded over time. In the cluster in Puglia (DTA) the number of members has increased from 15 in 2013 to 26[91]. Interviews with the cluster's managers of the DAC in Campania also revealed that the cluster has grown over time. Today it represents around 160 organisations (compared to the initial 30[92]), of which 20 are large companies, over 100 SMEs and nearly 20 research centres and universities. Specifically, private stakeholders have increased, thus modifying the cluster's structure from a group of members with a public majority to a private majority.

All four new clusters are still operating. However, only the two clusters in the aerospace sector in Campania and Puglia are currently part of the technological clusters identified at the national level and supported during the current programming period 2014-2020 (see Table below). In this respect, interviews confirmed that these two clusters have been able to adapt to the evolving national RTD policy and to ensure their self-sustainability over time. On the contrary, the evidence is rather scarce as concerns the Matelios and Stress S.c.ar.l.

Table 7. Participation of new regional technological clusters to National Technology Clusters

Regional technological clusters	Region	National Technology Cluster
Matelios	Calabria	/
Distretto Tecnologico Aerospaziale della Campania S.c.ar.l. – DAC	Campania	Cluster Aerospace
Stress S.c.ar.l.		/
Distretto Tecnologico Aerospaziale S.c.ar.l. – DTA	Puglia	Cluster Aerospace

Source: own elaboration based on web desk research.

Effects on knowledge creation and innovation

[91] Source: https://www.uniba.it/ateneo/organismi-associativi-partecipati-da-uniba/distretti/dta-distretto-tecnologico-aerospaziale and https://www.dtascarl.org/

[92] Source: http://www.regione.campania.it/regione/it/tematiche/distretti-tecnologici/dac-distretto-aerospaziale-campano?page=1

Publications and innovation output are reported in the final technical and scientific report produced by the beneficiaries and the technical-scientific experts' monitoring reports.

Interviews with beneficiaries **indicated positive effects in terms of knowledge creation and innovation**, despite the administrative delays and lengthy procedures identified during implementation. Achievement of expected results was confirmed in those clusters experiencing difficulties in the long-term.

Box 17. Examples of R&D projects achieving the intended results

IMAST S.c.ar.l.

Project Objectives: The GREEN project aimed to develop polymeric composite materials, processes, and architectures to create electricity-generating devices starting from renewable or waste energy sources.

Results Achieved: At the end of the project, three different types of new demonstrators have been developed, namely photovoltaic cells, thermoelectric generators and electromagnetic generators. The project's scientific objectives can be considered fully achieved, with three publications in scientific journals and one patent produced.

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Project Objectives: The ASAP project's objective was to develop new adhesive systems to improve the bonding processes and product performance for specific applications in the transport sector.

Results Achieved: In the aeronautics sector, an innovative thermosetting adhesive and related bonding process have been developed to fix the stringers to the skins. In the automotive industry, an innovative bonding process using a nano charged adhesive was developed. In the maritime sector, new adhesive systems with structural and fire resistance characteristics were designed. These will be used for the bonding of swimming pools and fire doors to the ship's structure. A bonded joint was inserted between a side panel and a floor inside a train for the railway sector, using a methacrylic adhesive to replace the mechanical bone. The project involved 218 researchers, producing five scientific publications and one pending patent.

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Di.T.N.E. S.c.ar.l.

Project Objectives: The EFFEDIL project aimed to develop energy-efficient materials and systems for the construction sector and the management and optimisation of buildings' energy balance.

Results Achieved: As a result of the projects, the cluster's members were able to produce concrete results already exploitable from an industrial point of view, such as smart sensors and new energy-efficiency materials for the construction of buildings. Moreover, the project generated several publications. Some examples are:

- Baglivo, C., Congedo, P. M., Fazio, A., Laforgia, D., 2014. 'Multi-objective optimisation analysis for high-efficiency external walls of zero energy buildings (ZEB) in the Mediterranean climate', *Energy and Buildings*, Volume 84, https://doi.org/10.1016/j.enbuild.2014.08.043
- Baglivo, C., Congedo, P. M. Fazio, A., 2014. 'Multi-criteria optimisation analysis of external walls according to ITACA protocol for zero energy buildings in the Mediterranean climate', *Building and Environment*, Volume 82, https://doi.org/10.1016/j.buildenv.2014.09.019

***

Distretto Tecnologico Aerospaziale S.c.ar.l. – DTA[93]

Project Objectives: The MAIPCO project intended to develop new methodologies for detecting and minimising construction defects associated with the construction of composite components in the aeronautical sector.

Results Achieved: The implementation of the project led to the development of:

- an automatic computer vision and signal analysis system with robotic handling (AVRIS) for the validation of assemblies (fuselage, transmission systems, stabiliser);
- the AVRIS System automatically identifies the presence/absence of components, their correct

[93] For more details on the objectives and results of the R&D projects see: https://www.dtascarl.org/progetti-e-iniziative/

installation and the presence of fixings.

Source: interviews with direct beneficiaries.

Interviews could not compare the performance of firms belonging to the clusters to those out with them. Still, some insights come from the work done by Bertamino et al. (2016) on the wider national experience of clusters in Italy (see Box 18). Overall, **cluster firms did not outperform similar firms not involved in a cluster** as concerns all variables considered, including innovation capabilities. As highlighted for the previous policy instrument, the low level of patents is confirmed by quantitative evidence on patent applications at a more aggregate level but may also find an explanation in the deliberate decision of firms not to inform competitors about innovative results, as sometimes highlighted by interviewees.

Box 18. Ex-post counterfactual evaluation by Bertamino et al. (2016)

'Local policies for innovation: the case of technology districts in Italy' by Bertamino et al. (2016)

This counterfactual ex-post evaluation focuses on the differences in performances between firms belonging and non-belonging to clusters, using **matching methods and differences-in-differences estimates**. The latter ensures the control for the initial differences in observables and unobservable between the two groups of firms. In more detail, firm performance is evaluated in terms of size (assets, sales and added value), profitability (gross operative margin over assets and returns on assets), accumulation of tangible or intangible assets (investment rate), financial structure (leverage), labour productivity, and innovation capabilities, measured by patent applications submitted to the European Patent Office.

To verify potential heterogeneity of the performance, the sample was broken down by the firm's size and the cluster's location. As a result, although the evaluation considers all the clusters in the country, it is possible to extend results to the context of this evaluation, considering only the results provided for those located in the South.

The **main finding** of the evaluation is that, on average, the performance of firms belonging to a cluster does not differ from that of non-cluster firms located in the same area.

Although some of the results of this ex-post evaluation can be used in the context of the case study, **some limitations** are highlighted below:

- The unit of analysis of the ex-post evaluation includes all technological clusters operating in the country and not only the technological clusters located in convergence regions; however, regional differentiation is provided while drawing the conclusion;
- The evaluation focuses solely on companies, and it does not take into account the positive effects, even indirect ones, that the creation of new links between the various actors can also have on the absorption capacity of companies.

Source: own elaboration based on Bertamino et al. (2016)

Effects on skills development

Interviews confirmed that in the context of those research projects funded by the OP in existing technological clusters, training courses were positively implemented and helped **researchers develop specific skills and competences** related to the sector and technological field of application of the supported project.

Results in terms of intermediate outcomes are similar to those already shown for the first policy instrument assessed. Overall, the policy instrument ensured that technological skills and employment opportunities in the R&D sector improved for young researchers from convergence regions; this is reflected in the several examples provided by anecdotal evidence (see also Box 19). For instance, in the IMaST cluster in Campania, the results show that a very high percentage of researchers, very close to the total (between 90 and 100%), are now employed in industrial partners or members' suppliers. The Di.T.N.E. cluster in Puglia also reported a placement rate among trainees reaching almost 100%. However, a partial achievement of the expected result is suggested because some of them were also employed in research centres or universities, or even went to non-convergence regions or abroad, or were not necessarily engaged in R&D sectors or divisions.

Box 19. Examples of training activities achieving the intended results

IMAST S.c.ar.l.

Training activities: IMaST has implemented different 'on the job' training projects to train professionals in the sector of composite materials. The number of researchers involved was established by a pre-project analysis to determine the partner firms' specific needs, both in terms of the number of human resources and field of specialisation.

Results: IMaST also set up an internal system to monitor the levels of employment of the trained researchers at a different point in time, generally after six months and one year. The results showed that the vast majority of these professionals became employed (a share close to 97%), either within a business partner of the cluster or at a partner's supplier.
In particular, in the framework of the GREEN project supported by PON R&C resources, four professionals were involved in a training program for almost two years. The monitoring system indicated that all of them became employed within 12 months. Similar results are recorded for the PRADE project, which involved eight professionals.

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Di.T.N.E. S.c.ar.l.

Training activities: In the framework of the 'Smart energy boxes' project, a training program was developed with the provision of five training grants targeting the profile of 'Expert researcher in intelligent systems of high-efficiency energy production'.

Results: According to the project's performance indicators, five more professionals than the expected target were hired by one of the private firm's project partners.

Source: interviews with direct beneficiaries.

Verification of pre-conditions

For those effects showing better results, namely the governance and network creation and consolidation and skills development, pre-conditions were generally verified. The opposite applies to the results for knowledge creation and innovation and on broader impacts. This limited materialisation of outcomes and effects stems from several failed pre-conditions.

Among the ten existing technological clusters, almost all received funding and were then able to strengthen their governance. All clusters were able to submit the 5-year strategic development aggregation plan necessary to implement research projects. The significant number of proposals proved that these **geographical aggregations were overall able to understand private and public needs and guide science and industry actors towards realising** common research objectives (pre-condition 1). However, the performance of managerial capacity differed from one cluster to another. This explains the differences in results across clusters and regions. As already mentioned above, the ex-post evaluation carried by INNOVA S.p.A. (2013) identified three types of categories under which clusters could be classified based on their performance. In managerial capacity, IMaST and D.A.Re were the clusters performing better.

Differences across clusters can also be identified at the end of the implementation of the policy instrument. In the long term, clusters were expected to develop the ability to adapt their mission to the changing environment and become financially self-sustainable by finding funding sources additional to public support. However, **their capacity to adapt their role and activities** varied. Only in some cases have the clusters been able to evolve according to the evolving context and needs of beneficiaries, thus showing the limited materialisation of pre-condition 8. Moreover, the shift in the national policy strategy from regional to national technological clusters further exacerbated the required changes and adaptive behaviour.

With the newly created clusters, interviews highlighted, for example, that *Distretto Tecnologico Aerospaziale S.c.ar.l.* in Puglia showed good managerial capacities after the policy instrument's implementation. The cluster was able to diversify financing sources compared to the period in which it benefitted from this policy instrument only. Currently, sources of funding include the European Space Agency (ESA), MIUR, MISE, INTERREG, and H2020, testifying to the consolidation and development of the cluster's management

capacity. An analysis of the financial statements of clusters such as IMaST or DHITECH, publicly available on their respective websites, confirmed that these clusters have also expanded the list of funding sources. A comparison of the 2009-2013 financial report to that of the most recent years revealed that R&D projects are currently funded by other sources beyond ERDF, such as regional and national funding and other European programmes (e.g. the European Research Council - ERC, INTERREG, H2020). This was not the case for other clusters. For instance, the Agrobiopesca cluster in Sicilia now coordinates smaller scale projects since it faces difficulties in identifying additional financing sources for its members. By contrast, as long as the OP provided funding, the cluster proved able to coordinate partners and helped them implement projects. A similar case was identified in Puglia, regarding the MEDISDIH S.c.ar.l. cluster. The latter has now become a digital innovation hub[94]. However, since more limited public funding is now available for clusters, the governance established is experiencing difficulties finding viable investment alternatives.

Besides the verified pre-conditions, two additional elements should be included. First, the significant amount of feasibility studies received confirmed that **there was local demand for geographically concentrated research activities** (pre-condition 2). Second, all research projects managed to attract talent and scientists to be trained (pre-condition 3) and therefore included training activities to increase the scientific and technological competences of potential R&D personnel, in line with requirements set out in the call.

Conversely, the timely establishment of new cluster organisations and the selection of projects in these newly created territorial aggregations were not verified. Interviewees highlighted that the long process necessary for establishing the governance structure within the cluster and signing the Framework Programme Agreements between the Ministry and the regional administrations affected the timely selection and then the implementation of research projects (pre-condition 4). As a result, a considerable share of the cost of research projects admitted to co-financing was ultimately not funded by the OP under evaluation; the time limits for the eligibility of expenditure of the 2007-2013 programming period were exceeded Out of the 81 projects eligible for co-financing[95], 34 were only partially funded by the OP. A portion of their cost has been re-allocated to national resources, as confirmed by the Managing Authority.

Overall, no specific issues emerged with **the quality of research projects** submitted by clusters (pre-condition 5). It should be considered that the regional pre-allocation of the total budget aimed at ensuring a territorially balanced selection might have impacted the overall quality. However, no evidence is available in this respect.

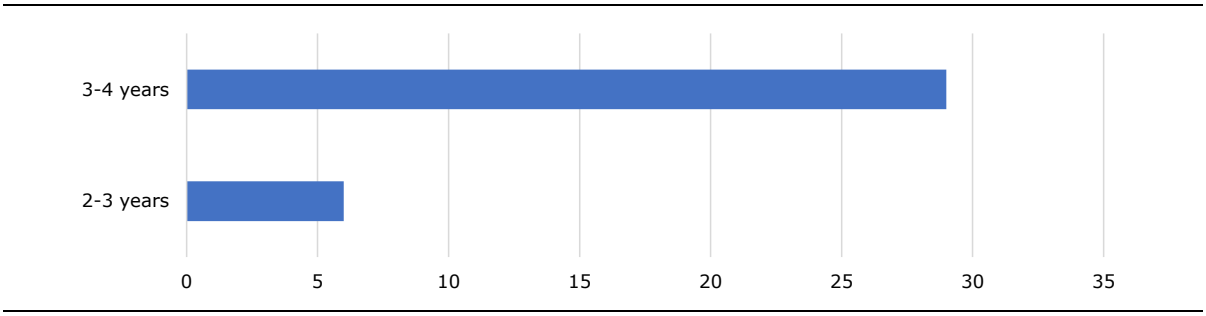
A factor limiting the effectiveness of research projects in terms of knowledge creation and innovation was **the lack of timely disbursement of funds and smooth procedures** hampered by administrative capacity issues (pre-condition 6). After the call's launch in October 2010, the deadline was extended from February to March 2011[96] and a second time from March to April 2011 for the new aggregations only [97]. The final ranking of the applications was approved only in July 2012, almost two years after the call issue. Delays were due to the revisions of proposals requested by most of the projects' administrations to meet minimum eligibility requirements [98]. In August 2012, the four Framework Programmes Agreements with the regional administrations were also stipulated. Moreover, problems related to the Managing Authority's administrative capacity postponed most of the disbursements based on the biannual control procedures.

As a result, the implementation of the interventions under assessment was delayed in most cases and generally exceeded the 36 months initially foreseen. Although 19 projects were closed within the three years initially planned, the remaining sample exceeded this deadline

[94] As a consequence it changed its original name MEDIS into MEDISDIH
[95] Source: information provided by the Managing Authority in July 2020.
[96] Decreto Direttoriale n. 53/Ric. (2nd February 2011).
[97] Decreto Direttoriale n. 133/Ric. (21st March 2011).
[98] Decreto n. 286/Ric. (2011).

by a maximum of one year. Project extension was allowed from July 2016 to May 2017. Also, deadlines for submitting the final expenditure certificates were first extended in December 2014, and in October 2015, the Managing Authority approved a decree allowing project variation up to a limit of 20% in terms of content and actors involved in the project[99].

Figure 20. Project duration (in years)



Source: own elaboration based on Task 1 data.
Note: data refer to 35 projects only and exclude projects from the previous programming period.

As with the previous policy instrument, the partial achievement of longer-term effects linked to training activities was also due to the limited verification of pre-condition 7. The correspondence between the available workforce (number of researchers involved in the project and looking for a job) and the job demand (number of potential employees within the industry) was not always ensured.

Verification of supporting factors

All the identified supporting factors partially took place and, in some cases, positively influenced the achievement of intended results as a part of the causal package.

Overall, lengthy administrative procedures and payment delays did not affect the research projects' results, especially in the context of those clusters involving **large firms with more robust capital and financial solidity** and of research centres or universities able to attract additional research funding (supporting factor 1). In consideration of the MIUR response time, many companies achieved part of the expected results even before the projects were admitted to financing, as confirmed by interviewees.

The **presence of large enterprises specialising in a strategic sector as members of the cluster (supporting factor 2) also favoured some clusters' ability** to adapt their vocation in the long-term, including after the focus of the national RTD policy shifted its attention from regional to national technological clusters. As pointed out in interviews, in those clusters where large firms were among the main partners, the management was more able to preserve their coordinator's role. For instance, this was the case of the IMaST cluster in Campania, where all enterprises involved were large[100], or of the Distretto Tecnologico Aerospaziale S.c.ar.l. (DTA) in Puglia. There, large enterprises and only a few SMEshelped the cluster build a one-to-one relationship between each member, thus easing their coordination. The case of the Agrobiopesca cluster in Sicilia is different. This cluster operated in the agro-industrial sector, which is very branched, with a wide variety of small partners[101], making their coordination more difficult.

Synergies and complementarities with other national and regional RTD strategies were not always ensured, and clusters overall suffered from the change of direction introduced by the national RTD policy favouring the national technology cluster (supporting factor 3). This initiative introduced a discontinuity in the RTD policy; there was no longer a clear context under which existing and newly created technological clusters at the regional level should develop. It is only where regional administrations were able to guide

[99] Decreto n. 2350 (20th October 2015).
[100] Avio, Centro Ricerche Fiat, Cetena, Cytec Solvay Group, Adler Plastic, Dompé, FCA, Leonardo Spa, MBDA, STMicroelectronics and Boeing Company. Source: https://www.imast.biz/it/il-distretto/soci
[101] See the list of enterprises involved here: http://www.agrobiopesca.it/Curriculum.pdf

and coordinate technological clusters towards selecting the relevant national technological cluster that other sources of funding contributed to increasing the propensity to invest in R&D and ensure self-sustainability of the cluster. Moreover, as evidenced by the literature, clusters alone cannot create a favourable business environment and other framework conditions, as well as the necessary skills, are necessary to make existing cluster flourishing and lasting.

Verification of risks and threats

in the context of implementation and payment delays, it is clear that the levels of knowledge creation and innovation were affected by the materialisation of **typical project risks** such as project delays or cancellation (risk 1). As already highlighted, in some cases, the commercial and/or industrial relevance of project results was affected by delays in implementing the intervention, as confirmed by some interviewees.

The **outbreak of the 2008 economic crisis** also impacted (risk 2) the policy instrument's overall effectiveness. The technological upgrading of beneficiaries in particular, and the economic development in general of convergence regions, were hindered. The crisis negatively affected the economic and financial capacity of many firms in convergence regions.

3.3.3. General assessment

There is a wide consensus and evidence that the policy instrument managed to give a determinant contribution to the consolidation of existing clusters and the creation of a few new clusters by providing an initial boost, promoting stable cooperation networks of science and industry actors. There is evidence that the policy instrument in existing clusters contributed to tangible results associated with the implementation of R&D projects for knowledge creation and innovation. However, its contribution in newly created clusters is more limited. The outcomes of the limited number of R&D projects finally funded in new territorial aggregations are only limitedly related to the policy instrument under evaluation since other sources of funding were ultimately allocated to support a considerable portion of those projects.

The contribution of the intervention to the long-term consolidation of these clusters is less evident. The lack of synergies and continuity with other national policies has created a fragmented and uncertain situation. In this context, only clusters with a higher managerial capacity could adapt their mission and ensure their self-sustainability over time.

The policy instrument contributed in a necessary way to observed results (i.e. they would have been possible only to a certain extent without the intervention's inputs). Still, additional supporting factors were also influencing the pathway. However, the level of achievement is below expectations.

The policy instrument was implemented according to the initial logic and managed to generate a significant number of project proposals, from which a considerable number of development plans and feasibility studies were selected. Still, the implementation of research projects was limited in both existing and new technological clusters. In existing clusters, public support led to the expected outputs, although to a more limited extent than expected. In new clusters, out of the 81 projects admitted to co-financing[102], the OpenCoesione platform's data reveal that 42 research projects were implemented by new technological aggregations, absorbing payments for a total of EUR 79 million, far below the allocated budget.

Thanks to the ERDF support, new and existing clusters were strengthened, and overall, their self-sustainability was ensured. However, the level of R&D investments did not significantly improve across beneficiaries. In this respect, the absence of supporting factors

[102] Source: information provided by the Managing Authority in July 2020.

ensuring synergies with other national RTD policies negatively influenced such outcomes. The impact on the technological upgrading of recipients and target territories is even less evident. More details on the achievement of the four identified levels of effects are provided below.

The governance structure of clusters was strengthened in most cases thanks to the policy instrument. However, the effects of consolidation of existing collaboration networks, observed immediately after the project implementation, varied across clusters and regions; in particular, there was more success in Campania and Puglia. In these regions, clusters showed a better managerial capacity and ability to adapt to policy changes.

In terms of long-term results, evidence showed that the reinforcement of collaboration has generally been key for impacts in terms of input additionality.

Evidence shows that all the clusters still operate. However, not all clusters were able to adapt to their role over time, especially after the change introduced in the national RTD policy favouring national technology clusters. Some of them preserved their role and still guide public and private members in their collaboration activities. Others have changed their approach by adapting their functions based on the requests of the partners. However, others have not evolved and are currently experiencing some difficulties maintaining their role and coordinating collaboration networks. Where regional administrations were able to guide and coordinate them towards selecting the relevant national technological cluster, such as in Puglia and Campania, there has been greater self-sustainability.

Despite the long time necessary for the establishment of governance, newly created clusters contributed to the development of collaboration networks. All four new clusters are still operating now. Two of them are also part of the national level's technological clusters and supported during the current programming period 2014-2020.

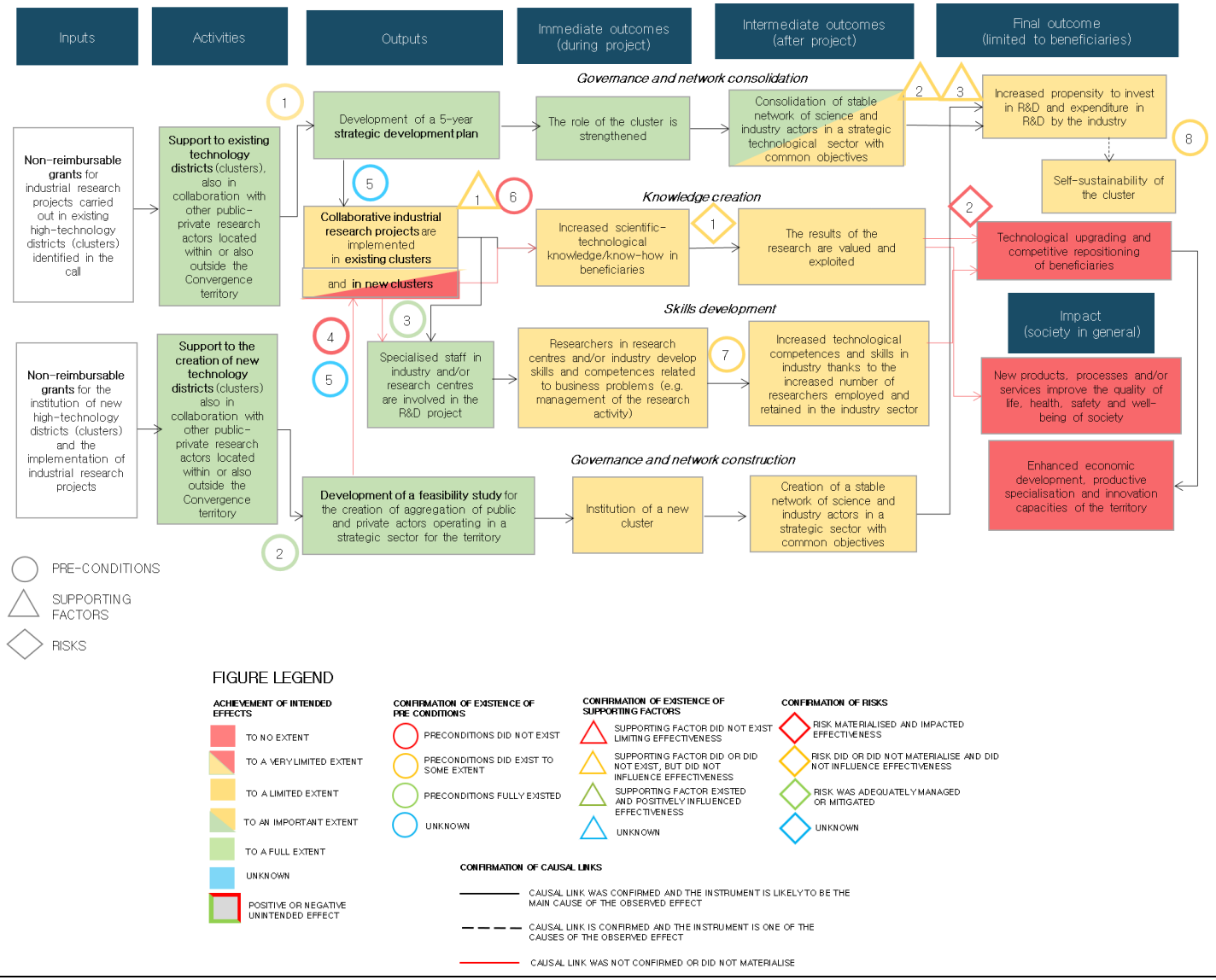
Research projects were implemented in the context of both existing and newly established technological clusters. However, in new territorial aggregations, the long process necessary for creating governance within the cluster and signing the Framework Programme Agreements between the Ministry and the regional administrations affected the timely selection and implementation of research projects. Other national sources of funding ultimately funded a considerable portion of these projects. As a result, the contribution of the policy instrument in this respect is quite limited. Conversely, there is evidence of positive results in existing technological clusters and that the intervention contributed to the achievement of outcomes in terms of innovation in products and processes.

A factor limiting the effectiveness of research projects in knowledge creation and innovation is the lack of timely disbursement of funds and smooth procedures. This was hampered by administrative capacity issues which therefore impacted the effectiveness of funded research projects. In some cases, the commercial and/or industrial relevance of project results was affected by delays in implementing the intervention, as confirmed by interviewees. The economic crisis also exacerbated the effects of funding delays.

However, payment delays and the effects of the economic crisis did not affect the results of the research projects, especially in the context of those clusters involving large firms with stronger capital and financial solidity and of research centres or universities able to attract additional research funding.

All training activities were carried out in conjunction with the research projects and generally ensured that all researchers involved in projects could develop specific skills related to the sector of application of the project. Although the participants' placement rate was overall high, not all of them found a job in firms located in the convergence territory, as was the intention of the intervention’s logic. Some of them were also employed in research centres or universities or even went to non-convergence regions or abroad.

Figure 21. Representation of the results of the contribution analysis for the Collaborative R&D projects in technological clusters policy instrument



3.4. Policy instrument: Infrastructure investments for research under OP R&C

3.4.1. Theory of change of the policy instrument

Infrastructure investments for research in public universities, research centres and non-profit research organisations located in the convergence regions were funded through non-reimbursable grants by invitation to tender issued in May 2011[103]. The initial total budget of EUR 400 million was intended to subsidise:

- **Infrastructure investments** with a significant financial dimension (e.g. construction and renovation work, purchase of research and IT instrumentation and equipment)[104];
- **Related training activities**.

Support was provided based on **several pre-conditions** in line with the literature review in the First Intermediate Report. On the one hand, the beneficiary had to ensure the coordination of the procurement process and/or of the construction works, and funds should be timely disbursed to avoid implementation delays. On the other hand, the implementation of training activities was subject to leading scientists and R&D personnel interested in the research programmes offered by the beneficiary.

The policy instrument was introduced **to respond to the need for infrastructure modernisation** characterising convergence regions. Although public research organisations' presence was widespread across the convergence territory, there was the need to adapt the operating standards and the attractiveness and competitiveness of the scientific structures, especially in the sectors with more significant impact in terms of development and research excellence.

Infrastructure projects with an interregional dimension were actively encouraged. Although the call did not set out a specific requirement in this respect, the selection procedure privileged those projects implemented by large partnerships, with more significant spillovers over the convergence territory and located across different regions[105].

Eligible projects were submitted by public research actors (i.e. universities, research centres) or other non-profit research organisations, held neither directly nor indirectly by private companies, with a stable location in convergence regions[106]. Project proposals could be submitted either individually or in collaboration.

With the ultimate aim of increasing the participation of the public research system in international and European research projects as well as collaboration with industry, infrastructure investments were intended to have an impact on the economic development, productive specialisation and innovation capacities of the convergence territory. In this respect, **two different levels of effects** characterise the expected outcomes from the provision of support to research infrastructure:

- Improved research and innovation potential;
- Skills and institutional capacity development.

Improved research and innovation potential

Infrastructure investments were aimed at increasing the capacity of public scientific bodies to operate in support of the innovative processes of the entrepreneurial system by inserting

[103] Decreto Direttoriale n. 254/Ric. (18th May 2011).
[104] The project cost should not be less than EUR 15 million or over EUR 45 million.
[105] Source: information provided by the Managing Authority on 10th July 2020.
[106] Alternatively, beneficiaries could also commit to locate their organization in these areas for the purpose of the project activities and to maintain it for at least 5 years after the actual conclusion of the project.

themselves in a logic of connection and continuity with the other actions launched by the OP (i.e. industrial research and technological clusters).

The improved research and innovation capacity was expected to **increase the funded infrastructure's attractiveness and competitiveness** at regional, national and international level. Therefore, support was expected to contribute to the active participation of funded research infrastructure in the European Research Area and research and innovation activities in collaboration with firms, clusters, public-private laboratories, etc. Overall, the designed policy instrument was conceived in parallel with supporting, facilitating and encouraging, also through public-private collaboration, the development of new knowledge, with a possible impact on the territory. In this respect, two necessary pre-conditions had to hold. First, the research infrastructure had to be able to carry out projects of proven excellence and with an interregional and international vocation. Second, it had to be able to operate in strategic sectors, thus responding to the industry actors' needs in terms of innovation.

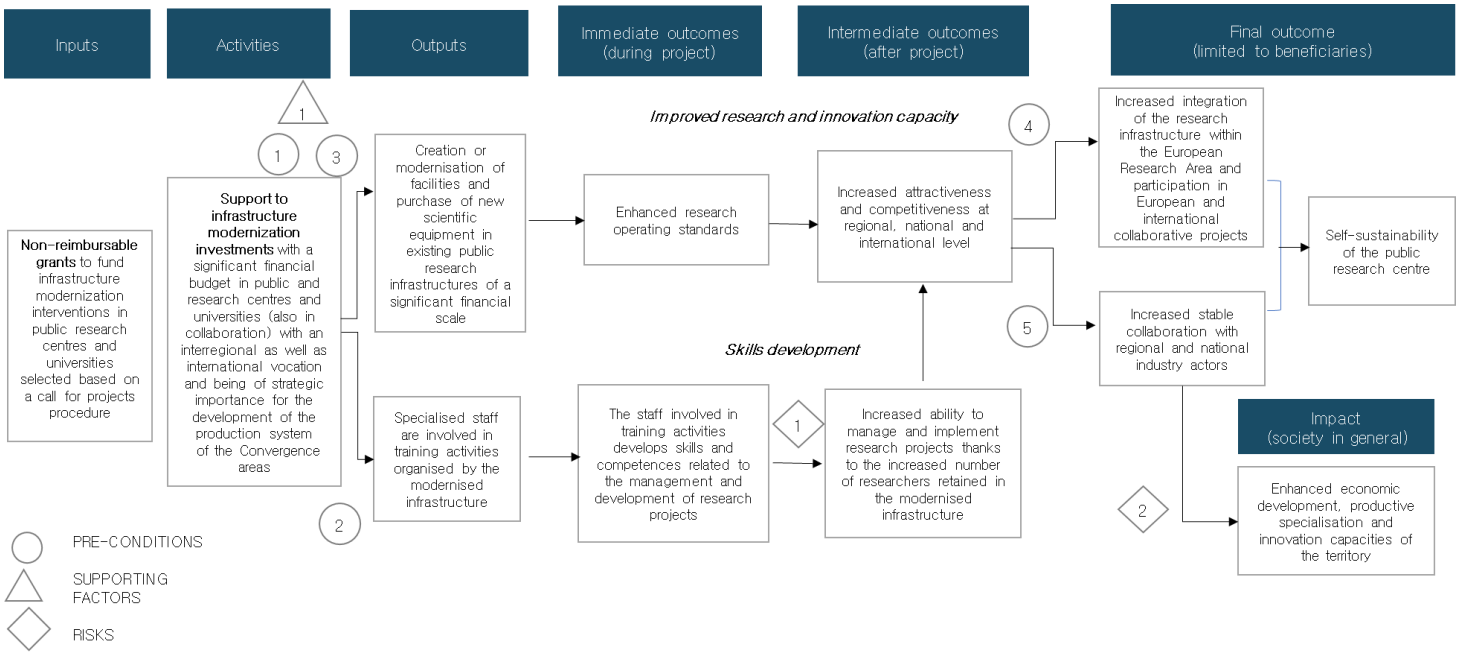
As a result of increased participation in research projects either at the national, European or international level, the public research infrastructures could benefit from continuous and stable support in financial terms, which therefore ensured their self-sustainability in the long-term. Moreover, as already seen with the collaborative R&D projects in previous sections, collaboration with the industry, in particular, was meant to favour the development of repositioning strategies of the economic system, provided that the research infrastructure operated in areas of particular strategic importance.

Skills and institutional capacity development

Training activities for research staff and R&D personnel were intended to generate new competences and differentiated skills across different research profiles: management, technical-commercial, scientific.

Training activities had to increase the skills and competences of researchers and the institutional capacity of the research infrastructure in managing research projects. As a result, the funded facility could increase its ability to manage and implement research projects thanks to the increased number of researchers retained in the modernised infrastructure. Moreover, trained R&D personnel would have higher impacts in terms of research project results (i.e. managerial, research and technical skills) and, consequently, on the research centre or university's attractiveness.

Figure 22. ToC for Infrastructure investments for research



Pre-conditions

1. The beneficiary is able to ensure coordination of the procurement process and/or of the construction work
2. Availability of leading scientists and R&D personnel, including graduates and doctoral students, postdoctoral fellows, trainees, and young scientists
3. Funds are disbursed timely and according to smooth procedures
4. The research infrastructure is able to carry out project of proven excellence and with interregional and international vocation
5. The research infrastructure operates in areas of particular strategic importance for the development of the production system of the Convergence areas

Supporting factors

1. The research infrastructure receives additional funding from other national or regional sources (e.g. Regional OPs)

Risks or threats

1. Financial and administrative issues within public research organisations prevent the hiring of additional human resources
2. Contextual factors (economic, social, institutional, cultural, political) hamper the socio-economic development

Source: Own elaboration based on primary and secondary data collected.

3.4.2. Contribution analysis

Verification of intended intervention implementation

The requirements, underlying rationale and goals set out in the invitation to tender in May 2011 were not altered during the implementation phase. Funding was distributed through an open call to select infrastructural investments in public research actors located in the convergence regions. The call was adequately circulated and generated a quite significant number of proposals. After the launch of the invitation to tender in May 2011, a total of 83 applications were submitted. Since it was possible to increase the total budget in case projects for a value higher than the resources made available were eligible for co-financing, an additional allocation of EUR 301 million was approved, and the EUR 400 million initially made available[107].

However, it is worth noting that some implementation issues emerged during the selection stage. The inclusion of non-profit organisations as potential eligible beneficiaries of infrastructure investments beyond public research actors made it possible to select organisations funded by private actors. Such circumstance raised a problem in terms of consistency with the European State Aid Regulation. As will be explained in the following sections, it partially affected the smooth management of administrative procedures and operations.

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

The objective to select and fund infrastructural projects for a total of EUR 701 million was **overall achieved**. Based on the data made available on the OpenCoesione platform, 46 projects with related training activities were eventually funded. The latter corresponded to payments equal to EUR 491.1 million, 30% lower than the allocated budget[108]. As is the case for the policy instruments previously assessed, the OP is not yet administratively closed can explain this difference. While 44 projects consisted of investments for the modernisation of research infrastructures implemented mainly in higher education institutions and research organisations, two projects were specifically ICT infrastructure investments.

Table 8. Breakdown of projects by types of policy interventions

	Number of projects	Total eligible cost
2.1. Infrastructure investments for research	**44**	**469,930,817.90 €**
a. In higher education institution	25	262,402,894.81 €
b. In Research and Technology Organisation	14	158,008,065.97 €
f. In science and technology parks	1	12,218,400.00 €
h. Others	4	37,301,457.12 €
2.3. ICT-based infrastructure	**2**	**21,183,109.70 €**
a. In higher education institution	1	10,457,276.80 €
b. In Research and Technology Organisation	1	10,725,832.90 €
Total	**46**	**491,113,927.60 €**

Source: own elaboration based on Task 1 data.

The information on the total project cost is not available. Still, data on eligible costs suggests that projects had a **significant financial scale** as required by the call (between EUR 15 and 45 million).

[107] Decreto Direttoriale prot. n. 924/Ric. (7th November 2011).

[108] Source: expenditure data collected in the context of Task 1 (with a cut-off date of 28th February 2020). Data provided by the Managing Authority on 20th October 2020 show that total certified payment up to July 2020 correspond to EUR 450.6 million (including both the national and the European co-financing) and that a total of EUR 24.6 million under measure IV.1 are still under suspension. The data are not definitive, since the operational programme has not yet been concluded and disbursements are still ongoing.

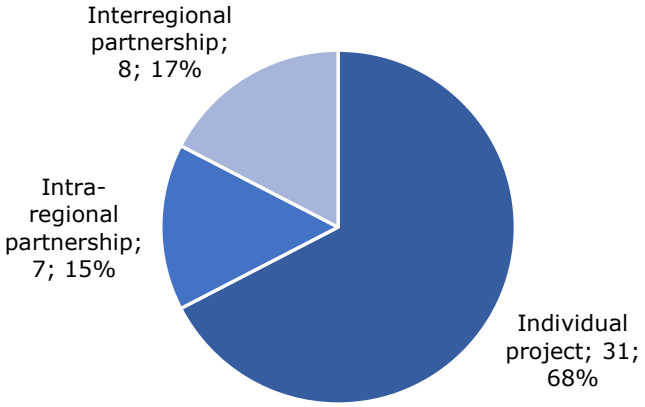
Table 9. The financial scale of infrastructure investments for research

	Average eligible cost	Maximum eligible cost	Minimum eligible cost
2.1. Infrastructure investments for research			
a. In higher education institution	10,496,115.79 €	17,683,176.00 €	5,711,949.26 €
b. In Research and Technology Organisation	11,286,290.43 €	18,217,594.41 €	7,564,000.00 €
f. In science and technology parks	12,218,400.00 €	12,218,400.00 €	12,218,400.00 €
h. Others	9,325,364.28 €	13,182,553.97 €	7,560,388.14 €
	10,680,245.86 €	**18,217,594.41 €**	**5,711,949.26 €**

Source: own elaboration based on Task 1 data.

Although it was not a specific requirement of the call, it is interesting to note that interregional partnerships represented only 17% of the total number of projects. In contrast, the majority of projects were implemented by single beneficiaries. Distributed infrastructures were much less frequently built or modernised than single-site research facilities.

Figure 23. Breakdown of projects by types of partnerships



Source: own elaboration based on Task 1 data.

Box 20. Examples of distributed infrastructures

BIOforIU infrastructure

Laboratories for advanced research were created or modernised in the University of Salento in Lecce for experimental bioecology, the National Research Council (CNR) of Bari for the study of molecular biodiversity, the Institute for the Coastal Marine Environment (*Istituto per l'ambiente marino costiero* – IAMC) of Capo Granitola in the Sicilia region for the marine biodiversity observatory, the National Research Council (CNR) of Naples for advanced bioimaging, and the Anton Dohrn Zoological Station for the study of marine organisms and consequent applications.

***

Beyond-Nano infrastructure

This infrastructure consists of a distributed infrastructure, in which different National Research Council (CNR) Institutes interact:

- The Institute of Microelectronics and Microsystems (Istituto per la microelettronica e microsistemi - IMM) of Catania;
- The Institute of Nanotechnologies (Nanotec) of Lecce and Cosenza;
- The Institute for Polymers, Composites and Biomaterials (Istituto per i Polimeri, Compositi e Biomateriali - IPCB) of Naples-Portici and Naples-Pozzuoli.

Source: own elaboration based on desk research.

Although lower than expected, expenditures allowed the construction and modernisation of a high number of research infrastructures and the purchase of high-quality research equipment. In addition to the 46 projects supported (see above), the **direct output target of the instrument was exceeded**. The performance indicator specifically related to this policy instrument reveals that the strengthened infrastructures were a total of 152, which

means 82 more than the target set out (equal to 70). Interviews also confirmed this finding. Funded projects received high visibility, and more than half of them were also publicised on the media or institutional websites (see some examples in the Box below).

Box 21. Some examples of built or modernised research infrastructures[109]

CECAP – A Protoni centre in Campania

€ **Total project cost**: EUR 13.4 million

Thanks to the funding made available in the context of the call, the research infrastructure bought two linear accelerators: an IORT - an in vivo microscopy and a spectrometer for nuclear magnetic resonance - and accurate calculation systems to develop treatment plans in radiotherapy[110].

***

LEDA - Laboratory of Earthquake Engineering and Dynamic Analysis

€ **Total project cost**: EUR 10.6 million

The LEDA centre was built inside the new University Campus of the Faculty of Engineering and Architecture of the University 'Kore' of Enna, located in the Santa Panasia district of Enna Bassa (Sicilia). Within the LEDA centre, the Experimental Dynamics Laboratory was equipped with a system of two vibrating tables used for seismic analysis and the qualification of devices to mitigate seismic risk[111].

***

Mediterranean Centre for Human Health Advanced Biotechnologies (MED-CHHAB)

€ **Total project cost**: EUR 22.1 million

The project involves the establishment of a research centre of excellence of approximately 3,000 square meters at the University of Palermo, aimed at the development of biotechnology applied to human health, and equipped with cutting-edge equipment for applications and the development of diagnostic biotechnology, regeneration, of treatment of pathologies, etc.[112]

***

Enhancement of advanced technological platforms for the development of gene and pharmacological therapies (TIGEM)

€ **Total project cost**: EUR 10 million

infrastructural investments have created three floors for 5 thousand square meters, 4 'open space' laboratories capable of hosting over 200 researchers, four meeting rooms with an auditorium and 28 other laboratories[113].

Source: own elaboration based on a web search.

Along with the infrastructure investments, **46 training activities were also launched**, generally taking the form of master's degrees. In line with the call, in most cases, two professional profiles were identified as the target of the training project: the 'manager' profile, with skills in the management, development, and marketing of scientific and technological services, and the 'technical' profile, with expertise in the use of technological equipment and services for applied and experimental research.

[109] The information on the total project cost has been retrieved from the OP R&C website.
[110] Source: https://www.ilmattino.it/napoli/cronaca/napoli_radioterapia_protoni-1160033.html, http://www.irpinia24.it/wp/blog/2015/09/10/napoli-un-progetto-per-curare-i-tumori-con-i-protoni/, https://www.quotidianosanita.it/campania/articolo.php?articolo_id=30033, https://www.superabile.it/cs/superabile/salute-e-ricerca/ricerca/in-italia/tumori-a-napoli-in-funzione-il-centro per-la-cura-del-cancro.html.
[111] Source: https://unikore.it/index.php/it/labtour-strumenti
[112] Source: http://www.system24.ilsole24ore.com/static/minisiti/2013/bside/230913_SUD_formazione_ricerca_innovazione/Pagine/4.pdf
[113] Source: http://www.ponrec.it/notizie/2013/dicembre/tigem/

Effects on research and innovation capacity

All consulted interviewees highlighted that investments for infrastructure upgrading have certainly played a role in the strengthened research potential and capacity of the funded infrastructures and, consequently, in their increased attractiveness. For instance, one of the scientific directors of the BIOMEDPARK@UMG project[114] pointed out that the creation of an infrastructure for the Integrated Biotechnological Platform was the starting point of specific applied research activities, the result of which has been the commercialisation of research services to local companies. Similarly, a representative of TIGEM, the Telethon Institute of Genetics and Medicine, declared that infrastructure modernisation contributed to the increased attractiveness of the research centre; a qualitative leap in their research capacity is evidenced by remarkable scientific results. Likewise, some university professors involved in research activities carried out by the new Mediterranean Centre for Human Health Advanced Biotechnologies (MED-CHHAB) observed that the research centre's cutting-edge technical solutions significantly attracted industry actors.

These findings were in line with the results of the desk research activity. For some projects, the increased research capacity and attractiveness were evidenced by patent applications and awards at the national and international levels. For others, publications in scientific papers and articles in the media confirmed their greater research potential (see some examples in the Box below).

Box 22. Evidence of increased research capacity and attractiveness in modernised infrastructure

Building Future Lab

The Building Future Lab is an applied and interdisciplinary research laboratory located within the Architecture and Technology Department of the Mediterranean University of Reggio Calabria. It carries out and offers certification, testing, prototyping, modelling and diagnostic services in the construction sector[115]. The specific research activities carried out within the infrastructure resulted in two patent applications, in 2014[116] and 2016[117] respectively, and the award of 'selected laboratory' for China–Italy Science, Technology & Innovation Week 2015 & 2016[118].

***

LEDA - Laboratory of Earthquake Engineering and Dynamic Analysis

LEDA is a new research facility located in the 'Kore' University of Enna, which operates in structural engineering and dynamics. The attractive features of the research centre were extensively presented in several publications, including:

- Navarra, G., Lo Iacono, F., Oliva, M. and Tesoriere, G., 2015. 'A new research facility: The Laboratory of Earthquake engineering and Dynamic Analysis (LEDA)';
- Fossetti, M., Lo Iacono, F., Minafò, G., Navarra, G. and Tesoriere, G., 2017. 'A new large-scale laboratory: the LEDA Research Centre (Laboratory of Earthquake engineering and Dynamic Analysis)' [10.7414/7aese.T6.18]

***

Enhancement of advanced technological platforms for the development of gene and pharmacological therapies (TIGEM)

Thanks to infrastructure modernisation, TIGEM has increased its research potential and capacity, as evidenced by over 800 scientific publications in prestigious journals such as *Nature*, *Science, The New England Journal of Medicine* and *Cell*[119].

[114] See: http://www.ponrec.it/open-data/progetti/scheda-progetto?ProgettoID=5384
[115] Source: https://www.guidafinestra.it/dentro-il-building-future-lab-strutture-e-servizi-per-linvolucro/
[116] (2014) 'APPARECCHIATURA PER PROVE DI PERMEABILITÀ ALL'ACQUA SU CAMPIONI DI FACCIATE DI EDIFICI'. CS2014A000035, Università Mediterranea di Reggio Calabria (50%), Trombetta C. (43%), Milardi M (43%), Rossetti M (04%). National patent (Patent co-author: Massimo Rossetti-IUAV)
[117] (2016) 'APPARATUS FOR TESTING OF WATER PERMEABILITY OF SAMPLES OF BUILDING FACADES'. PCTIB2016050011, Università Mediterranea di Reggio Calabria (50%), Corrado Trombetta (43%), Martino Milardi (43%), Massimo Rossetti IUAV (04%). International patent.
[118] Source: https://www.unirc.it/ricerca/laboratori.php?lab=69
[119] Source: https://www.sanita24.ilsole24ore.com/art/medicina-e-ricerca/2016-07-20/tigem-strumenti-all-avanguardia-e-ricerca-futurista-105335.php?uuid=ADLTsSv

Source: own elaboration based on desk research.

More limited effects can be identified concerning ultimate outcomes on beneficiaries, both in terms of enhanced competitiveness at the European and international level and increased collaboration with regional and national industry actors.

A few of the newly built or modernised infrastructures were then included in the strategic roadmap of the European Strategy Forum for Research Infrastructures (ESFRI), as recognised research infrastructures of pan-European relevance 'that fill an existing gap in research capability or capacity at the frontiers of knowledge'[120]. For instance, KM3NeT was included in the European and Italian ESFRI roadmap since 2006[121]. In addition to this infrastructure, the policy instrument funded three research infrastructures of pan-European relevance, notably EMSO – ERIC[122], ICOS – ERIC[123] and STAR[124]. Moreover, the NAFASSY infrastructure project focused on the construction of a unique infrastructure in Europe, originally proposed by Italian National Agency for New Technologies, Energy and Sustainable Economic Development (*Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile* - ENEA) with the name of ENFASI, and was included in the Italian roadmap of research infrastructures of pan-European interest[125].

Nevertheless, overall, there was no evidence of increased participation of funded infrastructures in research projects at the European level after the 2007-2013 programming period. From a combination of Cordis and OpenCoesione data, it emerged that, out of the 48 institutions receiving ERDF infrastructure investments, the number of beneficiaries of FP7 and H2020 funded projects has slightly decreased over time, but the overall financial contribution has increased[126].

Table 10. Comparing the participation of ERDF beneficiaries of infrastructure investments to FP7 vs H2020 projects

	ERDF recipients of infrastructure investments benefitting also from FP	Number of FP projects	Total FP contribution
FP7	34	1,755	660,156,342.48 €
H2020	29	1,471	717,444,198.66 €

Source: own elaboration based on OpenCoesione and Cordis data.

These findings are in line with the results reported by APRE (Agenzia per la Promozione della Ricerca Europea - Agency for the Promotion of European Research) in 2017 in the report 'Una panoramica sulla partecipazione italiana a Horizon 2020 (An overview of the Italian participation in H2020)'. Rather than increasing, the Italian performance in the H2020 remained stable compared to participation in the FP7.

Only anecdotal evidence is available for the increased competitiveness of research infrastructures at the international level. There are many examples of research organisations that have been able to launch international collaborations. For instance, the 'Building Future Lab' infrastructure (see above) features partnerships with several universities worldwide[127]. Similarly, the Institute of Preclinical Experimentation and

[120] See: http://roadmap2018.esfri.eu/strategy-report/background-and-history/

[121] Source: https://www.lns.infn.it/it/ricerca/progetti/km3net.html and http://roadmap2018.esfri.eu/media/1044/part1-project-landmarks-list.pdf

[122] See: http://emso.eu/ for more information on the European Multidisciplinary Seafloor and water column Observatory (EMSO)

[123] See: https://www.icos-cp.eu/about for more information on the Integrated Carbon Observation System (ICOS)

[124] See: http://www.ponrec.it/open-data/progetti/scheda-progetto?ProgettoID=5368#Descrizione for more information on the Southern Europe TBS source for Applied Research (STAR)

[125] See: http://www.ricercainternazionale.miur.it/media/documenti/Schede_Allegate.pdf

[126] The total number of FP7 projects during the period 2007-2013 amounted to 25,581 for a total contribution of EUR 50.7 billion. The total number of H2020 projects during the period 2014-2020 amounted to 27,017 for a total contribution of EUR 52.5 billion.

[127] Some examples: the Coimbra University (Portugal), the Pontifical Catholic University of Chile, the Polytechnic University of Madrid and the Higher Technical School of Architecture of Madrid (Spain), the University of

Molecular Imaging (ISPeMI[128]) entertains stable collaboration with the University of Pittsburgh, the McGowan Institute for Regenerative Medicine, and the European Infrastructure for Translational Medicine (EATRIS); the NEUROMED Foundation, thanks to the platform Cyber Brain, has built scientific collaborations with Albany Medical College and the Wadsworth Center, Albany, New York[129].

According to qualitative evidence collected, funded research infrastructures were also able to develop collaborations with industry actors at the regional and national level (see some examples in the Box below). However, for some projects, rather than collaboration with the industry, the main objective seemed to be increased collaboration with other research infrastructures. An example is represented by the 'KM3NET-ITALIA' projects, which, by housing the next generation of neutrino telescopes, aimed to increase collaboration with scientists rather than enterprises.

Box 23. Evidence of increased collaboration with industry actors

Institute of Preclinical Experimentation and Molecular Imaging (ISPeMI)

The ISPeMI project has been implemented to create an intercompany Institute consisting of a network-integrated laboratory to transfer results from preclinical research to the clinic and from the patient to the laboratory. As a result, ISPeMI has strengthened its research initiatives' attractiveness, characterised by a high technical-scientific content and a significant industrial potential. This is why the funded infrastructure is strongly integrated with the regional territory and, more specifically, with the Micro and Nano Systems clusters, the Biomedical cluster, the AMAR cluster, Public-Private Laboratories, and several companies Myrmex, Fidia Farmaceutici, and ST Microelectronics[130].

***

Innovative processes for Energy Conversion – PrInCE

The strengthening of the laboratories in the PrInCE project has allowed a quantitative and qualitative increase in academic research and collaboration with local industries, creating real joint laboratories for innovations in the field of energy efficiency. Existing partnerships were strengthened, such as that with Avio Aero in the joint laboratory 'Energy Factory Bari', for the implementation of research, technological development, and innovation activities in common interest areas in the aerospace and energy sectors. Overall, PrInCE has acted as an incubator for new joint works between the Polytechnic of Bari and businesses, creating an attractive place with technological effects on the territory and companies' interaction[131].

***

NAFASSY (NAtional FAcility for Superconduction SYstems)

NAFASSY is a unique research infrastructure in Italy, located at the University of Salerno. This is a research centre devoted to interacting with large research laboratories and companies in the supply chain of superconductivity and developing new materials. It operates with the most competitive Campania and national companies interested in outsourcing test or R&D activities[132].

Source: own elaboration based on desk research.

In consideration of results that emerged in the context of the collaborative science-industry R&D intervention, which was strongly linked to this policy instrument, and of the lack of quantitative evidence, the evaluation team considered the outcome 'increased number of collaborations between funded research infrastructures and firms' only partially achieved.

Constantine 3 (Algeria), the GD Goenka University (India) and the Polytechnic University of Timisoara (Romania).

[128] For more details see: http://www.ponrec.it/open-data/risultati/potenziamento-strutturale/pona3_00403/

[129] For more details see: http://www.fondazioneneuromed.it/cyber-brain/#1490117090169-f4f6d699-7e9f

[130] Source: http://www.fondazionerimed.eu/public/Rimed/file/PROGETTI%20FINANZIATI/ISPeMI_sintesi_ITA.pdf

[131] Source: https://www.ansa.it/europa/notizie/la_tua_europa/storie_di_successo/2018/08/28/con-il-progetto-prince-il-futuro-della-ricerca-energetica-e-a-bari_beadba03-1110-4993-b227-9d1cb47f4e91.html

[132] Source: https://www.premiobestpractices.it/universita-degli-studi-di-salernodip-di-fisica-nafassy-national-facility-for-superconducting-systems/

A similar conclusion was drawn for the impacts in terms of 'enhanced economic development'. As already shown in the context of policy instruments previously assessed, convergence regions' economic and RTD performance has remained stable over time.

At a lower level of impact, except for those projects targeted by interviews or for which evidence was available on the web, no evidence could be collected to confirm the self-sustainability of funded beneficiaries, and the extent of this effect is unknown. Desk research showed that the infrastructures for which information is available are operational, and their self-sustainability could be assumed. Some of them were also active in the current global outbreak of the Covid-19 pandemic (see, for instance, the Bio-nanotech Research and Innovation Tower - BRIT[133]). It should also be highlighted that most of these infrastructures started research activities only a few years ago, generally after 2015.

Effects on skills and institutional capacity development

Interviews overall confirmed that training courses were positively implemented and helped **researchers and research managers develop specific skills and competences** related to the sector and technological field of application of the supporting infrastructures.

Box 24. Examples of training activities achieving the intended results

Building Future Lab

Training activities: In the framework of the project, a master's degree in Management and development of experimental research for sustainability in the construction sector were implemented, aimed at improving the skills of both researchers and managers.

Results: Trainees acquired new skills which included: the ability to communicate in a complementary way with the various technical-design and specialist skills involved in the construction process; the verification procedures of the different phases of applied research in the field of advanced Testing, Modeling and Prototyping; experimental control of the performance levels of materials and components in use and the laboratory; innovation and technology transfer. Specific to the Management sector, attention was paid to the acquisition of skills related to the analysis of market dynamics and investment planning, human resource management, marketing, and national and European sector regulation[134].

Source: interviews with direct beneficiaries.

The increased ability to manage and implement research projects thanks to the number of researchers and managers retained in the modernised infrastructure is more limited. An interview carried out in the context of the MEDCHAB project, for instance, revealed that only about 20% of the trainees were hired, in contrast with the initial ambition to involve the entire trained staff in the research activities of the centre.

Verification of pre-conditions

Although there are some exceptions, most of the pre-conditions were verified only to a limited extent.

While all projects have positively concluded could prove the ability of beneficiaries to ensure the **coordination of the procurement process and/or of the construction work** (pre-condition 1), it should also be highlighted that in 45 out of 46 projects, the implementation period was extended[135]. Delays in implementation timescales entailed the need to grant a 7-month extension for the conclusion of project activities. Between December 2014 and June 2017, three directorial decrees were issued to postpone projects' final deadline suffering from delayed implementation. Since payment delays in most cases did not prevent the realisation or modernisation of the funded research infrastructures (see

[133] For more details see: https://www.lns.infn.it/it/eventi/archivio-notizie/252-a-catania-nasce-anti-covid-lab-per-testare-tessuti-per-mascherine-e-dpi-anti-covid-19.html

[134] Source: http://www.sitda.net/downloads/biblioteca/Building%20Future%20Lab.%20Ricerca%20sperimentale%20per%20la%20sostenibilita'%20nel%20settore%20delle%20costruzioni.pdf

[135] Source: data provided by the Managing Authority on 10th July 2020.

below), issues emerging during construction work might have played a role. For example, despite the approval received for the VULCAMED project in 2012, the beneficiary was not able to start the restructuring activities until February 2014 because of difficulties in ensuring that planning documentation was ready and that there were no unresolved property ownership rights on the land where the Volcanological Observatory had been located since the 1980s[136].

Moreover, some administrative capacity issues negatively impacted the **timely disbursement of funds** and the implementation of smooth procedures (pre-condition 3). As briefly mentioned above, some deficiencies in the definition of eligibility criteria raised the problem of compliance with the State Aid rules and led to the opening of judicial investigations to assess some recipients' correct eligibility[137]. As a result, payments for a total equal to EUR 153.8 million were suspended in 2015[138]. This situation caused significant delays for some beneficiaries in obtaining resources to cover the costs of the project. In some cases, the funds which the administration should have anticipated at the beginning of the procurement process, construction, or renovation work (80% of the total project cost) were not disbursed. In others, the final payments were transferred after the time initially scheduled.

Another pre-condition not always verified concerns the research infrastructure's capacity to carry out **projects of proven excellence** and with interregional and international vocation (pre-condition 4). Overall, it was not possible to assess whether all the funded infrastructures were able to design and implement excellent research projects after implementing the infrastructure investment. Evidence for this is available only at a more aggregate level in the report published by APRE (2017) on the Italian participation in the H2020 programme (see Box 25). Only for the research infrastructures mentioned above, included in the ESFRI roadmap or for which information was collected or publicly available, was it possible to confirm their improved capability to implement research projects at the frontiers of science and technology (e.g. the NEUROMED Foundation or the 'Building Future Lab' infrastructure).

Box 25. The Italian participation in the H2020 programme

The report '**Overview of the Italian participation in H2020**' shed light on the quality of projects submitted by Italian beneficiaries at the European level.

The low success rate of Italian beneficiaries shows a quality issue in Italian participation in the H2020 programme. Although Italy is an active participant in H2020 calls, the ratio between submitted and funded project proposals indicated the lowest success rate among the top eight beneficiary countries[139]. For instance, in 2017, only 5,042 winning projects were recorded out of the total of 42,408 project proposals, a success rate of 11.9%. Several weak points can account for this: a limited ability to aggregate (or join in) strong partnerships, the challenge of communicating the impact and innovation dimension of the project correctly, the limited capacity of project management, and, to a lesser extent, the quality (excellence) of the contents proposed.

Source: own elaboration based on APRE (2017)

Concerning the remaining pre-conditions, however, evidence confirmed their realisation. To begin with, the **availability of leading scientists and R&D personnel** to be trained (pre-condition 2) was reflected in the number of training activities, which was equal to the number of infrastructure projects. Qualitative evidence confirmed that most of the funded **research infrastructure operated in strategic importance areas** for the development of the production system of the convergence areas (pre-condition 5). In particular, interviewees reported that the infrastructure investments responded to specific research

[136] Source: https://ilfoglietto.it/enti/ingv/4923-ingv-progetto-vulcamed-e-mancata-ristrutturazione-dell-osservatorio-di-pizzi-deneri

[137] ANPRI. "Newsletter 8 del 30 aprile 2015". http://www.anpri.it/wp-content/uploads/2015/05/Newsletter-8-2015.pdf

[138] Source: Final Implementation Report, June 2017.

[139] Germany, United Kingdom, France, Spain, Italy, Netherlands, Belgium, Sweden. According to the report they benefit of around 75% of H2020 budget.

needs of beneficiaries' public research organisations and local firms. For instance, the BIOMEDPARK@UMG project was intended to have a positive repercussion on the agri-food industry[140]. Similarly, the 'Building future lab' serves a large number of users, such as companies in the sectors of curtain walling, casing, window frames, systems, and components for smart building management, as well as research centres and networks, clusters and consortia for innovation, certification bodies, spin-offs, and innovative start-ups[141].

Verification of supporting factors

The only supporting factor identified positively influenced the achievement of intended results. Where projects experienced delays of advance payments, the availability of additional funding sources was vital for the completion of the project activities. Some insights were provided by consulted interviewees, who confirmed that payment delays did not significantly impact the implementation of the projects, neither in public nor in non-profit research infrastructures. Both types of research institutions could cope with the lack of funds: the former by relying on the fixed amount of resources received from the State and redistributing their internal budget; the latter by looking for **additional sources of funding** (e.g. regional OPs, other public or private funds etc.).

Verification of risks and threats

The anticipated risks identified by the ToC did materialise throughout the lifetime of the policy instrument, thus affecting the achievement of some outcomes and broader impacts.

Financial and administrative issues within public research organisations (risk 1) prevented the hiring of additional human resources, limiting the effects of the training activities implemented along with the infrastructure investments. Such issues emerged, for instance, in the Med-CHHAB project, as evidenced in interviews and by a monitoring report updated in 2016[142]. To date, not all laboratories are in operation due to the lack of specialised personnel. The dependence on the university budget, which experienced severe cuts as discussed in Subsection 2.1.1, prevented additional researchers' selection. Evidence collected on the CECAP project also revealed that, despite the achievement of the infrastructure investment's objective, the research centre experienced a shortage of radiology staff working at the Neapolitan Institute. In 2015, only 50% of the potential number of human resources were engaged in the centre's activities, thus entailing a reduced use of the machinery and a consequent lengthening of the waiting lists[143].

3.4.3. General assessment

The policy instrument achieved some immediate and intermediate outcomes. However, additional supporting factors, such as the existence of additional funding sources to provide specialised staff, also influenced the achievement of longer-term results. Some pre-conditions were verified only to a limited extent, and the materialisation of some risks prevented the intervention from delivering some of the expected results and broader impacts.

The logic of the policy instrument was not altered during implementation and led to the intended results. The ambition to select R&D projects for a total of EUR 701 million was only partially met. The number of projects funded to date is equal to 46 R&D and corresponds to payments for EUR 491.1 million[144], below the allocated budget. This figure is not definitive since payments are still ongoing.

[140] Source: www.biomedparkumg.com
[141] Source: https://www.guidafinestra.it/dentro-il-building-future-lab-strutture-e-servizi-per-linvolucro/
[142] Source: https://monithon.org/reports/1068
[143] Source: https://www.superabile.it/cs/superabile/salute-e-ricerca/ricerca/in-italia/tumori-a-napoli-in-funzione-il-centro-per-la-cura-del-cancro.html
[144] Source: data provided by the Managing Authority on 10th July 2020. The data are not definitive, since the operational programme has not yet been concluded and disbursements are still ongoing.

The objective of funding infrastructure investments with significant financial dimension was overall achieved, and the direct output target of the instrument was even exceeded.

There is evidence of achievement of immediate and intermediate outcomes across the three different impact pathways, although limited in some specific cases. However, while not improving as expected, the innovative performance of convergence regions has remained stable over time, as shown by context indicators presented in Subsection 2.1.1.

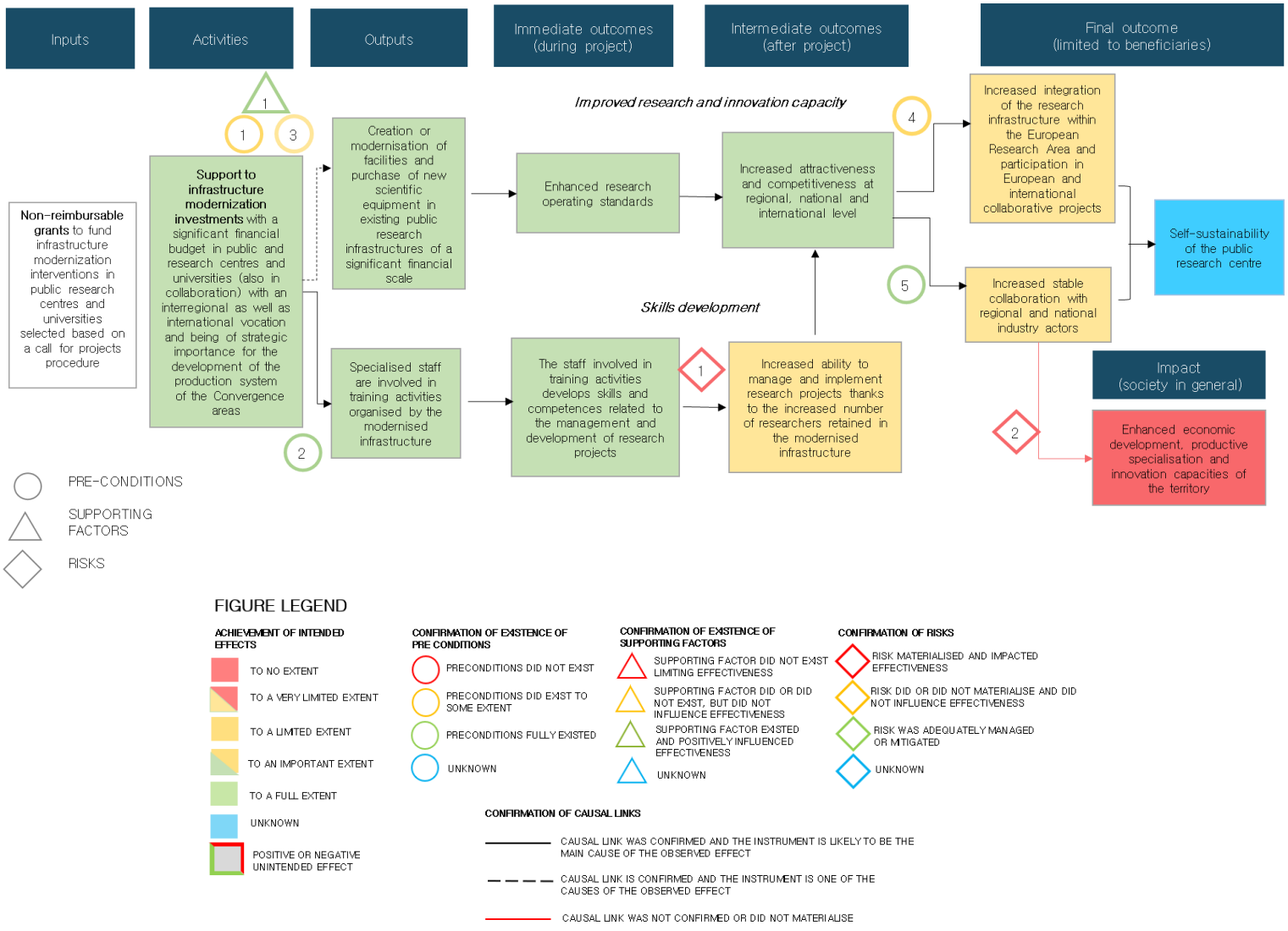
The intervention contributed to increasing the research capacity and attractiveness of funded infrastructures, despite some limitations. These included the ability of beneficiaries to ensure a smooth procurement process or smooth coordination of the construction works and the administration's ability to provide the timely disbursement of funds. However, additional sources of funding available to funded research infrastructures also played a role.

There is limited evidence of funded beneficiaries' ability to manage the new or modernised research infrastructure, as shown by the low level of participation in research projects of proven excellence funded at the European and international level and the moderate increase in collaboration activity with the industry. In both cases, the limited verification of some pre-conditions prevented the complete achievement of such results.

The impact on the economic development of convergence regions is even more limited. As already highlighted, the performance of this territory has overall remained stable over time. The 2008 Great Recession had a negative impact and represented a significant risk that could not be mitigated.

All training activities were carried out in conjunction with the realisation of the infrastructure investments. While evidence confirmed the improved skills and competences of researchers and research managers, limited evidence is available of the placement rate of participants. The materialisation of risk of financial and human resources constraint negatively impacted the achievement of this result.

Figure 24. Representation of the results of the contribution analysis for the Infrastructure investments for research policy instrument



4. GENERAL FINDINGS AND LESSONS LEARNT

Overall, there is a broad consensus indicating that the ERDF support to **RTD investments played an anti-cyclical role in Italy** with respect to the harmful effects of the economic crisis and the ongoing cut in public expenditures in R&D, especially in convergence regions. In these areas, the consequences of the outbreak of the 2008 Great Recession were more profound than in the rest of the country. The crisis changed companies' attitudes: they significantly decreased investments and rationalised their activities, including by minimising R&D expenditure, with the consequence of a sharp reduction in the use of policy tools and a limited effect of the incentive granted. The implementation of austerity policies further shrank the already limited support to research in public organisations.

In this context, the national OP Research and Competitiveness certainly **played a role in avoiding a dramatic drop in R&D investments, especially in businesses**. Most interviewees confirmed that research activities would not have been undertaken without ESI funds in convergence regions, which constituted the most significant source of funding in the RTD field (see Subsection 2.2.1). As discussed in Chapter 3, the innovative performance of convergence regions remained stable over the programming period and did not decrease despite the economic downturn after the Great Recession.

However, as emerged from the analysis of achievement indicators in Subsection 3.2.2 (see also ANNEX IV), the significant amount of funding received was not translated into output additionality. The translation of such investments into research results and further exploitation for innovation purposes was problematic; the context of the economic crisis, and austerity policies cutting public spending for research, hampered the additional effect expected from ERDF resources. This result is not new, and it is in line with the findings of the ex-post evaluation of ERDF programmes on the Support to SMEs[145]. The Italian case showed that the ERDF helped targeted SMEs withstand the crisis by coping with the credit crunch and supporting fixed capital accumulation.

These findings suggest that the OP R & R&C was more effective in promoting R&D activities, especially in collaboration, and in inducing investments, but less effective in improving the beneficiaries' competitiveness through product, process or service innovations. Compared to initial ambitions, **the OP was not effective in achieving the main objective** of supporting RTD investments in the convergence regions **to improve** their **competitiveness**. Perceptions collected through interviews indicate that the OP recorded a modest performance because of administrative and implementation issues beyond problems linked to the economic crisis and the structural weaknesses of the industrial fabric. Also, despite the geographical and sectoral concentration, the ERDF played mainly a substitution role in addressing a decrease in ordinary support measures from the national and regional governments, affecting the additionality effect, which should be associated with the mobilisation of ESI Funds.

As noted by many interviewees, the competitiveness performance of convergence regions and industries, however, also reflected other structural problems, including infrastructure deficiencies and inefficiencies of public administration, which are clearly out of the scope of the OP interventions for RTD. As late as 2019, the Council's Country Specific Recommendations for Italy drew attention to some of the most pronounced systemic weaknesses that could affect the country's RTD performance in general and of southern regions in particular. One of the main issues concerned the weak capacity of the public sector to administer funding. Italy's slow transition to a knowledge-based economy and slow productivity growth also stems from inadequate investment in skills, the low quality and sustainability of the country's infrastructure, and a lack of improvements in the business environment's framework conditions. The general contextual conditions were,

[145] European Commission, 2016, Support to SMEs – Increasing Research and Innovation in SMEs and SME Development. Final Report Work Package 2. Ex-post evaluation of Cohesion Policy programmes 2007-2013, focusing on the European Regional Development Fund (ERDF) and the Cohesion Fund (CF). Authors: CSIL in partnership with CSES and ZEW

therefore, not conducive to the materialisation of wider impacts. They might explain why ERDF interventions alone were not sufficient to improve the competitiveness of convergence regions.

There is some consensus about **a behavioural additionality effect of the OP**, and of collaborative measures in particular, which had some impact on the culture of the territory, on the way of conceiving innovation and on planning innovation interventions. The lessons learned from the experience of implementing the OP R&C paved the way for a revision of the logic of RTD interventions, and the design and implementation of the S3 in the 2014-2020 programming.

This more general conclusion also applies in the context of the three policy instruments under the OP R&C analysed more in-depth using the contribution analysis approach. Although in all cases ERDF support certainly contributed to the achievement of some short-term results, it overall failed to have a substantial impact on the economic development of the convergence territory, thus showing the overall low sustainability of achieved results. The limited achievement of longer-term effects derives from several deficiencies mainly related to implementation issues, while only a few success factors explain the achievement of shorter-term outcomes.

The policy instrument supporting **collaborative science-industry R&D activities** mainly favoured a knowledge exchange process and contributed to the consolidation of existing collaboration partnerships. Evidence of the impact on innovation in products and processes is more limited, even though investments were specifically concentrated on strategic sectors. Overall, administrative payment delays affected the smooth execution of research projects, especially those involving SMEs with low economic and financial capacity as beneficiaries. In contrast, projects led by large firms and research organisations proved to be generally more successful in light of their economic solidity, propensity to organise research activities according to a long-term research agenda and ability to collaborate with a consolidated network of SMEs as subcontractors. In these organisations, although there may have been a certain displacement effect in some cases, especially in the large firms, funding accelerated the pace and increased the scale of investments. Overall, the delayed disbursement of funds and the limited propensity of small firms to patent generally prevented the translation of research results into commercial applications.

Support provided **to technological clusters** managed to provide a determinant contribution providing an initial boost to the reinforcement of existing clusters and creating a few new clusters. This was evident in the overall good results achieved by research projects in innovation production. However, the intervention's contribution to their long-term consolidation as territorial reference aggregations in the regional research system is less visible. The lack of a clear political vision on their role has hampered the development of their coordinating role in the regional research system in the absence of a strong management structure. Overall, only a few can be mentioned as examples of clusters that have preserved their role and still guide public and private members in their collaboration activities or have changed their approach by adapting their functions and service offering based on the partners' requests. This is especially the case where large firms represent a large membership of the cluster. To conclude, except for those clusters that have been able to evolve and adapt their role to their members' requests and the changes introduced within the national RTD policy framework, it is unlikely that regional technological clusters will maintain a key role in the regional research and innovation system.

Infrastructure investments for the construction or modernisation of **research infrastructures** overall increased the research capacity and attractiveness of funded infrastructures. Evidence is more limited of the ability of funded beneficiaries to manage the new or modernised research infrastructure in the long-term, be involved at the national and European level in research projects of proven excellence, and contribute to the convergence's overall economic development territory. Budget constraints of public research organisations and universities, as well as limited capacity, have in some cases prevented funded research organisations from developing a research management structure able to coordinate research projects with European or international vocation.

Therefore, if budgetary constraints continue, it is unlikely that these research infrastructures will exploit their improved research potential and contribute to the economic development of convergence regions.

Finally, the evaluation did not find that the ERDF support for RTD activities and infrastructure generated significant EU-wide effects or increased the levels of cooperation between regions and Member States in the EU. Only in some specific cases were funded research infrastructures able to improve their research capacity and attract European and international partners' attention. Particular examples are the four research infrastructures of pan-European interest funded during 2007-2013, notably KM3Net, EMSO – ERIC, ICOS – ERIC and STAR.

Annexes

ANNEX I. OVERVIEW OF EVIDENCE COLLECTED ON EXPECTED EFFECTS OF THE COLLABORATIVE R&D PROJECTS POLICY INSTRUMENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Outputs	Collaborative R&D projects with significant financial dimension and aiming at technological advances are implemented	Partially (target based on the total budget)	**Task 1 data and interviews:** Based on the data of the OpenCoesione platform and the final ranking, a total of 171 projects with related training activities were finally funded, of which 27 dates back to the 2000-2006 programming period and 157 are collaborative industrial projects. These 171 projects spent a total of EUR 742 million. However, this figure is not definitive, several projects are not yet administratively closed, and payments are still ongoing. However, there is evidence already that not all the selected projects reached a conclusion. The average project cost was of almost EUR 9 million.	TO AN IMPORTANT EXTENT
	Specialised staff in industry and/or research centres are involved in the R&D project	As many training projects as research projects	**OP documentation:** As confirmed by the Final Implementation Report (June 2017), all research projects, excluding those dating back to the 2000-2006 programming period, included training activities.	TO A FULL EXTENT
Immediate outcomes	Knowledge transfer from research centres to firms, from large enterprises to SMEs and from competitive to convergence regions	No	**Interviews:** Interviews pointed out that most collaborative R&D projects, especially the science-industry, provided access to new ideas and competences. Many companies gained access to new ideas and became aware of new technologies. At the same time, research centres were also able to explore business partners' needs and develop skills needed for industrially oriented, applied R&D.	TO AN IMPORTANT EXTENT
	Researchers in research centres and/(or industry develop skills and competences related to business problems (e.g. management of the research activity)	No	**Interviews**: All training activities were carried out in conjunction with the research projects and generally implied a period of "on the job" training with the project's industrial partners. In this way, researchers were able to develop specific skills and competences related to the sector and technological field of application of the supported project, as confirmed by all interviewees.	TO A FULL EXTENT
	Increased scientific-technological knowledge/know-how in beneficiaries	Partially (target defined at Priority Axis level)	**Monitoring indicators**: achievement indicators at the Priority Axis level provide limited evidence as concerns the increased know-how of beneficiaries and the resulting increased number of product and process innovation over all financed projects, with an achievement equal to 0.91 as compared to the initial target of 1.62. **Interviews**: all interviews with beneficiaries of R&D projects noted that all research objectives found a reflection in the reported project results (see some examples in Box 4). However, the sample of beneficiaries interviewed might not be representative of the entire set of projects funded and might be somehow biased upward for self-selection of best-performing ones. By triangulating these pieces of evidence with interviews with the Managing Authority and other experts, it can be argued that the overall effect in terms of innovation in products and processes is limited. Nevertheless, within the sample, successful projects can also be identified.	TO AN IMPORTANT EXTENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Intermediate outcomes	Increased propensity to establish stable platforms of collaboration in specific production chains between firms, between science and industry and between territories	No	**Interviews:** As far as the effect of this knowledge transfer mechanism is concerned, interviews confirmed that the strengthening of public-private collaboration networks is evident in perception and the follow-up activities of collaborations activated after the end of the programming period. However, this was limited, especially to science-industry partnerships and to collaborations more in general already in place.	TO A LIMITED EXTENT
	Increased technological competences and skills in industry thanks to the increasing number of researchers employed and retained in the industry sector	Partially (target defined at OP level) Increase in the R&D personnel per thousand inhabitants from 1.6 in 2004 to 2.2 in 2015	**Interviews:** anecdotal evidence from interviews also confirmed that the placement rate of trainees was overall high. However, what emerged is that not all participants found a job in firms located in the convergence territory as it intended the intervention's logic. Some of them were also employed in research centres or universities or even went to non-convergence regions or abroad. As a result, the final outcome of training activities has been only partially achieved even though the participants' high employment rate is overall a positive result. **Evidence from regional indicators** (e.g. number of R&D personnel, science&technology employment): In 2007, the total R&D personnel as a percentage of the total population in convergence regions was about 0.17% at the end of 2015, it increased by 0.02 p.p. However, in 2017, the total R&D personnel was 0.23% of the total population. Only n the Sicilia Region the indicator did not significantly evolve. Similarly, also the percentage of people employed in science and technology as the percentage of the total population has increased from 2007 (3.94%) to 2015 (4.19%) and 2017 (4.37%). This increase has concerned all convergence regions except for the region Calabria.	TO A LIMITED EXTENT
	The results of the research are valued and exploited	No	**Interviews:** Interviewees noted that products and processes innovation were not always commercially or industrially exploited, nor were they patented. **Evidence from regional indicators (e.g. number of patents):** The number of patent applications per regional GDP decreased from 2007 to 2015 in Campania and Puglia, and a slight increase in Sicilia and Calabria. Overall, the performance of convergence regions in patent applications got worse during the 2007-2013 programming period. While in 2007, the number of PCT patent applications per regional GDP in these regions was equal to 642.7, in 2015, this number decreased to 625.6. **Evaluation study by Crescenzi et al. 2018:** The study highlights that the scheme's effectiveness on value-added (investment) is higher (lower) for firms with high patenting capacity, while there seems to be scant support for the idea that multinational corporations are key to successful innovative collaborations. This might mean that in such a case, the support is used to capitalise on the potential of previous investments (by increasing sales, for instance) rather than to support further investment.	TO A LIMITED EXTENT
Final outcomes	Increased propensity to invest in R&D and expenditure in R&D by the industry	Partially (target defined at OP level) Increase in the R&D expenditure over GDP from	**Interviews:** interviewees highlighted that most of the projects had follow-up research activities and collaborated with some of the actors involved in the same partnerships. **Evidence from regional indicators (e.g. total and private R&D expenditure):** Total R&D expenditure over GDP has increased in all convergence regions from 2007 (0.79%) to 2015 (0.99%) and 2017	TO A LIMITED EXTENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
		0.81% in 2004 to 1.2% in 2015 as well as in the private R&D expenditure over GDP from 0.23% in 2004 to 0.3% in 2015	(0.82%), but always remained far below the target set out at the beginning of the programming period. However, different is the case for private R&D. The latter increased in all convergence regions, reaching the OP's target. In 2007 private R&D as compared to GDP amounted to 0.22%, while in 2015 reached 0.32% and in 2017 0.31%.	
	Technological upgrading and competitive repositioning of beneficiaries and of productive value chains	No	**Interviews:** interviewees highlighted that there are examples of direct economic benefits derived from the exploitation of research projects' results. However, this seems to be limited to large firms or research centres and universities that can implement follow-up investments. **Evaluation study by Crescenzi et al. 2018**: As far as collaborative research projects are concerned, the intervention did not produce any impact on the performance of the beneficiary firms in terms of investments, value-added and employment. The results suggest that a more (or less) generous level of funding of the programme would not have improved its effectiveness. **Cluster analysis (Task 1):** the cluster analysis has shown that the overall RTD performance of convergence regions, as compared to other European regions, has remained stable over time.	TO NO EXTENT
Impact	New products, processes and/or services improve the quality of life, health, safety and well-being of society	No	**/**	TO NO EXTENT
	Enhanced economic development, productive specialisation and innovation capacities of the territory	No	**Cluster analysis (Task 1):** Overall, the innovative performance of the four convergence regions has not improved from 2007 to 2017, as shown by the cluster analysis performed under Task 1 (see Section 3.1)	TO NO EXTENT

ANNEX II. OVERVIEW OF EVIDENCE COLLECTED ON EXPECTED EFFECTS OF THE POLICY INSTRUMENT COLLABORATIVE R&D PROJECTS IN CLUSTERS

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Outputs	Development of a 5-year strategic development plan	No	**OP documentation:** 18 out of 26 strategic development plans for the reinforcement of existing clusters were selected	TO A FULL EXTENT
	Collaborative industrial research projects are implemented in existing clusters	Partially (target based on the total budget)	**Task 1 data and interviews:** Based on the data of the OpenCoesione platform and the final ranking, a total of 55 collaborative projects were finally funded, of which 20 dates back to the 2000-2006 programming period. These 55 projects spent a total of EUR 134 million, a figure lower than the total allocated budget of EUR 282 million. However, this figure is not definitive, several projects are not yet administratively closed, and payments are still ongoing.	TO A LIMITED EXTENT
	Collaborative industrial research projects are implemented in new clusters	Partially (target based on the total budget)	**Task 1 data and interviews:** Based on the data of the OpenCoesione platform and the final ranking, a total of 55 collaborative projects were finally funded, of which 20 dates back to the 2000-2006 programming period. These 55 projects spent a total of EUR 134 million, a figure lower than the total allocated budget of EUR 282 million. However, this figure is not definitive, several projects are not yet administratively closed, and payments are still ongoing.	TO A VERY LIMITED EXTENT
	Specialised staff in industry and/or research centres are involved in the R&D project	As many training projects as research projects	**OP documentation:** As confirmed by the Final Implementation Report (June 2017), all research projects, excluding those dating back to the 2000-2006 programming period, included training activities.	TO A FULL EXTENT
	Development of a feasibility study for the creation of aggregation of public and private actors operating in a strategic sector for the territory	No	**OP documentation:** out of a total of 196 feasibility studies for creating new technological clusters and public-private laboratories, 18 feasibility studies were selected.	TO A FULL EXTENT
Immediate outcomes	The role of the cluster is strengthened	No	**Task 1 data**: across the ten existing technological clusters identified by the call, funding was distributed in eight clusters. **Interviews**: interviewees confirmed that governance of existing clusters had been strengthened in all cases, although with some differences across types of clusters and regions.	TO A FULL EXTENT
	Institution of a new cluster	No	**Task 1 data**: four technological clusters have been identified **Interviews**: interviewees highlighted that newly created clusters have contributed to the development of collaboration networks.	TO A LIMITED EXTENT
	Increased scientific-technological knowledge/know-how in beneficiaries	No	**Interviews:** interviews with beneficiaries overall provide a positive picture as concerns the effects in terms of knowledge creation and innovation.	TO A LIMITED EXTENT
	Researchers in research centres and/(or industry develop skills and competences related to business	No	**Interviews**: All training activities were carried out in conjunction with the research projects and generally implied a period of "on the job" training with the project's industrial partners. In this way, researchers were able to	TO A FULL EXTENT

	problems (e.g. management of the research activity)		develop specific skills and competences related to the sector and technological field of application of the supported project, as confirmed by all interviewees.	
Intermediate outcomes	Consolidation of a stable network of science and industry actors in a strategic technological sector with common objectives	No	**Interviews**: interviews confirmed that strengthened governance helped the consolidation of collaboration networks. **Ex-post evaluation by Studiare Sviluppo (2015):** in Puglia, the agro-food technological cluster D.A.Re. had a decisive role in promoting collaborations thanks to its services. To a relatively more limited extent, this finding also applied to the technological cluster Agrobiopesca in Sicilia. Conversely, in Calabria, the cluster R & R&D.log did not carry out a governance policy to foster partnerships between individual actors. **Working paper by Florio et al. (2014):** in Puglia, MEDIS S.c.ar.l. strengthened collaboration between MEDIS members and even with other research centres, companies, industrial or technological clusters, business representative associations, universities on a regional and national scale. **Working paper by D'Esposito et al. (2015):** the paper shows the increasing intensity of collaboration between local organisations over time as well as the evolution of the cluster in terms of types of collaboration established	TO AN IMPORTANT EXTENT
	Creation of a stable network of science and industry actors in a strategic sector with common objectives	No	**Task 1 data**: since research projects were not funded under the policy instrument under assessment, it may also be argued that the effect of the OP on this outcome has been more limited than in the case of existing technological clusters considering that also other sources of funding have potentially contributed to this result.	TO A LIMITED EXTENT
	The results of the research are valued and exploited	No	**Interviews**: Interviewees noted that products and processes innovation were not always commercially or industrially exploited, nor were they patented. **Ex-post evaluation by Studiare Sviluppo (2015):** it was noted that in the context of some clusters, such as Agrobiopesca in Sicilia, beneficiaries, especially small and medium-sized enterprises, managed to access both incremental innovation mechanisms, as regards processes and products, and radical innovations. However, the evidence is not enough for assessing the materialisation of output additionality in the case studies under evaluation. **Evidence from regional indicators (e.g. number of patents):** The number of patent applications per regional GDP decreased from 2007 to 2015 in Campania and Puglia, and a slight increase in Sicilia and Calabria. Overall, the performance of convergence regions in patent applications got worse during the 2007-2013 programming period.	TO A LIMITED EXTENT
	Increased technological competences and skills in industry thanks to the increasing number of researchers employed and retained in the industry sector	Partially (target defined at OP level) Increase in the R&D personnel per thousand inhabitants from 1.6 in 2004 to 2.2 in 2015	**Interviews:** anecdotal evidence from interviews also confirmed that the placement rate of trainees was overall high. However, what emerged is that not all participants found a job in firms located in the convergence territory as it intended the intervention's logic. Some of them were also employed in research centres or universities or even went to non-convergence regions or abroad. As a result, the final outcome of training activities has been only partially achieved despite the fact that the high employment rate amongst participants is overall a positive result. **Evidence from regional indicators** (e.g. number of R&D personnel, science&technology employment): In 2007, the total R&D personnel as a	TO A LIMITED EXTENT

			percentage of the total population in convergence regions was about 0.17% at the end of 2015, it increased by 0.02 p.p. However, in 2017, the total R&D personnel was 0.23% of the total population. Only n the Sicilia region the indicator did not significantly evolve. Similarly, also the percentage of people employed in science and technology as a percentage of the total population has increased from 2007 (3.94%) to 2015 (4.19%) and 2017 (4.37%). This increase has concerned all convergence regions except for the Calabria region.	
Final outcomes	Increased propensity to invest in R&D and expenditure in R&D by the industry	Partially (target defined at OP level) Increase in the R&D expenditure over GDP from 0.81% in 2004 to 1.2% in 2015 as well as in the private R&D expenditure over GDP from 0.23% in 2004 to 0.3% in 2015	**Evidence from regional indicators (e.g. total and private R&D expenditure):** Total R&D expenditure over GDP has increased in all convergence regions from 2007 (0.79%) to 2015 (0.99%) and 2017 (0.82%), but always remained far below the target set out at the beginning of the programming period. However, different is the case for private R&D. The latter increased in all convergence regions, reaching the OP's target. In 2007 private R&D as compared to GDP amounted to 0.22%, while in 2015 reached 0.32% and in 2017 0.31%. **Evaluation study by Studiare Sviluppo (2015):** The case studies' analysis shows that there has been an additionality of input.	TO A LIMITED EXTENT
	Self-sustainability of the cluster	No	**Interviews:** interviewees confirm that technological clusters still represent stable forms of collaborations that constitute the regional nodes of the national technological clusters in most cases. Also, there have been positive experiences in the regions that have guaranteed continuity about newly formed clusters. **Desk review:** a desk review of the clusters' website showed that, with the exclusion of the technological clusters in Calabria, all the existing clusters still operate. Moreover, seven out of ten clusters are now part of the national level's technological clusters and supported during the current programming period 2014-2020. The four new clusters are still operating, and two of them are also part of the technological clusters identified at the national level and supported during the current programming period 2014-2020.	TO A LIMITED EXTENT
	Technological upgrading and competitive repositioning of beneficiaries	No	**Ex-post evaluation study by Bertamino et al. (2016):** On the whole, after joining a cluster, firms did not outperform similar non-cluster firms; only profitability of larger cluster firms turned out to be larger than that of the control group after the policy.	TO NO EXTENT
Impact	New products, processes and/or services improve the quality of life, health, safety and well-being of society	No	**/**	TO NO EXTENT
	Enhanced economic development, productive specialisation and innovation capacities of the territory	No	**Cluster analysis (Task 1):** Overall, the innovative performance of the four convergence regions has not improved from 2007 to 2017, as shown by the cluster analysis performed under Task 1 (see Section 3.1)	TO NO EXTENT

ANNEX III. OVERVIEW OF EVIDENCE COLLECTED ON EXPECTED EFFECTS OF THE INFRASTRUCTURE INVESTMENTS FOR RESEARCH POLICY INSTRUMENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Outputs	Creation or modernisation of facilities and purchase of new scientific equipment in existing public research infrastructures of a significant financial scale	Selection of infrastructural projects for a total of EUR 701 million and target of 70 strengthened infrastructures	**Task 1 data:** 46 projects with related training activities were eventually funded. The latter corresponded to payments equal to EUR 491.1 million, 30% lower than the allocated budget. As is the case for the policy instruments previously assessed, the OP is not yet administratively closed can explain this difference. **Monitoring indicators:** strengthened infrastructures were a total of 152, which means 82 more than the target set out (equal to 70). **Desk research:** Funded projects received high visibility, and more than half of them were also publicised on the media or institutional websites	TO A FULL EXTENT
	Specialised staff are involved in training activities organised by the modernised infrastructure	As many training projects as infrastructure projects	**OP documentation:** As confirmed by the Final Implementation Report (June 2017), all infrastructure projects included training activities. Along with the infrastructure investments, 46 training activities were also launched, generally taking the form of master's degrees.	TO A FULL EXTENT
Immediate outcomes	Enhanced research operating standards	No	**Interviews**: All consulted interviewees highlighted that infrastructure upgrading investments have certainly played a role in the strengthened research potential and capacity of the funded infrastructures. **Desk research**: For some projects, the increased research capacity is evidenced by patent applications and awards at the national and international level. For others, instead, publications in scientific papers and articles in the media confirm their higher research potential.	TO A FULL EXTENT
	The staff involved in training activities develops skills and competences related to the management and development of research projects	No	**Interviews**: interviewees informed on the increased capabilities and competences of trainees.	TO A FULL EXTENT
Intermediate outcomes	Increased attractiveness and competitiveness at regional, national and international level	No	**Interviews**: As a consequence of improved research operating standards, funded infrastructures also improved their attractiveness. **Desk research**: For some projects, the increased attractiveness is evidenced by patent applications and awards at national and international level. For others, instead, publications in scientific papers and articles in the media confirm their higher research potential.	TO A FULL EXTENT
	Increased ability to manage and implement research projects thanks to the increased number of researchers retained in the modernised infrastructure	No	**Interviews**: some interviewees provided limited evidence about the achievement of a high placement rate in the funded infrastructure after the training activity. **Desk research**: a web search confirmed that some projects funded infrastructures suffered from a shortage in terms of human resources in the context of some projects funded infrastructures.	TO A LIMITED EXTENT

Final outcomes	Increased integration of the research infrastructure within the European Research Area and participation in European and international collaborative projects	No	**Combination of Cordis and OpenCoesione data**: out of the 48 institutions recipients of ERDF infrastructure investments, the number of beneficiaries of Framework programmes and FP7 funded projects has slightly decreased. However, the overall total FP contribution to those beneficiaries has also increased in light of the higher overall H2020 budget. **Report by APRE (2017)**: The data presented in this report showed that, rather than increasing, the Italian performance in the H2020 remained stable compared to the participation in the FP7. **Desk research**: there is also evidence of funded infrastructures having established international partnerships.	TO A LIMITED EXTENT
	Increased stable collaboration with regional and national industry actors	No	**Interviews**: there is evidence of increased collaboration with industry actors. **Desk research**: in the context of some projects, rather than collaboration with the industry, the main objective seems to be the increased collaboration with other research infrastructures	TO A LIMITED EXTENT
	Self-sustainability of the public research centre	No	/	UNKNOWN
Impact	Enhanced economic development, productive specialisation and innovation capacities of the territory	No	**Cluster analysis (Task 1):** Overall, the innovative performance of the four convergence regions has not improved from 2007 to 2017, as shown by the cluster analysis performed under Task 1 (see Section 3.1)	TO NO EXTENT

ANNEX IV. CORE AND COMMON ACHIEVEMENT INDICATORS RELATED TO RTD INTERVENTIONS FUNDED BY THE OP RESEARCH AND COMPETITIVENESS

Achievement indicator	Target	Result	Level of achievement
Number of RTD projects	340	628	✓
Number of cooperation project enterprises-research institutions	220	231	✓
Research jobs created	1,200	639.87	⚠
Number of strengthened infrastructures	70	152	✓
Number of training courses (R&D projects)	280	333	✓
Number of participants to training courses (R&D projects)	2,800	3,687	✓
Induced investments (in million EUR)	706	1,073	✓
Enterprises introducing product/process innovation out of financed enterprises	63.0%	18.2%	⚠
Number of applications for patent at EPO (financed projects)	170	78	⚠
Number of product and process innovation over all financed projects	1.62	0.91	⚠
Number of enterprise-public research institution partnership	300	172	⚠
Number of new product and services over all financed projects	2.23	0.94	⚠

Source: Final Implementation Report (June 2017).

Legend:

✓ Achieved

⚠ Not achieved

ANNEX V. PRESENTATION OF THE METHODOLOGY AND THE RESULTS OF THE EX-POST EVALUATION BY INNOVA S.P.A. (2013)

As part of the evaluation exercise n ° 6 "The intermediary structures between scientific-technological organisations and companies for the promotion of innovation and the strengthening of competitiveness of the economy in the convergence regions", the final evaluation report produced by INNOVA S.p.A. in 2013 illustrates the results of the analyses conducted in the period December 2012 - March 2013:

- **Desk analysis** for the development of the topics under investigation and the mapping and selection of the intermediary structures subject to the evaluation study in the four convergence regions;
- **Field Analysis** for the collection of data and information from the selected structures, through questionnaires and interviews, to outline the framework of the offer of services for innovation and technology transfer, and the administration of questionnaires to the companies benefiting from the services offered by the structures, for an analysis of the demand aimed at verifying the needs and the degree of satisfaction of companies;
- **Performance Analysis** to verify the performance level of the selected intermediary structures through an Evaluation Grid (Performance Indicators Evaluation Scheme - PIES) with qualitative and quantitative parameters to measure and analyse some selected performance areas.

The objective of the evaluation was to provide a mapping of the existing intermediary structures operating the four convergence regions, analysing their positioning in the innovation chain and the segmentation of the services offered, to then highlight the most effective and virtuous experiences useful to define a possible transfer path of good practices.

The structures that have been considered for the study's purpose are mainly those created through measures and actions of the OP Research 2000-2006 and the OP R&C 2007-2013. However, the analysis also focused on other intermediary structures present in the territory, created starting from regional policy actions or other public or public-private initiatives. Overall, a total of 30 structures were considered. However, for the field and the Performance Analysis, the sample has been reduced to 18, including:

- 2 regional competence centres;
- 10 technological clusters;
- 4 public-private laboratories;
- 2 innovation poles.

To measure these intermediary structures' performance, it was decided to select 5 Performance Areas divided into 15 measurement parameters. The latter was defined to evaluate the structures' ability to:

- Monitor internal processes and therefore optimise the effectiveness of the action and management (Performance Area 1 - P1);
- Monitor the quality of services and the adequacy of the offer to the needs of demand (Performance Area 2 - P2);
- Generate revenues and define an economic model of economic-financial autonomy with respect to public support (Performance Area 3 - P3);
- Generate tangible results/outputs with an impact on the territory (Performance Area 5 - P5);
- Interact in a local and international context and implement a networking strategy (Performance Area 6 - P6).

Table 11. List of performance areas and measurement parameters

Performance area	Measurement parameter
P1. Evaluation and monitoring systems of the activity carried out	# 1. Adoption of a performance evaluation system (achievement of objectives and targets, implementation of the activity plan, implementation of the strategic plan)
	#2. Adoption of a quality control system for services offered to businesses
P2. Interaction with firms	# 3. No. of companies that make up the reference basin of the Structure
	# 4. Existence of a continuous mechanism for diagnosing the technological and innovation needs of companies (audit)
	# 5. No. of technological and innovation audits carried out on average each year
P3. Economic model and sustainability	# 6. % of revenues from business services for innovation and technology transfer on total annual revenues (three-year average 2009-2011)
	# 7. % coverage of the costs of the structure through revenues from business services (average for the three years 2009-2011)
	# 8. Average annual volume of financial resources deriving from projects financed at national, regional and European level
P4. Technology transfer, innovation and integration of skills	# 9. Internal system for the promotion/generation of R&D collaboration projects between research centres and companies (to be drawn from public funds)
	# 10. Mechanisms to promote the creation of start-up companies
	# 11. N ° new high-tech companies started in the three-year period 2010-2012
	# 12. No. of research orders carried out in the three-year period 2010-2012
	# 13. No. of patents presented in the three-year period 2010-2012
P5. Networking and internationalisation	# 14. Participation in national and international networks
	# 15. N ° of networks/clusters

Each of the 15 parameters listed in the table above was then associated with a measurement scale to measure the Target achieved by the structure on each parameter (from 0 to 3). The measurement scale must be read as follows:

Parameter measurement (Target)

- 0 = parameter does not exist
- 1 = low level of parameter
- 2 = medium level of parameter
- 3 = high level of parameter

The measurement of the parameter via the target scale represented the result of that parameter. Each parameter was then assigned a weight of 1 or 2 depending on the importance of the measured aspect concerning the intermediary's role recognised to these structures. The weight represents how much the specific parameter indicates the structure’s ability to play an effective role in the mediation of knowledge with tangible effects on the reference area. The multiplication of the target by the weight defines the parameter's indicator, which can vary from 0 to 6.

The sum of the indicators in the 5 Performance Areas defines a Synthetic Performance Indicator (IPS) which summarises the overall evaluation of the Performance Areas studied and which can have a minimum value of 0 and a maximum value of 44. The measurement of each parameter's indicators made it possible to outline a performance profile for each intermediary structure. Since only technological clusters fall within this evaluation's scope, the final evaluation grid presented in the table below shows the results of the ten existing technological clusters analysed only.

Table 12. Final evaluation grid of the ten existing technological clusters

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	Total
IMaST	1	2	2	0	0	0	3	3	1	1	2	3	4	1	3	**26**
D.A.Re.	0	0	3	2	2	2	1	1	1	1	2	2	0	1	2	**20**
R&D.Log	0	0	2	2	1	2	1	2	1	0	0	2	0	1	1	**15**
DHITECH	0	0	1	0	0	0	3	2	1	1	4	0	0	1	1	**14**
Cultura e innovazione	0	0	2	0	0	0	1		1	1	4	0	0	1	1	**13**
DI.T.N.E.	0	0	3	0	0	0	3	0	1	0	0	0	0	1	1	**9**
Trasporti navali, commerciali e da diporto	0	0	1	0	0	2	3	0	1	0	0	0	0	1	1	**9**
Agrobiopesca	0	0	3	0	0	0	1	0	1	1	0	1	0	1	1	**9**
MEDISDIH	1	0	1	0	0	0	3	0	1	0	0	0	0	1	1	**8**
Micro e nano sistemi	0	0	3	0	0	0	1	3	0	0	0	0	0	0	0	**7**

ANNEX VI. INTERVIEW LIST

Stakeholder category	Organization	Role in the organization	Name and contact
DG REGIO Desk Officer	DG REGIO - European Commission	Italy Desk Officer – Unit G.4 Italy and Malta	Pasquale D'Alessandro
Managing Authority	Ministry of Education, University and Research	Director – Office VII of the Directorate-General for the coordination, promotion and enhancement of research	Fabrizio Cobis
Managing Authority	Ministry of Education, University and Research	Director – Office IV of the Directorate-General for the coordination, promotion and enhancement of research	Antonio Di Donato
Managing Authority	Agency for Territorial Cohesion (previously Ministry of Education, University and Research)	Director - Office 1 Coordination of the Programmes and Procedures Area	Anna Maria Fontana
Stakeholder national RTD policy	Agency for Territorial Cohesion	Director - Office 4 (Authority for the management of national operational programmes relating to metropolitan cities)	Giorgio Martini
Stakeholder national RTD policy	Agency for Territorial Cohesion	Senior Advisor in R&D and innovation policy fields	Osvaldo La Rosa
Stakeholder national RTD policy	Agency for Territorial Cohesion	Senior Advisor in R&D and innovation policy fields	Marco De Maggio
Regional Managing Authority	Regione Puglia	Director – Support to the coordination of international policies	Adriana Agrimi
Trade association	Confindustria	Industry and Innovation Manager	Nicoletta Amodio
Managing Authority – Technical Assistance	Technical Assistance	Expert	Giuseppe Nota
Managing Authority – Technical Assistance	Technical Assistance	Expert	Fabio Landi
Managing Authority – Technical Assistance	University of Rome (Roma Tre)	Professor	Edoardo Bemporad
Beneficiary – Policy instrument science-industry collaborative R&D	Istituto di Analisi dei Sistemi ed Informatica "Antonio Ruberti" - CNR	Researcher	Giuseppe Stecca
Beneficiary – Policy instrument science-industry collaborative R&D	University of Foggia	Professor	Giancarlo Colelli
Beneficiary – Policy instrument science-industry collaborative R&D	Istituto per i Polimeri, Compositi e Biomateriali - CNR	Director	Concetto Puglisi
Beneficiary – Policy instrument science-industry collaborative R&D	University of Messina	Professor	Antonio Puliafito
Beneficiary – Policy instrument science-industry collaborative R&D	STMicroelectronics Srl	Senior Marketing manager	Mirko Guarnera
Beneficiary – Policy instrument science-industry collaborative R&D	FIAT CHRYSLER FINANCE SpA	Public Finance Manager	Massimo Casali
Beneficiary – Policy instrument collaborative R&D in clusters	Plastica Alfa S.r.l.	Project manager	Luciano Falqui
Beneficiary – Policy instrument collaborative R&D in clusters	MEDISDIH Scarl	Director	Mario Ricco

Beneficiary – Policy instrument collaborative R&D in clusters	DTA - Distretto Tecnologico Aerospaziale	Director	Giuseppe Acierno
Beneficiary – Policy instrument collaborative R&D in clusters	DiTNE Scarl	Director	Angelo Colucci
Beneficiary – Policy instrument collaborative R&D in clusters	IMAST Scarl	Director	Eva Milella
Beneficiary – Policy instrument collaborative R&D in clusters	Distretto Tecnologico Aerospaziale della Campania	Technical manager	Gennaro Russo
Beneficiary – Policy instrument collaborative R&D in clusters	Distretto Tecnologico Aerospaziale della Campania	Technical manager	Claudio Voto
Beneficiary – Policy instrument infrastructure investments	TIGEM	Chief Scientific Office	Graciana Diez-Roux
Beneficiary – Policy instrument infrastructure investments	University of Palermo	Professor	Giulio Ghersi
Beneficiary – Policy instrument infrastructure investments	University of Palermo	Professor	Livan Fratini
Beneficiary – Policy instrument infrastructure investments	University Magna Grecia of Catanzaro	Professor	Arturo Pujia
Beneficiary – Policy instrument infrastructure investments	NEUROMED	Managing director and innovation manager	Fabio Sebastiano
Beneficiary – Policy instrument infrastructure investments	NEUROMED	Responsible for the R&D Office	Emilia Belfiore

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