

Impact evaluation study of the aid scheme on CDTI R&D projects. FINAL EVALUATION EXECUTIVE SUMMARY

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Impact evaluation study of the aid scheme on CDTI R&D projects

Final evaluation executive summary

This report was
commissioned by the
Centre for the Development
of Industrial Technology-
CDTI.

This report was commissioned by the Centre for the Development of Industrial Technology in the year 2020.

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Summary

The object of this evaluation refers to the 2015-2020 period subject to the Block Exemption Regulation (SA.45828), which includes the funding granted by CDTI as of 2015, in the form of loans and subsidies for business R&D projects.

This evaluation report is the last phase of the impact evaluation study of the aid scheme of the CDTI's R&D projects, in accordance with the Evaluation Plan approved by the European Commission through Decision C (2015) 4147 final, dated 22 June 2015. A mid-term evaluation was done in 2018 and served as learning for this final evaluation. The final evaluation covers the main instruments of the scheme: individual R&D projects and in cooperation (PID); CIEN projects; ERDF-ININTERCONECTA projects; INNOGLOBAL projects; CDTI-Eurostars-2, international inter-company projects; and CDTI Eranets.

The ultimate goal of the evaluation is to provide evidence on both the direct impacts (input additionality, outputs additionality and behavioural additionality) and indirect impacts (externalities, collaborations etc.) of public support granted by CDTI to Spanish companies, as well as on the proportionality and appropriateness of the aid measure.

In line with mid-term evaluation, we can say that the **CDTI funding, during the period considered, do not distort the market, i.e. do not distort competition in the product markets, neither do they influence the choice of location of the companies. Overall, we can stated that the final balance in terms of impacts is positive.**

Based on these results and conclusions, a series of recommendations addressed to the users of the evaluation have been specified.

The results of the evaluation are based on the use of quantitative and qualitative techniques, and the triangulation of results involving combination, complementarity, confirmation and corroboration of quantitative and qualitative results.

Previous empirical evidence

Governments use different tools to support the R&D efforts of companies and innovative performance (Aschhoff, 2009). In many countries (mainly in developed economies) large amounts of public funds are devoted to supporting R&D projects carried out by private companies through subsidies, public procurement, loans and other instruments, such as collateral for loans or tax credits on R&D, among others. These public policies are largely justified on the basis of market failures and, mainly, due to the inability of companies to take ownership of all the benefits of the investment in R&D that results in insufficient investment in relation to that what is socially optimal (Roper and Hewitt-Dundas, 2016).

Likewise, other goals of the public innovation policy are focused on incorporating more innovative companies and generating a change in the behaviour of companies towards innovation. R&D subsidies are a common tool of technological policy (Busom, 2000). The empirical evidence on their effectiveness in fostering private innovation activities has produced mixed results so far. One possible explanation is that companies and the rules for the selection of projects can be, in practice, fairly heterogeneous both in the agencies and industries, which leads to different results in terms of the additional private effort triggered (Blanes and Busom, 2004).

The concept of “additionality” is fundamental for analysing public policies supporting innovation. Additionality indicates the extent to which the public support stimulates additional innovation activity and is based on the fact that the activity of additional innovation will in turn lead to greater side effects of innovation than what would have occurred in the absence of public support (Roper and Hewitt-Dundas, 2016). The evaluation of the effectiveness of public support has focused on measuring additionality in terms of the resources of the companies (input additionality) and the results of innovation (output additionality). In addition to those mentioned above, public support has behavioural effects in the companies’ capacity for innovation (behavioural additionality).

In other words, not only does public support produce short-term effects on the resources allocated to a project or the results derived from a project, but there may also be other complementary effects such as changes in behaviour in the innovation process. The effects of learning are integrated into the routines and capabilities of companies to innovate. In turn, these learning effects can have a positive long-term impact on the results of the innovation (Roper and Hewitt-Dundas, 2016).

An alternative view in respect of R&D policies is that subsidies for R&D produce an effect called crowding out on the R&D expenditure of companies, that is, produces a total replacement between public and private funds and that the activities of private innovation remain constant. The existence of this effect implies that public financing for innovation is a poor allocation of public funding.

Based on the review of the literature on quantitative research, it seems that there can be no definitive statements with regards to the effect of public financing for R&D. On the other hand, to our knowledge evidence on the impact of R&D public funding using triangulation methodologies are scarce or non-existent.

Logical framework of intervention

The logical framework of the intervention of the CDTI’s aid scheme aims to structure the connection between the overall objectives, specific objectives, instruments used, economic resources used, the activities carried out by the different areas of the Agency, the results of the Agency and the results and impacts achieved by the companies benefiting from public support.

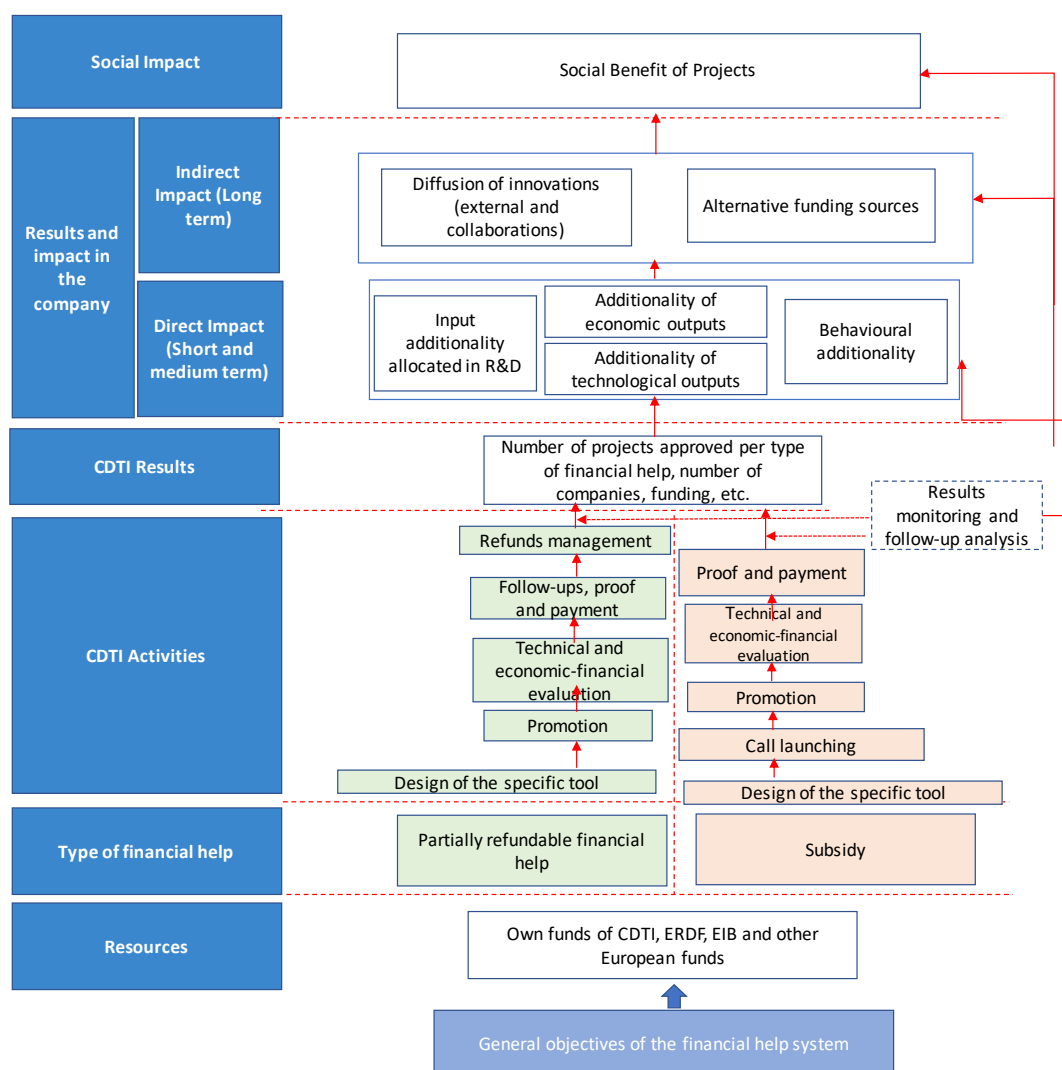
In this regard, a general framework for intervention has been designed differentiating between the two types of generic funding existing in the CDTI that are the subject of the evaluation (partially reimbursable funding and grants modality). This is necessary to observe the existing differences between CDTI activities and procedures in the two types of funding, which, in any case, converge in pursuing the general objectives of the CDTI.

In general, the CDTI aid scheme has the following objectives:

- Increase private expenditure on innovation in Spain. The purpose of the funding is to promote and increase the participation of companies in R&D activities, so that those that are already innovative carry out more ambitious projects and systematise their R&D strategy, and the non-innovative ones begin to develop innovative projects of this type.
- Promote development and business competitiveness through cooperation with companies, research centres and other economic agents in the field of R&D.

- Achieve innovative, high quality R&D projects with a commercial approach and market-oriented.
- Promote internationalisation and international technological cooperation, as well as exports and investments abroad.

Generic Logical Framework of Intervention



Source: Own compilation

The specific objectives of each instrument subject to the General Block Exemption Regulation (SA.45828) are contained in the following table. Instruments subject to the General Block Exemption Regulation (SA.45828)

Instrument	Objectives
PID	<ul style="list-style-type: none"> • Increase private expenditure on innovation in Spain. • Achieve innovative, high quality R&D projects with a commercial approach and market-oriented. • Promote development and business competitiveness through cooperation. • Promote internationalisation and international technological cooperation, as well as exports and investments abroad.
CIENT	<ul style="list-style-type: none"> • Promote development and business competitiveness through cooperation among companies. • Promote cooperation with research centres and other economic agents in the field of R&D. • Achieve innovative, high quality R&D projects with a commercial approach and market-oriented. • Promote internationalisation and international technological cooperation.
ERDF - ININTERCONECTA	<ul style="list-style-type: none"> • Increase private expenditure on innovation in Spain. • Promote development of less-favoured regions. • Promote development and business competitiveness through cooperation among companies. • Achieve innovative, high quality R&D projects with a commercial approach and market-oriented projects.
Innoglobal	<ul style="list-style-type: none"> • Promote internationalisation and international technological cooperation, as well as exports and investments abroad. • Increase private expenditure on innovation in Spain. • Promote development and business competitiveness through cooperation. • Achieve innovative, high quality R&D projects with a commercial approach and market-oriented.
CDTI-Eurostars-2	<ul style="list-style-type: none"> • Promote internationalisation and international technological cooperation among SMEs. • Promote development and business competitiveness through cooperation with companies, research centres and other economic agents in the field of R&D. • Achieve innovative, high quality R&D projects with a commercial approach and market-oriented. • Increase private expenditure on innovation in Spanish SMEs.
CDTI-Eranets	<ul style="list-style-type: none"> • Increase private expenditure on innovation in Spain. • Achieve innovative R&D projects: the projects must represent high scientific-technical quality and be significantly innovative. • Foster collaboration of companies. • Dissemination of the knowledge acquired from the projects through publications, platforms, conferences and other events and instruments. • Promote internationalisation and international technological cooperation. • Coordinate the national and regional research programmes of the EU Member States and associated countries.

Source: Own compilation

Methodology and data sources

Quantitative methods and data sources

Quantitative information come from the Technological Innovation Panel (PITEC) and from the CDTI in the 2010-2018 analysed period. We try to address most of the evaluation questions through the PITEC-CDTI panel. We use additional quantitative data sources (CDTI electronic surveys) when information is not available in this panel.

The technological innovation panel (PITEC) is a panel-type database that the National Institute of Statistics (INE) prepares annually with information from the survey on innovation and R&D activities of companies (Innovation Survey). This database lets us to analyse the technological innovation activities of Spanish companies and their evolution. This database is completed with the information provided by the CDTI that allows us to identify companies granted and to build suitable control groups – “matched samples”. This database is referred as “PITEC-CDTI database: 2010-2016”. Despite the yearly character of the Innovation Survey, 2017 survey was not available in PITEC database due to budgetary constraints at national level.

Compared to other databases (i.e. the Iberian Balance Sheet Analysis System -SABI), the use of PITEC database allow us to analyse a wide range of R&D&I activities, resources and results of firms across time. In addition, the use of the database as a primary source was required in the technical specification of the evaluation call.

The PITEC data includes variables relating to fifteen fundamental aspects for analysis: general data, type of innovation, product innovation, process innovation, organisational innovation, marketing innovation, non-successful innovation, R&D activities and expenditures, barriers to innovation and its effects, staff for innovation, cooperation, sources of information and access to knowledge for innovation, protection of the innovation results, and innovation objectives. With regard to the data from the CDTI, merged with PITEC, these include variables related to whether, during the analysed period, the company has finished a project granted from the CDTI and in which year the project granted was completed, and sectoral taxonomy. Therefore, we neither are able to distinguish successful from unsuccessful CDTI applicants, nor firms that have been awarded but not completed the project granted by CDTI. Statistical confidentiality reasons made it difficult to include an additional variables or categories. The inclusion of any additional variable to be merged with the PITEC database results in an important loss of information provided by the INE.

The **full sample** is an unbalanced panel containing 57,988 observations. Of these, 9,116 (16%) correspond to companies that have received funding from the CDTI subsidy programs of Individual and Cooperative Projects (PID)¹ (beneficiary companies) and finish their project granted and 48,882 (84%) correspond to non-beneficiary companies over the 2010-2016 period. PID represent approximately 80% of the CDTI's subsidies in the analysed period. The evaluation focuses on the PID program in order to reduce the potential biases of analysing different aid schemes.

From the full sample, we extract **three matched samples** that allow us to:

¹ Therefore, the quantitative evaluation does not include the CIEN partially reimbursable subsidies and the ERDF ININTERCONECTA and INNOGLOBAL grants, CDTI-Eurostars Projects and CDTI-Eranets projects.

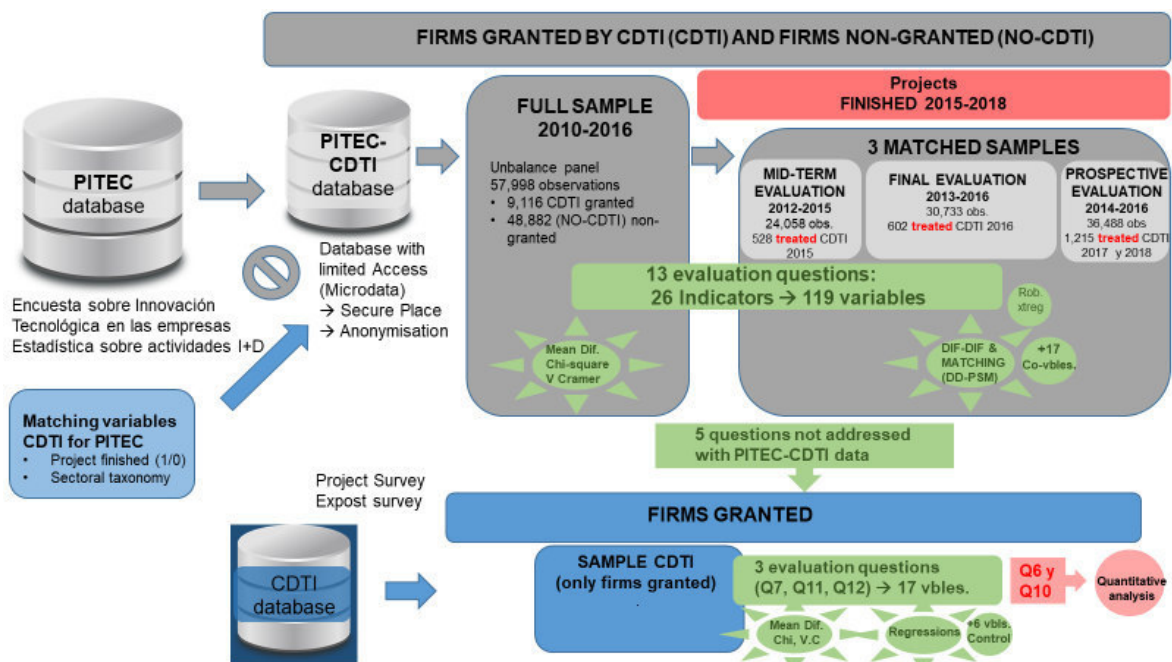
Final evaluation executive summary

- (I) carry out the final evaluation (**matched sample of the final evaluation**, considering projects finished in 2016 (CDTI) and controls over the 2013-2016 period);
- (II) to compare results with the mid-term evaluation (**matched sample of the mid-term evaluation**, considering projects finished in 2015 (CDTI) and controls over the 2012-2015 period);
- (III) and to forecast some result for 2017 and 2018 (**prospective matched sample**, considering projects finished in 2017 and 2018 (CDTI) and controls over the 2014-2016 period).

We implemented this three-matched sample approach instead of a one-matched sample approach for two main reasons. Firstly, the information for the prospective matched sample is limited compared to the other two samples. Secondly, the three-matched sample allows us to increase the comparison points over the required period to be evaluated (2015-2020).

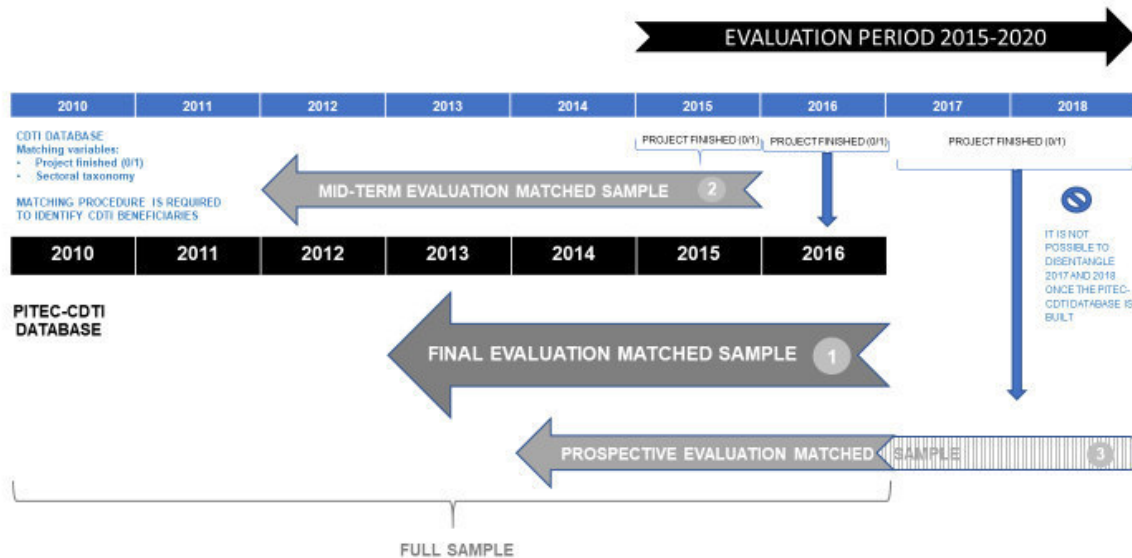
The *software* used for the analysis is STATA.

Summary of the approach and the databases used



Source: Own compilation

Summary of the approach and timeline



Source: Own compilation

Additionally, several questions have been addressed quantitatively with data collected internally by the CDTI through two electronic surveys that beneficiary companies are requested to complete at two points in time: 1) after completing the technological development of the project R&D (*project* survey) and 2) two years after the commercialization of the innovations (*ex-post* survey). The first survey (or results survey) is mainly based on the Community Innovation Survey questionnaire, but also includes other relevant issues. The *ex-post* survey is shorter and focuses on the economic impact.

The **quantitative methods** include descriptive and multivariate statistics that vary across full and matched samples.

Over the **full sample** we use a more descriptive approach. We calculate mean differences, percentages and provide graphic representation over time across beneficiary (CDTI) and non-beneficiary firms (NO-CDTI) in order to summarize the behaviour of these two set of firms. We also apply t-test, chi-squared tests and Cramer's V to test these differences. We apply this approach to the 26 indicators requested in the evaluation for which we calculate a total of 119 variables.

The methodology applies to build and analyse the **matched samples** aim to control some of the biases that occur when analysing the results with a more descriptive approach. Firms that received grants from CDTI could, for example, have specific characteristics (i.e. they could be bigger than an average Spanish firm) or could operate in specific markets that could explain the increased performance observed across indicators and over time when analysing the full sample. Thus, this methodology allows comparing firms that have the same probability of receiving CDTI aids.

Due to the fact that any of the approaches have their advantages and disadvantages, we use a mixed approach of Differences-in-Differences with matching (Villa, 2016) – **double difference combined with propensity score matching (DD-PSM)**. This method allows to establish causal inferences with non-experimental data and deal with the unobserved heterogeneity that does not vary over time. To control the heterogeneity observed, we have

considered a series of control variables that enable to explain the probability of being treated (in this case, completing a project with CDTI funding). A total of 13 control variables have been considered, including the sectoral taxonomy.

Therefore, we use a double difference (DD) method refined with a propensity score matching (PSM) (DD-PSM). We use PSM with the baseline data to be sure that the comparison, or control, group is similar to the treatment group and, then, we apply double differences to the matched sample. Then, the observable heterogeneity in the initial conditions can be dealt with. Following this approach, we build three matched samples.

- (I) **Matched sample of the mid-term evaluation.** We apply a DD-PSM method for this sample in order to get results for the 26 indicators requested in the evaluation for which we calculate a total of 119 variables.
- (II) **Matched sample of the final evaluation.** Over this core evaluation sample, we apply the general approach and the following additional analysis:
 - We calculate DD-PSM to get results for the 26 indicators requested in the evaluation for which we calculate a total of 119 variables.
 - We select 12 indicators taking into account the previous results and the strategic character of the indicator and perform additional analysis. With these indicators we:
 - perform a DD-PSM across sectors -Traditional, Dynamic, Stationary, and Challenges- to assess heterogeneous effects. Construction sector was not considered due to the lack of observations that created anonymity problems with the results.
 - check the consistency of the results when covariates are considered across the treatment period (not only at the baseline year).
- (III) **Prospective matched sample.** We apply a DD-PSM method for this sample in order to get results for the 26 indicators requested in the evaluation for which we calculate a total of 119 variables.

Despite the controls applied in the second approach (control samples), several limitations remain. In the first place, the limitations of the original sample (PITEC) that, for example, cannot be considered to be representative for companies with less than 10 employees and which has suffered modifications in its sampling strategy. Secondly, the limitations of the cross-sample (PITEC-CDTI), in order to safeguard the anonymity, INE limits the use of variables for building the cross-sample.

However, and despite these limitations, we have used probably the best available database (PITEC-CDTI). CDTI doesn't rank the unsuccessful applicants, making it impossible to use this information in order to build a natural control group of beneficiary companies. Thirdly, the methodology used, although it controls part of the possible biases, does not allow to control for unobserved heterogeneity that changes over time.

TECHNICAL NOTE ON THE SECTORAL TAXONOMY

The sectoral taxonomy includes five categories (traditional, dynamic, stationary, challenges, and construction) for those indicators whose results are considered more relevant. The construction sector was not considered in the final result in order to avoid the limitations imposed by the INE on the delivery of the results.

- **Traditional:** includes farming and mining activities and those included as “sectors in withdrawal” in the Molero-García taxonomy (sectors with little global dynamism and where Spain has technological disadvantages).
- **Dynamic:** made up by the manufacturing sectors with “dynamic specialisation”, according to the Molero-García methodology, and which are those where Spain has technological advantages and has significant global dynamism. They are added to the knowledge intensive business services sectors (KIBS).
- **Stationary:** made up by the manufacturing sectors with “stationary specialisation”, according to the Molero-García methodology, and which are those where Spain has technological advantages, but has less global technological dynamism.
- **Challenges:** sectors called “missed opportunities”, according to the Molero-García methodology and that are dynamic sectors at a global level, but where the Spanish industry has technological disadvantages.
- **Construction:** made up by the construction industry.

Qualitative methods and data sources

The **qualitative information** is a fundamental aspect to complement the quantitative data through the use of techniques for the integration of results. In addition, qualitative methods were essential for those kinds of aids that could not be evaluated through quantitative data.

In accordance with the general methodology, and in coherence with the information used in the quantitative analysis, the time frame of the sample universe for this part of the analysis corresponds to the 2015-2020 period. Only completed projects have been selected for the case of beneficiary companies.

As was to be expected, the sample universe in its entirety corresponds to databases from the CDTI for the years and types of funding indicated. The Agency also provided the names and contact details of people responsible for R&D projects developed with funding from these public support initiatives, as well as for the managers or coordinators that submitted projects to the CDTI, in the event of said companies not becoming beneficiaries.

In particular, two different typologies of samples were selected on the basis of random and representative criteria:

- Sample for in-depth interviews and case studies.
- Samples for working groups, specifically six, one per working group.

For **in-depth interviews and case studies** a total of 100 projects submitted to the CDTI were selected, both from beneficiary and non-beneficiary companies (original sample).

The selected projects of both samples (original and replacement) were classified according to the following criteria:

- **Resolution of the funding:** (1) Beneficiary companies and (2) non-beneficiary companies.

- **Company size:** (1) small companies (less than 50 employees), (2) medium-sized companies (50 to 250 employees) and (3) large corporations (more than 250 employees).
- **Registered office of the company:** On the basis of the EU-2014-2020 classification framework, (1) less developed regions (Extremadura), (2) transition regions (Castile La Mancha, Andalusia, Murcia, Melilla and Canary Islands) and (3) more developed regions (Galicia, Asturias, Cantabria, the Basque Country, Navarre, La Rioja, Aragon, Madrid, Castile and León, Catalonia, Valencia, Balearic Islands and Ceuta).
- **Sectors:** (1) pharmaceutical manufacturing, (2) manufacture of metal products, (3) technical services of architecture and engineering, (4) manufacture of computer, electronic and optical products, (5) food industry and (6) the rest of the sectors.
- **Type of instrument requested:** (1) PID, (2) CIEN, (3) ERDF-INNTERCONECTA, (4) INNOGLOBAL; (5) CDTI-Eurostars-2 and (6) CDTI Eranets.

For each **working group** were selected five projects (original sample) in based on the type of instrument requested, while the rest of the criteria were random.

As a specific block of the questionnaire of in-depth interviews, but methodologically speaking within the case studies, interviewers plated several questions related to the potential distorting effects of the aid.

The interviews were conducted by telematic means (Skype or Blue Jeans), by telephone or in person and questionnaires were used to support the implementation of the same. There are two types of questionnaires, for “beneficiary” companies and for “non-beneficiary” companies.

Means and type of companies selected for the in-depth interviews

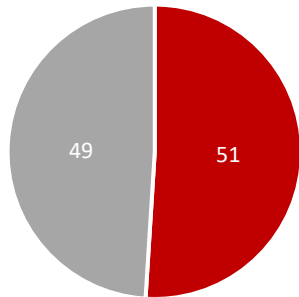
	Face-to-face interviews	Telematic interviews	Total
Beneficiary companies	33	18	51
Non-beneficiary companies	13	36	49
Total	46	54	100

Source: Own compilation

As shown in the following charts, regarding the distribution by size, 54 small companies, 31 medium-sized companies and 15 large companies were interviewed. According to the type of region, within the EU-2014-2020 classification framework, 3 interviewed companies were located in less developed regions, 24 in transition regions and 73 in more developed regions.

On the other hand, 57 applicant companies of PID aids, 30 of ERDF INNTERCONECTA aids, 7 OF CIEN aids, 4 OF CDTI Eurostars-2 aids and 2 of INNOGLOBAL were interviewed. No CDTI-Eranets aid applicant companies were interviewed as they were not statically significant in relation to the overall number of applications.

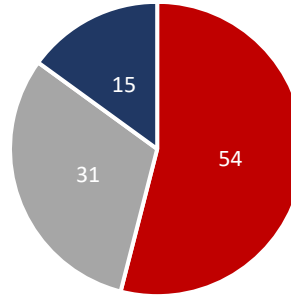
*Distribution of interviewees by resolution of the
funding*



■ Beneficiaries ■ Non-beneficiaries

Source: Own compilation

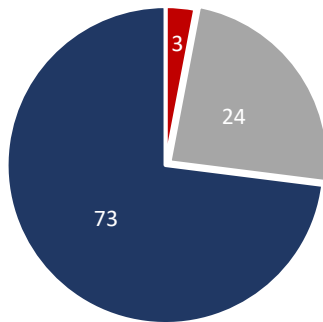
*Distribution of interviewees by company
size*



■ Small companies ■ Medium-sized companies ■ Large companies

Source: Own compilation

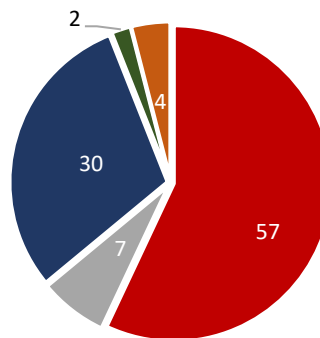
*Distribution of interviewees by registered office
of the company*



■ Less developed regions ■ Transition regions
■ More developed regions

Source: Own compilation

*Distributions of interviewers by type of
instrument requested*



■ PID ■ CIEN ■ ERDF INNTERCONECTA ■ INNOGLOBAL ■ CDTI-Eurostars-2

Source: Own compilation

Although participants have been randomly selected, a reinforcement was introduced in the sample in regard to five strategic sectors within the R&D field: pharmaceutical manufacturing; manufacture of metal products; technical services of architecture and engineering; manufacture of computer; electronic and optical products; and food industry.

The number of interviewees within these sectors constitute 25% of the total.

In view of the successful experience of the mid-term evaluation and in base on governmental restriction due to epidemic caused by coronavirus disease (COVID-19), working groups were carried out electronically.

Six working groups were carried out, with a total participation of 33 beneficiary companies of CDTI funding. These working groups were grouped based on the type of received aid.

Participant companies in the working groups

Working group	Companies that refused to participate	Participant companies	Response rate
PID	1	5	83,33%
CIEN	1	4	80%
ERDF INNTERCONECTA	1	5	83,33%
INNOGLOBAL	6	5	45,45%
CDTI Eurostars-2	1	7	87,5%
CDTI-Eranets	6	7	53,85%
TOTAL	16	33	67,35%

Source: Own compilation

Triangulation methodologies

The concept of triangulation is used in a broad sense, as a mixed and integrator method, in the meaning proposed for the performance of this study: the qualitative analysis is used to supplement (add and complete - additive function-), combine (refining, detailing and improving) and seeking confirmations and convergences with the quantitative results.

In this regard, the triangulation strategy is multiple, both structural and temporal (at different stages).

From a structural point of view, the following classification can be made:

- **Data triangulation:** using a variety of quantitative information sources (PITEC and CDTI databases) and qualitative information from interviews with samples of companies from the CDTI.
- **Triangulation of researchers:** involves the multidisciplinary participation of several quantitative and qualitative evaluators in the process (academic staff, consultants, specialised technicians, etc.), whose goal is to compensate for the potential bias derived from the analysis of data from a single perspective.
- **Methodological triangulation:** consisting of a combination of several methods (quantitative and qualitative) for gathering and analysing data in order to come closer to the reality researched.).

On the other hand, the methodology of triangulation of results, conclusions and recommendations consists of several stages:

1. **Triangulation of results:** in the first stage of the analysis, an *intra-method quantitative triangulation* has been carried out, consisting of a first phase of global analysis that provides some general results which allow to define, broadly speaking, the innovative business profile (full sample) to then, from a stricter point of view, define the specific nature of the evolution of the companies before and after the CDTI funding (matched sample).

Finally, the results of the evaluation are constructed on the basis of the *inter-method triangulation (quantitative and qualitative)*, where one seeks confirmation and convergence of the findings resulting from both methods.

2. **Triangulation of findings, conclusions and recommendations:** Once the overall results have been obtained, two meetings are held:
 - An internal workshop (discussion panel) with the qualitative and quantitative evaluators.

- Then, a meeting is held with technical experts of the CDTI to extract conclusions and recommendations based on the information previously synthesised in the preliminary phases.

Results of the evaluation

On the basis of the results of the final evaluation report, **the overall balance of CDTI aids for the 2015-2020 period is positive**. This means that the **direct and indirect impacts encountered are sufficient and relevant, without having found clear indications of market distortions**.

The results can be summarised grouping them in five kinds of impacts and other qualitative and strategic aspects.

Input additionality

The existence of input additionality, is confirmed for R&D inputs, both economic and personnel inputs and both as the propensity of using them and for the intensity of that use. In summary (see below table summary), we find that **beneficiary firms increase the probability of carrying out internal R&D activities by about 13 percentual points compared to their controls. Beneficiary firms increase the likelihood of having created R&D jobs by about 14 percentual points [Final Evaluation sample]**.

The qualitative analysis complements the results obtained in the quantitative analysis. the beneficiary companies have a better trend innovative behaviour than non-beneficiaries in several key areas:

- Public aid has allowed them to start in R&D activities.
- They invest more financial resources.
- The R&D effort is greater.
- Greater number and variety of R&D projects.
- They carry out technically riskier projects and with greater uncertainty.
- Their projects are greater scope, scale and complexity.
- More frequently they invest in complementary assets and undertake innovative activities.
- Projects of longer duration and longer development periods.
- More experience of R&D team.
- Further consolidation of R&D personnel.
- More internal staff are incorporated into R&D projects.
- More R&D staff are hired.
- Greater research importance in R&D teams.
- Teams with more specialised and multidisciplinary staff: PhDs, higher education graduates (graduates in scientific degrees, engineers and PhDs) and vocational training techniques.

However, the additionality not always can be confirmed when we compare other innovative inputs. For more information, consult the section “Input additionality” in chapter 6: “Results of the Evaluation”.

Technological and economic output additionality

The **technological output additionality** is confirmed in the case of **patent data**. In the **Dynamic sectors** (those with technological advantages and a world positive evolution) the **positive impact** is confirmed in **product innovation**. In contrast, in the **Traditional sectors** the **output additionality** is confirmed in **process innovation**.

The qualitative analysis complements the positive findings in several aspects:

- Production process optimization.
- Reduction of labour costs and other productive costs.
- Logistics process optimization.
- Development of process innovations through integration of existing technologies.
- Improvement of productive and technological capacities.
- Development of new products not existing on the market.
- Development of new prototypes.
- Development of product innovations through integration of existing technologies.
- Improvement of the characteristics/quality of existing products.
- Expanding product variety.

Despite the traditional obstacles and difficulties (economic costs, bureaucracy, likelihood of litigation, costs of litigation, software, etc.), **beneficiary companies increase the likelihood of patenting by about 2.9 percentual points (not significant) [Final Evaluation sample]**. They also use, to a greater extent, other means of protection for industrial property (industrial secrecy, confidentiality agreements, etc.).

Regarding the economic output additionality, the **positive impact is only observed for projections in exports and international markets**.

As a consequence of qualitative analysis, **positive results on some economic output variables are obtained (new products, expansion into new markets or customers, new commercialization strategies, exports, investment in material goods, etc.)**. However, the companies do not assign a clear relationship of cause and effect with the CDTI funding.

Strategies and operational behaviour

In the case of cooperation to innovate **the beneficiary firms have improved more the rest their activity, mainly as far as cooperation with public bodies is concerned**. In summary (see below table summary), we find that **beneficiary firms increase the number of partnerships with research centres by about 0.26 [Final Evaluation sample]**.

According to the qualitative analysis, these findings are detected in several aspects:

- Promoting collaboration with universities, technology centres, laboratories, etc.
- Fostering various areas of cooperation, aside from the existing ones, but also mainly new ones.
- Improved access of the company to other public programmes (national, international, etc.).

- Improved company image for future collaborations in the development of projects.
- Strengthening of the strategic nature of the cooperation: systematisation and institutionalisation in the company.
- Increased learning ability and acquiring new knowledge.
- More likely to cooperate and form alliances with international partners.

Likewise, in some cases, the perception is positive in terms of changes in their organizational structures, methods and strategies (except in managing external and institutional relations): new organizational structures (R&D department, etc.); new working methods and procedures; new business strategies; modification of the processes: responsibility management and decision making and strategic R&D plans (medium and long term).

Indirect impacts

Beneficiary firms do not tend to use formal mechanisms for dissemination of knowledge. Regarding positive indirect impacts on collaboration and alternative funding (see table summary below), we find **positive indirect impacts in the diversity of the network cooperation. Beneficiary firms increase the number of international partnerships outside the group of by about 0.3 [Final Evaluation sample], diversifying international partnerships. Similarly, Beneficiary firms increase the probability of obtaining alternative funding by about 5 percentual points [Final Evaluation sample].**

The beneficiary companies tend not to use formal mechanisms for dissemination of knowledge (sale of licenses, etc.). Nevertheless, they do tend to use other dissemination mechanisms such as:

- Presence at congresses, trade fairs and dissemination workshops.
- Participation in training centres (university chairs, master's degrees, etc.).
- Participation in networks and platforms for the dissemination of knowledge.
- Agreements with suppliers with high technological component.

On the other hand, **some companies have consolidated previously existing partnerships and others have consolidated new relationships. Moreover, the companies obtain a more differentiate range of financial resources (tax deductions, international programs, etc.).**

Effects on free competition

The CDTI funding, during the period considered, do not distort the market. In particular, the following general conclusions are extracted for the set of beneficiary companies:

- *Markets tend to be atomized. In more concentrated markets competition is dominated by product differentiation.*

Small and medium business companies tend to compete with larger companies in the same markets, so product differentiation is a key and increasingly important aspect.

- *High level of international competition in the market segments in which the company operates.*

The competition in markets is increasing with high pressure in differentiated products, and where technological innovation is the key competitive variable.

- *Barriers to market entry in the field of R&D tend to be related to the structure of the market: economies of scale and scope, product differentiation, etc.*

CDTI aid does not facilitate or intensify market entry barriers, mainly because R&D projects are financed in pre-competitive phases far from the market and with special emphasis on small and medium-sized companies. Therefore, there are fewer probabilities of seeing serious exclusion effects.

- *Changing markets, growing and expanding.*

Companies compete in growing markets and with high growth expectations. This fact reduces the likelihood that the dynamic investment incentives of competitors will be adversely affected by public funding.

- *Social impacts in different areas.* CDTI aids have had beneficial effects for society in different fields:
 - Emission reduction, thanks to encouraging the use of renewable energy and fostering energy efficiency.
 - Improvement of public health.
 - Increase of professional retraining and vocational training.
 - Fight against social exclusion.

- *Competing companies generally benefit from the achievements or knowledge generated by beneficiary companies thanks to the aids.*

The effect of dissemination of the results achieved, by formal and informal means, reduces the likelihood of the exclusion effect due to the competing companies benefiting from the findings made by the companies that have received funding.

- *Companies can access CDTI aids on equal terms through a fair and transparent process.*

In general terms, beneficiary companies agree with CDTI's procedures for applying for aid programmes are fair and transparent.

- *The funding does not constrain the location of businesses.*

The location for the development of the project is only conditional on ERDF INNTERCONECTA due to the requirement of developing projects in a certain ERDF region. Thus, companies are located in the same site with and without funding. In general, all companies state that, in the event of not having been beneficiaries, they would have carried out the project at their R&D centre or their normal production centre and they would not have invested in another region.

Proportionality and suitability

Proportionality

A higher CDTI aid contribution is positively related to the indicators of commercial activity (i.e. percentage of sales) and, more importantly, to R&D effort. On the other hand, a greater proportion of the non-reimbursable tranche appears not to have a consistent positive effect on the considered variables.

The **size of the budget -associated to large-scale projects-** has **significant positive effect on commercial aspects, on human and economic resources devoted to R&D and on an increase in technological leadership**; being more consistent across surveys the positive results on research and technological inputs.

Suitability

Positive results are found mainly for ID programme. The data shows that instruments that seek to achieve specific objecties, such as Eurostars or Innterconecta, fulfil their purpose, generating greater additionality in exports and in the creation of employment in less favoured areas, in the case of Innterconecta.

Summary of the main results

OBJECTIVE	TYPE OF IMPACT	Q	TREATMENT	IMPACT	METHOD
Direct effects	Input additionality	1	Getting funding support from CDTI (2 years avg.)	Positive impact in internal R&D expenditures (3 y 16) and job creation (46) across sectors Beneficiary firms increase the probability of carrying out internal R&D activities by about 13 percentual points compared to their controls (3) Beneficiary firms increase the likelihood of having created R&D jobs by about 4-14 percentual points (46)	Quantitative: Double difference with propensity score (DD-PSM) with PITEC-CDTI data Qualitative: interviews, working groups
	Output additionality	2-4	Getting funding support from CDTI (2 years avg.)	The impact on product innovation varies across sectors (dynamic +, stationary -) Positive impact on process innovation in the traditional sector Positive impact on patenting activity (63), not consistent across samples, And heterogenous effects across sectors on patent number (65) (traditional and dynamic +, stationary -)	Quantitative: Double difference with propensity score (DD-PSM) with PITEC-CDTI data Qualitative: interviews, working groups
	Behavioural additionality	5	Getting funding support from CDTI (2 years avg.)	Positive impact on cooperation indicators and quite consistent across sectors (e.g. 99) Beneficiary firms increase the number of partnerships with research centres by about 0.15-0.26, becoming more internationally oriented (99)	Quantitative: Double difference with propensity score (DD-PSM) with PITEC-CDTI data Qualitative: interviews, working groups
Indirect effects (positive)	Technological	7	Getting funding support from CDTI (2 years avg.)	Beneficiary firms tend not to use formal mechanism of knowledge dissemination	

OBJECTIVE	TYPE OF IMPACT	Q	TREATMENT	IMPACT	METHOD
					Qualitative: interviews, working groups
	Collaboration	8	Getting funding support from CDTI (2 years avg.)	Positive impact in diversity of network cooperation (107) Beneficiary firms increase the number of international partnerships outside the group of by about 0.2-0.3, diversifying international partnerships (107)	Quantitative: Double difference with propensity score (DD-PSM) with PITEC-CDTI data Qualitative: interviews, working groups
	Alternative funding	9	Getting funding support from CDTI (2 years avg.)	Positive impact in obtaining alternative funding across sectors except for "challenges" (117) Beneficiary firms increase the probability of obtaining alternative funding by about 2-5 percentual points (117)	Quantitative: Double difference with propensity score (DD-PSM) with PITEC-CDTI data Qualitative: interviews, working groups
Wider economy effects Indirect effects (negative)	Market distortion	10	Getting funding support from CDTI (2 years avg.)	There is no evidence of market distortion	Qualitative: interviews, working groups, case studies
Proportionality and suitability	Proportionality	11	Getting funding support from CDTI (2 years avg.)	Budget positively impacts technological leadership, patent and R&D activity (personnel and expenditure)	Quantitative: Probit and linear regression model with CDTI surveys (Ex-post and project)
	Suitability	12	Getting funding support from CDTI (2 years avg.)	ID instrument tend to obtain best results across result variables, except for labour productivity CDTI-Eurostars-2 and ERDF Interconecta instruments improve export activity	Quantitative: Probit and linear regression model with CDTI surveys (Ex-post and project)

Note: In bold letters indicators with robust results

Source: Own compilation

Conclusions

The CDTI funding, during the period considered, do not distort the market, i.e. do not distort competition in the product markets, neither do they influence the choice of location of the companies. Overall, we can state that the final balance in terms of impacts is positive.

Main results of the CDTI intervention, as we have already mention, are:

- The existence of input additionality is confirmed for R&D inputs, both economic and personnel inputs and both as the propensity of using them and as the intensity of that use.
- Beneficiary firms increase the probability of carrying out internal R&D activities, as well as increasing the likelihood of having created R&D jobs.
- Technological outputs additionality is confirmed in the case of patent data.
- In dynamic sectors the positive impact on product innovation is confirmed, whereas in the traditional sectors the outputs additionality is confirmed for process innovation.
- Beneficiary firms have improved regarding to cooperation with public bodies is concerned: they increase the number of partnerships with research centres, becoming more internationally oriented.
- Beneficiary firms increase the number of international partnerships outside the group –diversifying international partnerships– and increase the probability of obtaining alternative funding.
- The CDTI funding do not distort the market.
- A high CDTI aid contribution is positively related to the indicators of commercial activity.
- The size of the project budget has significant positive effect on commercial aspects, on human and economic resources devoted to R&D and on an increase in technological leadership.
- Regarding to suitability, positive results are found mainly for ID programme.

Although the funding shows a positive impact in all these indicators, the regime also has room for improvement in different aspects related mainly with some indicators of additionality of technological and economic outputs, behavioural additionality and other indirect impacts.

Thus, it is presumed that, due to the nature of the projects financed, either through reimbursable loans and/or grants, —aimed at industrial research and experimental development activities—, it is more likely to achieve additionalities in the investment of financial and human resources. In this sense, the idiosyncrasy of these projects (far removed from the market) determines to a large extent the achievement of additionalities in effective technological and economic outputs, difficult to control ex-post by the CDTI and, mainly, in the latter cases.

As is known, a large proportion of the economic results (sales, exports, etc.) occur in the medium term (and depending on the sector, in the long term), that is to say, mainly after the company has ended its relationship with the CDTI. In addition, these results are determined not only by the characteristics of the R&D project and the company that performs it, but also by market variables (competition, demand for the product, economic situation, etc.) that are difficult to estimate at the time of the assessment and granting of the funding.

Similarly, this affects the ability of the funding to motivate a change in operational and strategic behaviour. Commercial success derived from the results of the R&D performed is a driver that intensifies and accelerates changes in corporate behaviour in the medium and long term. This is not to say that there may not be behavioural additionality, even though there is no commercial success, but that the impact on the organisational structure of the companies is greater when companies increase their sales, exports, etc. In any case, the quantitative methodology used in this evaluation does not allow measuring these medium and long-term effects, due to the unavailability of data for a sufficiently long series of years. On the other hand, after the qualitative analysis, it can be stated that, in general terms, the CDTI funding do not distort the market.

Anyway, it is not to avoid intervening in the market, but to do so to compensate for market failures (negative externalities, imperfect and unbalanced information) and coordination failures of existing network² failures. And only in this frame of reference can public support influence the market. This is the main public policy challenge of the present and of the future, and which therefore affects the CDTI as a public funder and evaluator of business R&D.

Therefore, the recommendations to users of this final evaluation are addressed in this sense.

Recommendations to users of the evaluation

Based on the above results, the following pages include a set of recommendations from the consultants evaluating the aid scheme of the CDTI (Novadays and Universidad Complutense de Madrid). These recommendations are addressed to those responsible for the CDTI, to the European politicians, to companies and other social actors, and they are originated from the quantitative results and qualitative evidence of the companies interviewed.

CDTI

Instrument design

Firstly, the general objectives of the instruments have been successfully achieved. In spite of this, it is necessary to take into account that some of them are transversal objectives without having detailed and proper specifications for each instrument. In this sense, the secondary and complementary objectives could be defined in a more specific way in each of the instruments in order to improve their design and the results obtained.

It has been found that there is a gap between the results achieved with the realisation of an R&D project and its subsequent commercialization. Despite the direct financing of this

² Framework on State Aid for research and development and innovation (2014/C 198/01).

gap goes against the European legislation on State aid, various measures can be taken to promote the entry of developments in the market.

It would also be useful to differentiate the entry flow into CDTI of new companies that ask for aids for the first time and do not have a technological base (more financial relief in the start-up phase, personalised guidance for these companies, etc.) and those that have technological base and ask for aids on a recurring basis (greater demands, higher evaluation criteria, higher results required, greater control over technological intensity and the risk assumed, further evaluation on the possibility of distorting the market, etc.). In interviews and working groups we found a need to diversify the presentation model of projects with two different input flows (with personalised advice and attention based on the type of company) and, therefore, with different criteria of *ex-ante* evaluation for these two types of companies. This measure would be oriented to improve the current situation where there is a single-entry framework regardless of the type of company.

Diffusion and dissemination

The CDTI could incorporate in its functions and areas of activity the promotion of communication means aimed to disseminate and spread the importance of R&D as a fundamental asset in business strategy to improve efficiency (technological results, economic profitability, productivity, sales, etc.) and with an important involvement of successful companies with the CDTI.

In this sense, the CDTI could reach collaboration agreements with business associations and other entities to disseminate the results and best practices through their communication channels.

Ex-post monitoring and open data

In order to an *ex-ante* orientation of actions (i.e. implementing mechanisms for the prevention of possible market distortions, and ensuring access to the data that enables the performance of external and internal evaluations.), it is proposed to carry out institutionalised *ex-post* monitoring of the aid received by the companies (the accumulation of aid, market research, etc.).

This measure could be implemented in order to institutionally incorporate a new area of studies in the CDTI to carry out strategic monitoring of aids granted to companies. The main function of those studies would be to detect and prevent situations that might lead to some distortion of the market.

In line with the previous measure, the conduct of evaluation studies more frequently is a necessary task, not only for the strategic goals of the CDTI, but also in relation to accountability to companies, national and international policy institutions (European Commission, etc.) and society as a whole.

The CDTI should complete its digital transformation process and design and implement an open data strategy to improve decision making. The aim is to put in value the CDTI data and become a key entity in the design of evidence-based policies and not just a mere implementer of programs.

National policy-makers

Therefore, it is necessary to define a joint strategy together with national policy-makers in order to obtain the most useful data for further analysis. The CDTI should become a key actor in the design of the new innovation policy.

With the aim of ensuring maximum effectiveness of the CDTI instruments and alignment with respect to public policies designed by national institutions, the creation of instruments to facilitate continuous feedback among policy-makers, implementers and the beneficiaries is recommended.

The constant interaction between these key players (through forums, meetings, specific committees, etc.) is essential for the design, implementation, and evaluation of policies and aids schemes. The aim is to positively benefit from feedback (business needs, existing resources, lines of action, impacts, etc.) and generate a virtuous circle in the follow-up and implementation of public actions aimed at business R&D.

On the other hand, and in line with the recommended actions for the CDTI, it is important to take into account in the design of differentiated policies for companies' different characteristics and needs of them. Those factors would be considered in the instrumentation and implementation of measures aimed at those particular cases.

For instance, the objectives and characteristics of the Science and Innovation Missions Program (CDTI) could be adapted and scaled according to the needs and capacities of the beneficiaries (size, sector, etc.) with the aim of generating synergies, coherence and transversality with other CDTI programs and other public entities.

European policy-makers

As has been advanced, quantitative indicators and the experiences of companies suggest that sometimes there are difficulties in commercializing the products, services and processes developed in the framework of aids for R&D.

For this reason, the European institutions are encouraged to develop more flexible standards to finance investments of complementary assets and the possibility of financing the commercial risk related to the results of R&D. In particular, this legislation could allow:

- To finance the gap between technological and economic outcomes, so that those business projects with high technological and social impact may have commercial success.
- To increase aid intensity to promote the commercial exploitation of business R&D results.
- To finance not only the performance of international R&D, but also its commercialization. The findings obtained in the evaluation lead to a perception of the need to improve exports and the presence in foreign markets of the beneficiary companies. Thus, the financing of the exploitation of the results abroad could boost sales in foreign markets and, consequently, drive the international strategy of the companies.
- Designing special lines of financing for R&D-intensive (high risk) and high growth companies, which are market-oriented (combine subsidy, venture capital,

partially reimbursable loans and participative loans). It is important not to be confused with financing start-ups. The measure proposed, aimed at high-risk projects, could align corporate R&D strategies and the exploitation of results from those companies in which industrial research and experimental development are the core of their business.

To prevent a more flexible regulation from causing interference on the European market, it is previously proposed to carry out a more in-depth analysis of market failures. This preliminary stage is a key element to design specific and differentiated public aids that may be granted to these companies and, in turn, could be useful for the preparation of new regulations.

It is also considered interesting that the rules differentiate between the various existing needs (market failures and network) between companies that are commencing to work with R&D and those doing so on a recurring basis. This involves an analysis of the limits on aid intensity (equivalent gross grant, different premiums, etc.).

Companies

The qualitative evaluation studies draw conclusions about the needs and problems that companies have to deal with R&D projects. There is a lack of more organisational and proactive involvement of business associations to institutionalise and make their demands visible. It would be convenient to generate greater proactivity of sectoral business organisations (and in particular of small businesses) in order to gather the problems and needs of the companies (R&D financing, commercial exploitation of R&D results, etc.).

Derived from the recommendations made to the CDTI, from a business point of view, business associations should promote actions (forums, conferences, publications, etc.) to raise awareness among the business community on the importance of performing R&D to improve the efficiency of the company and to promote innovation as a key competitive variable in the development of the firm.

The CDTI aids should generate synergies and enhance the activities of companies, bearing in mind that the ultimate goal is to allow companies to develop their own R&D strategies. This is crucial to be competitive in the long term, aside from any aid they may receive. It should be borne in mind that the horizon is to generate long-term public resources for companies that really need the aid and which have good high impact projects (additionalities, externalities, etc.).

Other Social Actors

Many of the recommendations aimed at companies are applicable to the rest of social agents involved in R&D (universities, public research institutions, technological centres, etc.). In this regard, it is necessary to establish and strengthen other channels and instruments that facilitate the participation of other social actors in business R&D.

On the other hand, and more specifically, it is crucial to improve and expand access to PITEC and other official data, on the part of the National Institute of Statistics (INE) to public agencies and researchers.

This recommendation aims to facilitate the work of public agencies and researchers to carry out specific studies on the impact of public policy in the innovative activities of companies and, mainly, for those evaluations of public programmes and aids required by the Spanish Government or the European Commission.

CDTI R&D PROJECTS

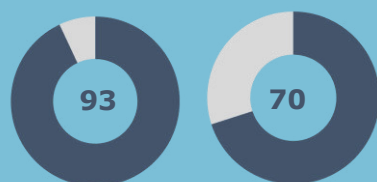
IN THE 2015-2020 PERIOD

Beneficiary companies of the CDTI aids...*

DIRECT EFFECTS

RESOURCES FOR R&D

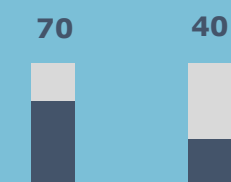
Carry out R&D activities more frequently



CDTI % No CDTI %

% of companies that carried out internal R&D activities

Create R&D jobs



CDTI % No CDTI %

% of companies that created jobs in R&D

PROTECTION OF KNOWLEDGE

Patents more frequently



CDTI % No CDTI %

% of companies that applied for patents

Different effects in the number of patents depending on the sector

TECHNOLOGICAL COOPERATION

Collaborate more with research centres and tend to collaborate more internationally



1.189

CDTI

0.67

No CDTI

Number of partnership with research centres

INDIRECT EFFECTS

TECHNOLOGY DISSEMINATION

Participate in congresses, fairs, workshop, training centres and platforms for the dissemination of knowledge

Not usually commercialise the know-how acquired through R&D by means of licenses or other mechanisms



INTERNATIONAL COOPERATION

Increase cooperation with other companies outside the group and this is more international

CDTI

1.12

No CDTI

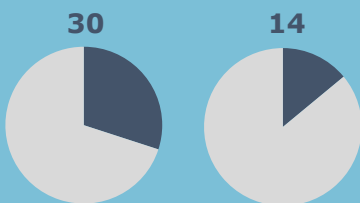
0.68

Number of international cooperation agreements outside the group



ALTERNATIVE SOURCES OF FUNDING

Find more easily external funding for the development of their projects



CDTI % No CDTI %

% companies that have alternative sources of funding



EFFECTS ON THE MARKET

The market is not distorted as a result of the aid received



OTHER EFFECTS

PROPORTIONALITY OF AIDS

It is observed that a larger project budget has a positive influence on technological leadership, patent development and R&D resources



INSTRUMENTS ADAPTED TO CONCRETE NEEDS

When they receive aid from CDTI-Eurostars-2 and ERDF Innerconecta, they improve their exports



* RESULTS CORRESPONDING TO MAIN RESULTS COMPARED TO A CONTROL GROUP.

THE DATA REPRESENTED GRAPHICALLY REFER TO THE YEAR 2016.

"CDTI funding has allowed us to tackle higher risk projects and, at the same time, a greater number of these projects"

"We have carried out some international collaborations, both in Europe and in Japan, though the CDTI's international cooperation programmes"

"Thanks to the CDTI aid, we offer a better functionality, with innovative products related to artificial intelligence or neural networks"

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