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

FINAL REPORT

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

Final evaluation report

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

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Executive summary

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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-INNTERCONECTA 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.

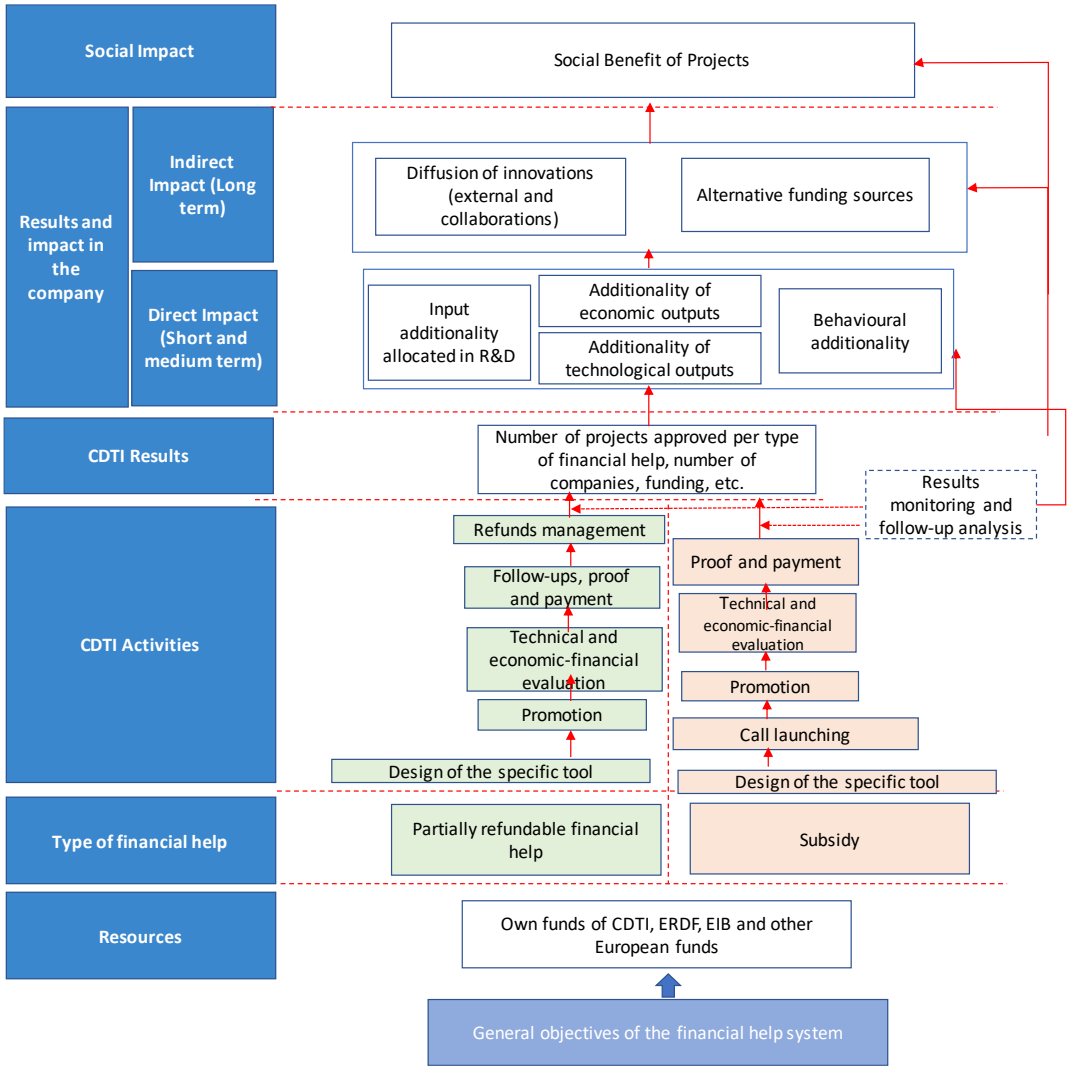
In this regard, a general framework for intervention has been designed differentiating between the two types of generic funding existing in the CDTI that are the subject of the evaluation (partially reimbursable funding and grants modality). This is necessary to observe the existing differences between 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	• 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.
CIEN	• 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 - INNTERCONECTA	• 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	• 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	• 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	• 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:

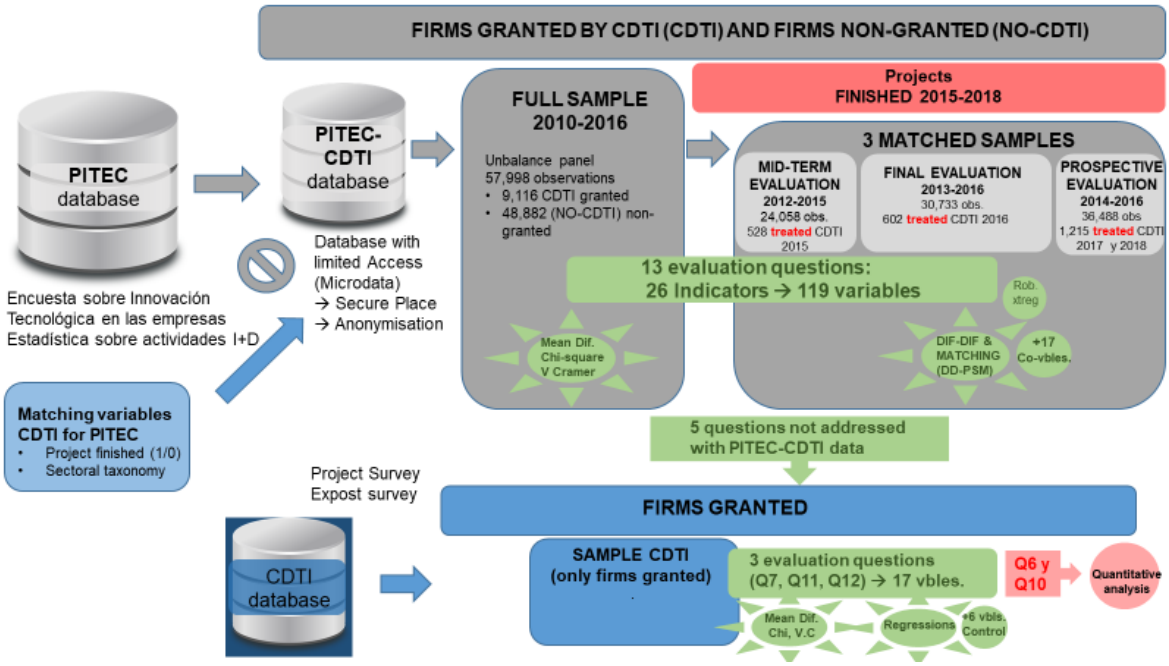
[1] Therefore, the quantitative evaluation does not include the CIEN partially reimbursable subsidies and the ERDF INNTERCONECTA and INNOGLOBAL grants, CDTI-Eurostars Projects and CDTI-Eranets projects.

- (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 allow us to increase the comparison points over the required period to be evaluated (2015-2020).

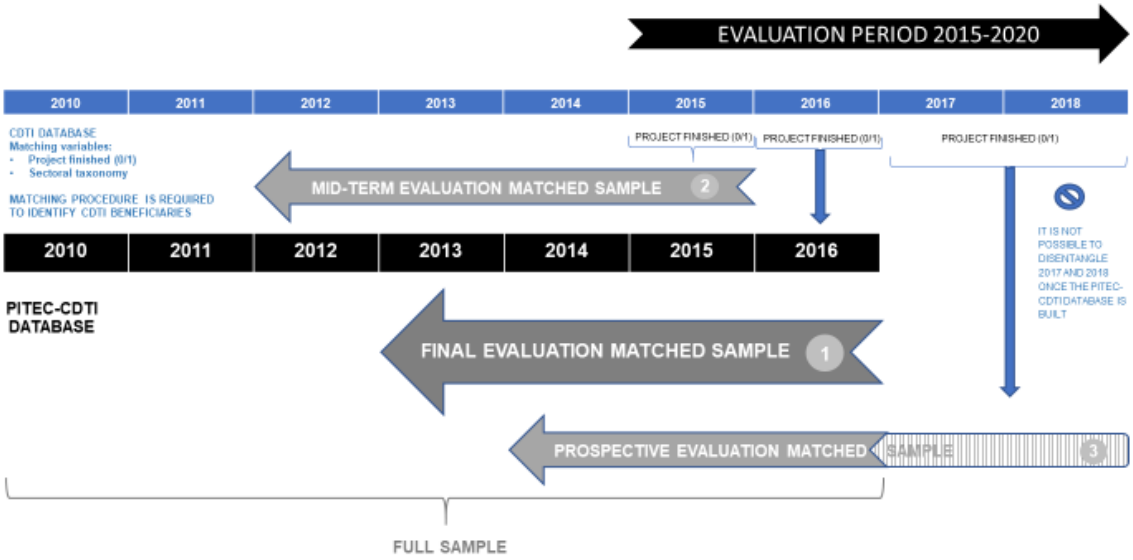
The *software* used for the analysis is STATA.

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).

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 (see Table A 1).

- **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-Garcia 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

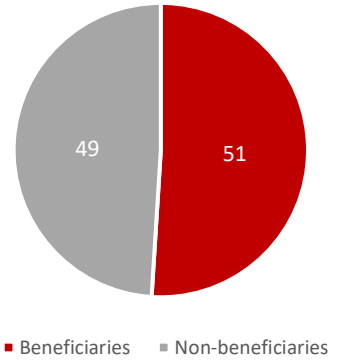
	Face-to-face interviews	Telematic interviews	Total
Beneficiary companies	33	18	51
Non-beneficiary companies	13	36	49
Total	46	54	100

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.

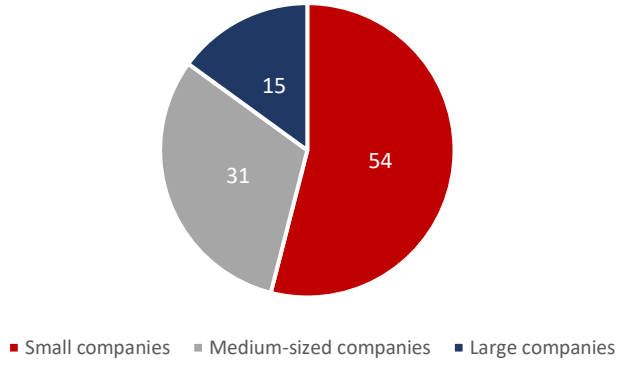
On the other hand, 57 applicant companies of PID aids, 30 of ERDF INNTERCONECTA aids, 7 OF CIEN aids, 4 OF CDTI Eurostars-2 aids and 2 of INNOGLOBAL were interviewed. No CDTI-Eranets aid applicant companies were interviewed as they were not statically significant in relation to the overall number of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

Distribution of interviewees by resolution of the funding



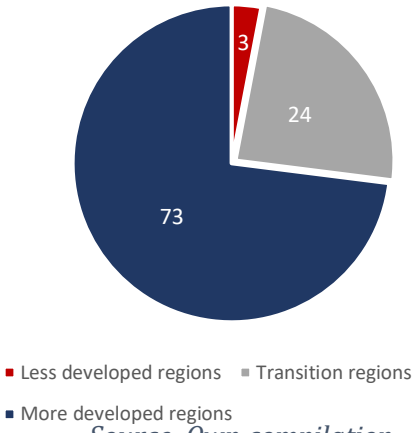
Source: Own compilation

Distribution of interviewees by company size



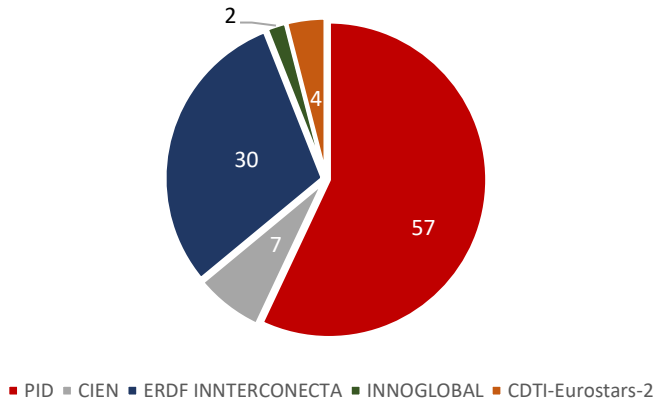
Source: Own compilation

Distribution of interviewees by registered office of the company



Source: Own compilation

Distributions of interviewers by type of instrument requested



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 positive 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	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	Qualitative: interviews, working groups

OBJECTIVE	TYPE OF IMPACT	Q	TREATMENT	IMPACT	METHOD
	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 (positive externalities, imperfect and unbalanced information) and coordination failures of existing network[2] 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 gap goes against the European legislation on State aid, various measures can be taken to promote the entry of developments in the market.

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

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.

Introduction

2

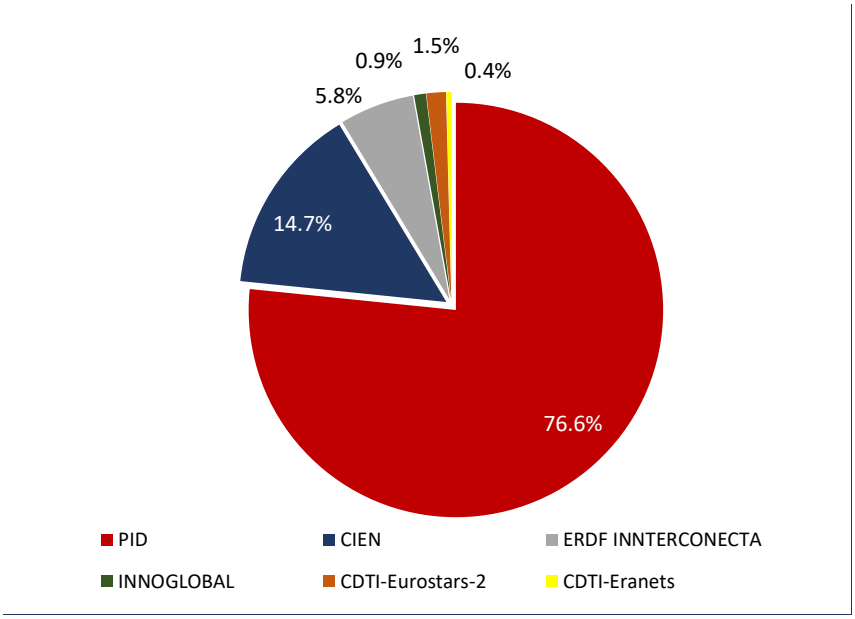
The object of the evaluation refers to the 2015-2020 period subject to the Block Exemption Regulation (SA.45828), which includes the funding granted by CDTI as of 2015, in the form of loans and subsidies for business R&D projects.

The mid-term evaluation served as learning for the final evaluation in order to relate the results obtained with those obtained in the final evaluation. The final evaluation covers the following instruments: individual R&D projects and in cooperation (PID); CIEN projects; ERDF-INNTERCONECTA projects; INNOGLOBAL projects; "CDTI-Eurostars-2", international inter-company projects; and CDTI Eranets.

This final 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.

We use both quantitative and qualitative techniques and we carry out a triangulation of results involving combination, complementarity, confirmation and corroboration of qualitative and qualitative results. Likewise, it is necessary to consider that the majority of aids granted by the CDTI corresponds to PID projects (see chart below), having taken this into account in the samples and qualitative methodologies. On the other hand, as mainly PID projects have been analysed from a quantitative perspective, triangulation techniques between quantitative and qualitative results have been applied mainly for PID projects.

Chart 1: % of the total budget corresponding to each instrument



Source: Own compilation

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, it can be said 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, it can be stated that the final balance is positive.

Finally, on the basis of these results and conclusions, a series of recommendations addressed to the users of the evaluation will be specified.

The report consists of several sections that follow the sequential logic of the research carried out:

- Review of the literature on the quantitative empirical studies carried out.
- Description of the object to be evaluated and the logical framework of intervention.
- Description of the methodologies and information sources used (quantitative and qualitative).
- Results of the evaluation.
- Conclusions.
- Recommendations to users of the evaluation.

Review of the literature

3

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). There is also the perspective that public support has behavioural effects in the companies' capacity for innovation (behavioural additionality) in addition to those mentioned above. 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. The following are a synthesis of the state of the issue.

The results of the review are contained in two formats that complement each other. The first is Annex 3, which includes more than 50 references used by the authors in a variety of previous research papers and other incorporated in the current study. Its function is to have a broad reference base for the purpose of the analyses and the discussion of results. The second is the text included below that, on a selection of references in Annex 3, synthesises

the most important results that have been obtained in the research regarding the impact of public support on innovation within companies.

> Synthesis of the results

Aerts and Czarnitzki (2004) studied the impact of R&D policies in Flanders. By applying a *non-parametric matching*, they concluded that subsidised companies would have invested significantly less in R&D activities, on average, if they had not received public funding for research and development. Therefore, the effects of *crowding out* were rejected in this case.

Aerts and Thorwarth (2008) studied the impact of R&D subsidies on R&D private spending, differentiating between research and development activities. They used models of parametric treatment effects. The results showed that the companies respond differently to subsidies according to the nature of the R&D activity, therefore, contributing mainly to an increase in development spending; on the contrary, the effects of *crowding out* for the research part cannot be rejected.

David et al. (2000) revealed macro- and microeconomic studies on the impacts of R&D policies and found that macroeconomic studies generally identify a complementary relationship between public and private R&D expenditure (that is to say, there is additionality), while several company-level micro-studies cannot confirm this effect. Wallsten (2000) examined whether the R&D grants for small businesses in the industry increase the private R&D in the United States. Finding evidence that subsidies displace R&D expenditure funded by the company "dollar for dollar" (that is to say, there is total *crowding out*).

Lach (2002) investigated the effects of subsidies granted to local manufacturing companies in Israel. Using the differences-in-differences model and a dynamic panel data model, it was concluded that the grants would not completely move the R&D expenditure financed by the company (although mixed results were found from the different models applied).

Cappelen *et al.* (2012) analysed the effects of tax incentives on the probability to innovate and patent in Norway and found that the projects that receive tax credits are more likely to develop new production processes and new products for the company. However, the effect on the new products for the market and in patents is not significant.

Czarnitzki and Hussinger (2004) analysed the effects of public R&D funding on R&D expenditure and the behaviour of patents for German companies. They found that both the R&D financed with private funds and R&D additionally induced by public subsidies have a significant positive impact on patents. However, R&D additionally induced through the receipt of a subsidy has a slightly lower impact on patentability. This result is in line with the neo-classical paradigm of diminishing returns.

Hewitt-Dundas and Roper (2010) found that subsidies for innovation in companies increase sales of new products, as well as also encouraging a greater proportion of the population of companies to innovate in Ireland.

Busom (2000) presented evidence on the effects that subsidies for R&D have in the R&D effort of recipients, and in the probability that a company will participate in a programme that grants subsidies for R&D, using a sample of companies in Spain. The main findings were that 1) small businesses are more likely to obtain a grant than large companies, which probably reflects one of the objectives of public policy; 2) in general, public funding induces

more private effort, but for some companies (30% of participants) the effects of total *crowding out* cannot be ruled out, and 3) the size of the company is still related to the effort, regardless of whether the company obtains public funding.

Herrera and Heijs (2004) evaluated the effect of the policy of subsidies to innovation in Spain, on the intensity in R&D companies, using the *Propensity Score Matching*. The results reject the existence of a *crowding out* effect of public funds on private ones.

Huergo et al. (2009) studied the effectiveness of the CDTI loans (in Spain) for R&D projects on the expenditure on business R&D using the Heckman selection model. They found no evidence of a positive and significant impact of the CDTI loans on the likelihood of companies to invest in R&D with own funds, confirming the effectiveness of this aid system.

Huergo et al. (2016) once again investigated the effect of public loans for R&D projects on the likelihood to perform R&D of Spanish companies. On this occasion they confirmed the effectiveness of the public loans (as in the previous paper), and found that the effect of the stimulus is greater for SMEs than for large companies and also greater for manufactures than for services.

Gonzalez and Pazó (2008) analysed the effects of public support for R&D in the private investment in R&D of Spanish companies using data from a Survey of Business Strategies (ESEE). Through a *matching* approach, they found that there is no *crowding out* effect, partial or total, between public and private funds, and that some companies, mainly small ones operating in low-technology sectors, might not have participated in R&D activities in the absence of subsidies.

González et al. (2005) investigated the effects of subsidies for R&D in a panel of more than 2,000 Spanish manufacturing companies using a Tobit modelling. They came to the conclusion that many companies that do not perform R&D activities, would do so if they had subsidies. In addition, some companies that perform R&D would cease this activity if the subsidies were removed. However, the majority of the grants are aimed at companies which would have carried out projects regardless.

A very recent study (Fiorentin et al., 2018) offers an excellent panoramic view on the studies on the impact of innovation policy and performs a taxonomy on it (Table 4), which is of great use for positioning the different methodological problems found, the methodologies used and the results obtained. One last thought based on that content is to highlight the lack of coherence and the differences in the results obtained.

Table 1: Innovation policy studies-Summary of literature and main contributions

Theoretical approach		Research question	Dependent variable	Independent variable	Main results	Main contributions
1. Evaluation studies	1.1. Traditional impact studies	Crowding-in and crowding-out effects of public policy	Innovation intensity Innovation results Economic performance	Public subsidy to innovation (average t). Controls: structural and economic dimensions of the company.	Heterogeneous results in terms of input additionality on innovation investments. Lack of significance on the company's economic performance.	(Lööf and Heshmati 2005; Cin, Kim, and Vonortas 2017; Dimos and Pugh 2016; Cappelen Raknerud, and Rybalka 2012; Boeing 2016; David, Hall, and Toole 2000; Piekkola 2007; Jaumotte and Pain 2005; Le and Jaffe 2017; Czarnitzki and Delanote 2017)
	1.2. Dynamic impact studies	Time window of innovation policy impact	Innovation intensity Innovation results Economic performance	Different lapse of years since accessing public subsidy to innovation (t, t+1, t+2, t+n). Controls: structural and economic dimensions of the company.	Positive impact on innovation investments and results, with different lags. Heterogeneous impact on economic performance, starting at least 4-5 years after the treatment.	(G. Crespi et al. 2015; Hall and Maffioli 2008; Lopez-Acevedo and Tan 2010; Aboal and Garda 2015; Castillo et al. 2014)
2. Matthew effect analysis		Allocation of public funds	Accessing public policy Innovation intensity	Past access to public policy (t-1). Controls: structural and economic dimensions of the company.	Matthew effect is verified. Heterogeneous result in terms of impact of Matthew effect on innovation investments.	(Busom, Corchuelo, and Martínez-Ros 2017; González and Pazó 2008; Duguet 2003; M. Pereira and Suárez 2017; Aschhoff 2009; Tanayama 2007; Radicic et al. 2014; Antonelli and Crespi 2013)
3. Institutional reports		General evaluation of public programme	Public programme	Programme's characteristics, selection of beneficiaries, economic impacts and spillovers	Positive impact of programmes in terms of additionality and spillovers	(Ruegg, O'Connor, and Loomis 2014; Tassey 2003; Ruegg and Jordan 2007; Rowe et al. 2008; Link and Scott 2012; Peirano 2011; MINCyT 2013; Aguer, Moori Koening, and Carugati 2015; Huergo and Trenado 2018)

Source: Fiorentin, F; Pereira, M and Suarez, D., 2018

> Some methodological reflections

One of the most important and recurring problems that occurs in the measurements of the impact of the public financing of innovation is the selection bias in the sample, linked to the decision of public funding, as well as the self-selection bias: the decision to seek the funding may be determined by the same variables that affect their results. The difficulty of this aspect lies in the potential selection bias of the public institution which, depending on the applicant company and the relevant R&D project, decides on the public funding process (David et al., 2000). For example, governments generally follow a strategy of "*picking-the-winner*", that is to say, the companies that are very innovative even in the absence of public incentive schemes are more likely to receive public subsidies.

The reason for this is that public authorities want to maximise social benefits and reduce the risk of failure among R&D projects. The companies that have been innovative and successful in the past are, therefore, the best candidates to receive grants, which are expected to generate the greatest social return on public investment due to low failure rates and high indirect effects (Aerts and Czarnitzki, 2004). In other cases, the characteristics of the R&D support programmes impose conditions which segment the population who may request public support.

Another important problem that occurs when estimating these models is that public funding is an endogenous variable, which can cause inconsistent estimates if it is correlated with the error term (Busom, 2000). Companies that invest more in R&D activities are those that receive greater public funds.

Thus, the challenge of the evaluations is to try to respond with non-experimental data, and when there is no information about the counterfactual situation that is posed, what would the company have done if it had not received funding. This is reflected in the previously mentioned problems relating to selection and endogeneity. There are different methods to resolve this situation (e.g. Heckman et al. 1999, Blundell and Costa, 2000) such as the use of quasi-experimental methods (e.g. cross-sectional matching), the use of instrumental variables (VI), selection models ("control function approach") and conditional estimates of Difference-in-Difference (conditional) (DID or DIF-DIF), which require panel data. This evaluation has chosen a mixed approach of Differences-in-Differences with matching (Villa, 2016) and that makes it possible to establish causal inferences with non-experimental data and to deal with the unobserved heterogeneity that does not vary over time. The control variables of the matching enable to control the heterogeneity observed and allow to explain the probability of being treated (in this case, completing a project with funding from the CDTI).

To our knowledge evidence on the impact of R&D public funding using triangulation methodologies are scarce or non-existent.

Description of the object to be evaluated and the logical framework of intervention

4

4.1 Description of the object to be evaluated

The final 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.

The object of the final 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.

The mid-term evaluation served as learning for the final evaluation in order to relate the results obtained with those obtained in the final evaluation. The final evaluation covers the following instruments: individual R&D projects and in cooperation (PID); CIEN projects; ERDF-INNTERCONECTA projects; INNOGLOBAL projects; "CDTI-Eurostars-2", international inter-company projects; and CDTI Eranets.

Thanks to the availability of the data provided by the Spanish National Statistics Institute, the impact of the PID projects has been studied mainly in a quantitative manner, whereas the impact of the rest of the instruments have been analysed mostly using a qualitative approach. Qualitative techniques were also useful for complementing and extending the quantitative results of the impact of the PID projects.

In this regard, it is necessary to consider that the majority of aids granted by the CDTI corresponds to PID projects, having taken this into account in the samples and qualitative methodologies. On the other hand, as mainly PID projects have been analysed from a quantitative perspective, triangulation techniques between quantitative and qualitative results have been applied mainly for PID projects.

In this context, using the techniques of quantitative and qualitative analysis, have been analysed the direct impacts (input additionality, additionality of economic and technological outputs, and behavioural additionality), indirect impacts (dissemination of knowledge - externalities and collaborations-, overcoming barriers associated with asymmetric information - access to external financing, and possible market distorting effects), as well as the proportionality and suitability of the aid scheme.

4.2 Logical Framework of Intervention

4.2.1 Generic logical framework of intervention

The logical framework of intervention of the CDTI's aid scheme aims to structure the logical 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.

First, 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 subsidy modality). The first step is necessary, -before performing the specific analysis based on the type of instrument-, 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.

The funding comes mostly from the CDTI's own resources, although there is also presence of the European Regional Development Fund (ERDF), the European Investment Bank (EIB) and other European funds.

One of the main differences is that although the partially reimbursable funding, through loans, are granted through all-year-round calls, the subsidy modality grants financing through closed calls for proposals with deadlines for submission (opening and closing). This fact has important implications in the day-to-day in the Agency and the response from the companies when it comes to choosing between one type of funding modality or another, and therefore in the typology of the specific instrument.

The processing procedure will vary depending on the type of instrument. In the general case of partially reimbursable funding, it is possible to speak of four basic stages after the design of the specific instrument by the CDTI.

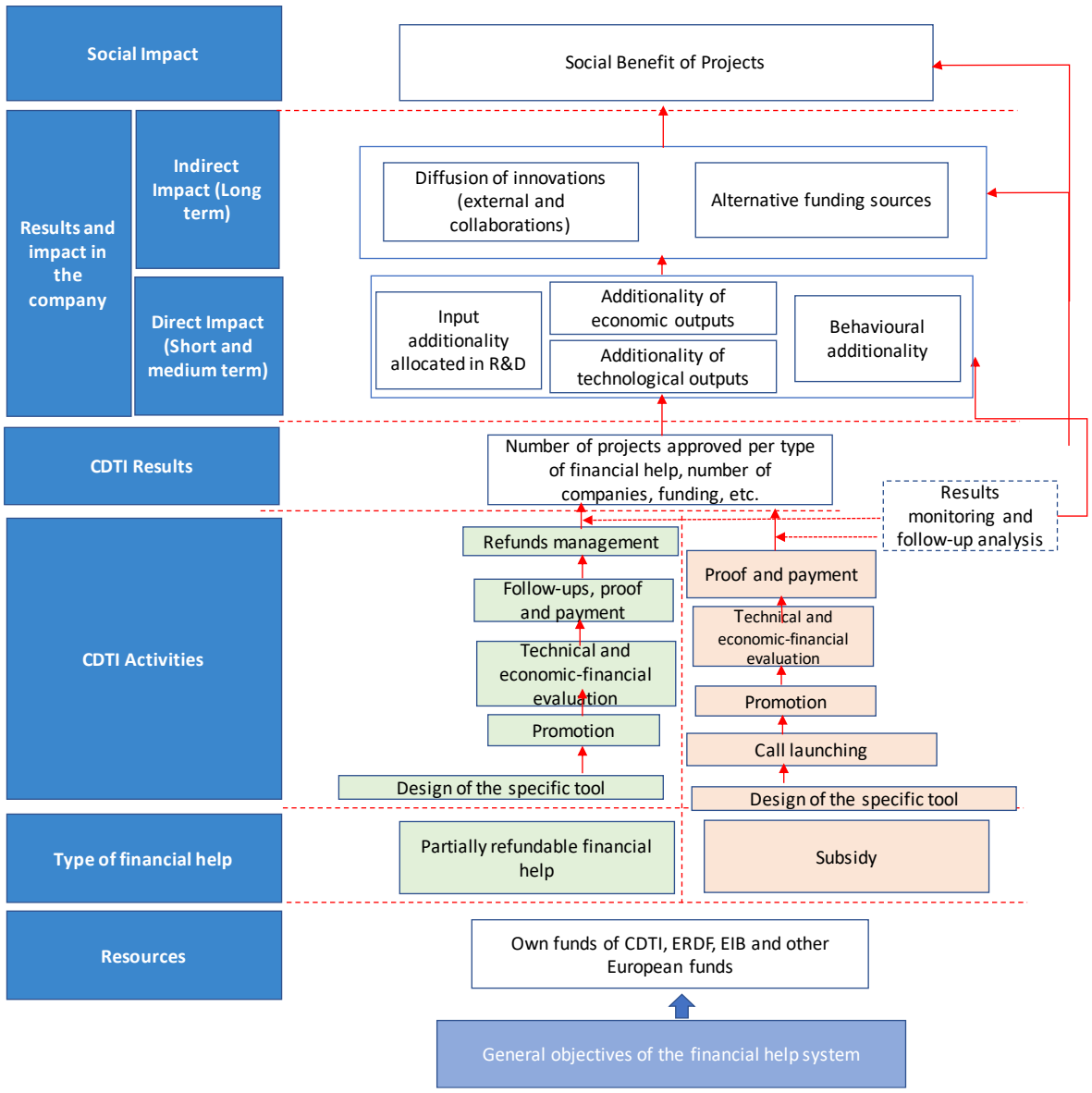
- Promotion: Through events and outreach activities to promote awareness of the public support among potentially interested companies. Also providing guidance to companies with the objective of ensuring the proposed projects are submitted through the instrument that best adapts to their needs.
- Technical and economic/financial evaluation: The project is studied to ensure it meets the financial and technical requirements of the instrument. The financial solvency of the companies is also studied.
- Follow-up and payment: The implementation of the milestones set by the company in the project presented are analysed, certifying and executing the payments that are involved.
- Managing reimbursements: After the conclusion of the project and, where appropriate, after the grace years of each funding, the company is asked to return the part corresponding to the reimbursable amount.

As for the subsidies, the different stages can be classified into:

- Launch of the call, since unlike the previous one, these do not remain open throughout the year.
- Promotion: Very similar to the partially reimbursable funding in nature, although the activities and events focus on the various calls.
- Technical and economic/financial evaluation: The project is studied to ensure it meets the financial and technical requirements of the instrument.
- Financial reporting and payments: As the company justifies the expenses and investments, the project expenditures for each annuity are certified, and the payment is made.

The CDTI's activities are likely to produce a series of direct impacts (input additionality devoted to R&D, additionality of technological outputs, additionality of economic outputs, and changes in the behaviour of the company) and indirect impacts (diffusion of innovations and the attraction of alternative sources of funding). Thus, the CDTI permanently monitors and follows up on the projects and their results, which are completed with ex-post evaluation analyses in collaboration with the beneficiary companies.

Chart 2: Generic Logical Framework of Intervention



Source: Own compilation

The specific objectives of each instrument and a comparison of the main characteristics of the last year that cover the mid-term evaluation, and the last call of the final evaluation are contained in the following pages.

4.2.2 Characteristic of the instruments

4.2.2.1 PID projects

> **Type**

Partially reimbursable funding.

> **Objectives**

The objectives of the individual PID projects are aligned with the following general objectives of the CDTI:

- 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.
- Achieve innovative, high quality R&D projects with a commercial approach and market-oriented.

In addition, the PID projects in cooperation are also aligned with the following general objective:

- Promote development and business competitiveness through cooperation with companies, research centres and other economic agents in the field of R&D.

And the international PID projects are also aligned with the following general objective:

- Promote internationalisation and international technological cooperation, as well as exports and investments abroad.

In this sense, the PID projects (individual or in cooperation) are guided towards the creation and/or significant improvement of a productive process, product or service, and they may encompass both industrial research and experimental development.

The direct beneficiaries are companies, they may outsource to research bodies and cooperate with other companies, there is no restriction on the sector or the technology to be developed, and the duration of projects ranges from 12 to 36 months for individual projects and 12 to 48 months for the rest of categories.

> **Characteristics and specifications**

The call is open the whole year. Thus, their main characteristics and their evolution are described as follows.

- The minimum budget financed per company is 175,000 euros.
- The maximum financial coverage of projects is the 85% of funding on the total budget. The non-reimbursable tranche (NRT) depends on the size of the company, on the typology of the project (industrial research or experimental development), and on the collaboration with other undertakings.
- The interest rate applied to the granting loans is the Euribor in force at the time of project approval.

- Non-reimbursable tranche (NRT) of between 20% and 33% of the funding (of the approved budget), regarding the size of the company (higher NRT for SMEs).
- The company must finance at least 15% of the project budget with its own resources.
- Advanced payment of 35% of the funding, limited to 250,000 euros, without a requirement to provide any additional guarantees.
- The reimbursable tranche will be returned to the CDTI within 7 to 10 years.
- Eligible costs: The scheme finances staff costs, costs of instruments and material, equipment depreciation, contractual research costs, technical knowledge and patents acquired, consultancy and equivalent services; additional overheads and other expenses derived from the project. The cost of the auditor's report is also eligible.

4.2.2.2 CIEN projects

> Type

Partially reimbursable funding.

> Objectives

The objectives of the CIEN projects are especially aligned with the following general objectives of the CDTI:

- Promote development and business competitiveness through cooperation among companies. The purpose of this instrument is to finance large R&D projects carried out in effective collaboration by business groups and aimed at carrying out planned research in strategic areas for the future.
- 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 projects.
- Promote the internationalisation and the international technological cooperation. The CIEN projects have an international projection.

> Characteristics and specifications

Table 2: Comparison between the first and the last call for CIEN projects for the period 2015-2020.

Characteristics	2015	2020 (open call)[3]
Beneficiaries	Consortia: From 3 to 8 companies, at least two of them independent and one SME. No company or group of companies may exceed 70% of the financed budget of the project.	No changes.
Subcontracting requirements	Research organisations must account for at least 15% of the project budget, and at least one must me public. The subcontracting costs may not exceed 65% of the budget of each company of the consortia.	Research organisations must account for at least 15% of the project budget, and at least one must me public.

3 From 2019 onwards, the CIEN project have been integrated into an open call.

Characteristics	2015	2020 (open call)[3]
Eligible expenses	• Research, technical and auxiliary personnel expenses. • Instruments and material costs. • Costs inherent to contractual research, research and patents. • Additional overheads: up to a maximum of 20%. • Other expenses: costs of materials, supplies, etc.	• Research, technical and auxiliary personnel expenses. • Instruments and material costs. • Costs inherent to contractual research, research and patents. • Additional overheads related to the investigation project. • Other expenses: costs of materials, supplies, etc. • Audit costs up to a maximum of € 2,000 per company and milestone.
Duration of the projects	From 36 to 48 months.	No changes.
Project budget	From 7 to 20 million euros.	From 5 to 20 million euros.
Minimum project budget per company	€ 350,000 for medium and large companies. € 260,000 for small and micro companies.	4,5 million euros per project and € 175.000 per company
Maximum funding intensity	• Industrial research projects: - Small-sized companies: 80% of the eligible costs. - Medium-sized companies: 75% of the eligible costs. - Large-sized companies: 65% of the eligible costs. • Experimental development projects: - Small-sized companies: 60% of the eligible costs. - Medium-sized companies: 50% of the eligible costs. - Large-sized companies: 40% of the eligible costs.	No changes.
Interests	Euribor.	No changes.
Non-reimbursable tranche	30%	33%
Refund period of the reimbursable tranche	10 years.	From 7 to 10 years.
Advanced payments	• 25% per company up to a maximum of € 200,000. More than € 200,000 is allowed with bank guarantees. • 50% per company, providing bank guarantees worth 25%. • 75% per company, providing bank guarantees worth 50%.	• 35% per company up to a maximum of € 250,000. • 50% per company, providing bank guarantees worth 25%. • 75% per company, providing bank guarantees worth 40%.

Source: Own compilation

4.2.2.3 ERDF INNTERCONECTA projects

> **Type**

Subsidy.

> **Objectives**

The objectives of the ERDF INNTERCONECTA projects are especially aligned with the following general objectives of the CDTI:

- Increase private expenditure on innovation in Spain. The overall purpose of the funding is to increase the innovative capabilities of companies in various Spanish regions, promoting territorial cohesion.
- Promote development and business competitiveness through cooperation among companies. In this regard, the ERDF INNTERCONECTA projects fund experimental development projects in the modality of cooperation between companies.
- Achieve innovative, high quality R&D projects with a commercial approach and market-oriented projects. Another objective is the subsidising of projects oriented towards the needs of different regions in future areas with economic and commercial projection.
- Promote the internationalisation of companies. The subsidised projects are often of an international projection.

> Characteristics and specifications

Table 3: Comparison between the first and the last call for ERDF INNTERCONECTA projects for the period 2015-2020.

Characteristics	2015	2018
Beneficiaries	Consortia: Minimum of two to six independent companies, of which at least one must be large or medium-sized and one SME. No company or group of companies may exceed 70% of the financed budget of the project.	No changes.
Territorial scope	Andalusia, Asturias, the Canary Islands, Castile La Mancha, Ceuta, Extremadura, Galicia, Melilla and Murcia.	Andalusia, Castile and León, Castile La Mancha, the Canary Islands, Extremadura and Murcia.
Thematic areas	Experimental development projects in the modality of projects in cooperation, in the following areas: (a) health, demographic change and welfare; (b) food safety and quality; productive and sustainable agricultural activity, natural resources, marine and maritime research; (c) safe, efficient and clean energy; (d) intelligent, sustainable and integrated transport; (e) action on climate change and efficiency in the use of resources and raw materials; (f) social changes and innovations; (g) digital economy and society; (h) security, protection and defence.	No changes.
Subcontracting requirements	The subcontracting costs may not exceed 50% of the beneficiary's financed budget.	No changes.

Characteristics	2015	2018
Eligible expenses	• Personnel expenses. • Acquisition costs relating to equipment, instruments and material necessary for the action. • Costs inherent to contractual research, research and patents. • Additional overheads. • Other operating expenses.	• Personnel expenses. • Acquisition costs relating to equipment, instruments and material necessary for the action. • Acquisition of consumables, supplies and similar products. • Costs inherent to contractual research, research and patents. • Audit costs.
Duration of the projects	2 or 3 calendar years.	No changes.
Minimum project budget	From 2 to 3 million euros.	From 1 to 4 million euros.
Maximum funding intensity	- Small-sized companies: 60% of the eligible costs. - Medium-sized companies: 50% of the eligible costs. - Large-sized companies: 40% of the eligible costs.	No changes.
Advanced payments	Up to 75% prior to performing the action.	No changes.

Source: Own compilation

4.2.2.4 INNOGLOBAL projects

> **Type**

Subsidy.

> **Objectives**

The objectives of the INNOGLOBAL projects are especially aligned with the following general objectives of the CDTI:

- Promote the internationalisation and the international technological cooperation, as well as exports and investments abroad. The nature of the aid is to finance international business projects.
- Increase private expenditure on innovation in Spain. Projects must be led by a Spanish company within an international consortium.
- Promote development and business competitiveness through cooperation. Projects are focused on the added value of international R&D, allowing Spanish companies to strength their technological capabilities and widen the impact of their products, processes and services on global markets.
- Achieve innovative, high quality R&D projects with a commercial approach and market-oriented projects. Projects may comprise both industrial research and experimental development activities.

> Characteristics and specifications

Table 4: Last call for INNOGLOBAL projects of 2015-2020

Characteristics	2016	2018
Beneficiaries	Spanish companies participating in multilateral program projects, bilateral, or in international project of unilateral certification approved by CDTI.	No changes.
Subcontracting requirements	The subcontracting costs may not exceed 50% of the beneficiary's financed budget. The subcontracting of foreign entities may not exceed 30%.	The subcontracting costs may not exceed 50% of the beneficiary's financed budget.
Eligible expenses	• Personnel expenses. • Acquisition costs relating to equipment, instruments and material necessary for the action. • Acquisition of consumables and supplies. • Costs inherent to contractual research, research and patents. • Audit costs up to a maximum of € 2,000 per year.	• Personnel expenses. • Acquisition costs relating to equipment, instruments and material necessary for the action. • Acquisition of consumables and supplies. • Costs inherent to contractual research, research and patents. • Overheads and other additional operating expenses, including costs for material, supplies and similar products. • Audit costs.
Minimum duration of the projects	From 12 to 36 months.	No changes.
Minimum project budget	€ 175,000	€ 150,000
Maximum funding intensity	- Small-sized companies: 50% of the bankable budget approved. - Medium-sized companies: 40% of the bankable budget approved. - Large-sized companies: 30% of the bankable budget approved.	- Small-sized companies: 50% of the bankable budget approved. - Medium-sized companies: 40% of the bankable budget approved. - Large-sized companies: 30% of the bankable budget approved. In any case, the maximum amount will be € 400,000.
Advanced payments	75% per year, except the last one, which will be 50%.	No changes.

Source: Own compilation

4.2.2.5 CDTI-Eurostars-2

> Type

Subsidy.

> Objectives

The objectives of the CDTI-Eurostars-2 projects are especially aligned with the following general objectives of the CDTI:

- Promote the internationalisation and the international technological cooperation of SMEs. The first condition to apply for this kind of instrument is carried out the project through the transnational collaboration of SMEs. In particular, the target is to promote and increase the participation of SMEs without previous experience in translational research.
- Promote development and business competitiveness through cooperation between companies, research centres and other economic agents in the field of R&D. Participating SMEs must carry out research and development activities with other SMEs or other innovative agents such as universities or research centres.
- Achieve innovative, high quality R&D projects with a commercial approach and market-oriented projects. Results are expected to be introduced to the market within two years from its conclusion.
- Increase private expenditure on innovation in Spanish SMEs.

> **Characteristics and specifications**

Table 5: Comparison between the first and the last call for CDTI Eurostars-2 for the period 2015-2020.

Characteristics	2015	2020
Beneficiaries	Companies, individual or in cooperation, that carry out research and development project approved by Eureka Secretariat.	No changes.
Thematic areas	Any project that includes experimental development or industrial research activities.	No changes.
Eligible expenses	• Research, technical and auxiliary personnel expenses. • Instruments and material costs. • Acquisition of consumables, supplies and similar products. • Costs inherent to contractual research, research and patents, including consulting costs and equivalent services. • External audit costs: Up to € 5,000 per company and year.	• Research, technical and auxiliary personnel expenses. • Instruments and material costs. • Costs inherent to contractual research, research and patents, including consulting costs and equivalent services. • General costs and other operating costs: External audit costs up to € 2,000 per company and year, and travel costs up to € 8,000 per project.
Duration of the projects	36 months maximum.	No changes.
Project budget	The total amount of the project budget of each company may cannot exceed the total amount of the project presented in the call of the Eurostars-2 Programme.	No changes.

Characteristics	2015	2020
Maximum funding intensity	• Experimental development projects: 25% of the eligible costs. • Industrial research projects: 50% of the eligible costs. Intensity may be increased to a maximum of 80% in the following cases: - 10% for medium companies and 20% for small companies. - 15% if (1) the project is carried out in at least two different EU Member States, or in an EU Member State and a third country within the European Economic Area; (2) if research and knowledge dissemination organizations participate in at least the 10% of the eligible costs; (3) if the project is developed in an open manner.	- Small-sized companies: 60% of the eligible costs. - Medium-sized companies: 50% of the eligible costs. - Large-sized companies: 40% of the eligible costs. The intensity will take into account if: - At least one company is a SME, the project is carried out in at least two different EU Member States, or in an EU Member State and a third country within the European Economic Area, as long as no company runs itself with more than 70% of the eligible costs. - Companies collaborate with research and knowledge dissemination organizations in at least the 10% of the eligible costs, preserving the right to publish the results of their research. - Results are widely disseminated.
Advanced payments	Before the annual justification, 75% of the annual payment will be paid.	No changes.

Source: Own compilation

4.2.2.6 CDTI-Eranets

> Type

Subsidy.

> Objectives

Eranets projects have both, an international and a national phase, each with its respective requirements.
From the national point of view, the following objectives are pursued:

- Increase private expenditure on innovation in Spain. Beneficiaries are Spanish companies. Their activities must be carried out in Spain, seeking an incentive effect and additional resources.
- Achieve innovative R&D projects: projects must have a high scientific-technical quality and a being innovator.
- Promote collaboration with other companies (especially with SMEs) and research and knowledge dissemination organizations.
- Dissemination of knowledge through publications, platforms, conferences and other events and instruments.

From the international point of view, the following objectives are pursued:

- Promote the internationalisation and the international technological cooperation: this instrument finances transnational R&D projects of technological cooperation in European strategic areas.

- Coordinate the national and regional research programs of the EU Member States and associated countries.

> **Characteristics and specifications**

Table 6: Comparison between the first and the last call for CDTI-Eranets projects for the period 2015-2020.

Characteristics	2015	2020
Beneficiaries	Companies, individual or in cooperation, that carry out R&D project selected by the governing bodies of the Era-Nets.	No changes.
Coordination	Individual aids: there is no representative company for international cooperation projects, but each company is individually responsible.	No changes.
Thematic areas	Any project that includes experimental development or industrial research activities.	No changes.
Subcontracting requirements	The subcontracting costs may not exceed 50% of the beneficiary's financed budget.	No changes.
Eligible expenses	• Research, technical and auxiliary personnel expenses. • Instruments and material costs. • Costs inherent to contractual research, research and patents, including consulting costs and equivalent services. • Additional overhead: up to 20% of eligible costs.	• Research, technical and auxiliary personnel expenses. • Instruments and material costs. • Costs inherent to contractual research, research and patents, including consulting costs and equivalent services. • General costs and other operating costs: External audit costs up to € 2,000 per company and year, and travel costs up to € 8,000 per project.
Duration of the projects	36 months maximum.	From 12 to 36 months.
Minimum project budget	More than € 175,000 per company	No minimum and maximum budget requirements
Maximum funding intensity	- Small-sized companies: 60% of the eligible costs. - Medium-sized companies: 50% of the eligible costs. - Large-sized companies: 40% of the eligible costs.	No changes.
Advanced payments	Before the annual justification, 50% of the annual payment will be paid.	Before the annual justification, 75% of the annual payment will be paid.

Source: Own compilation

Methodology and data sources

5

5.1 Quantitative methods and data sources

5.1.1 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 (see Diagram 1). 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". 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)[4] (beneficiary companies) and finish their project granted and 48,882 (84%) correspond to non-beneficiary companies. 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. In addition, statistical confidentiality reasons made it difficult to include an additional variable identifying the different instruments implemented by CDTI from the INE. The inclusion of any

[4] Therefore, the quantitative evaluation does not include the CIEN partially reimbursable subsidies and the ERDF INNTERCONECTA and INNOGLOBAL grants, CDTI-Eurostars Projects and CDTI-Eranets projects.

additional variable to be merged with the PITEC database results in an important loss of information provided by the INE.

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

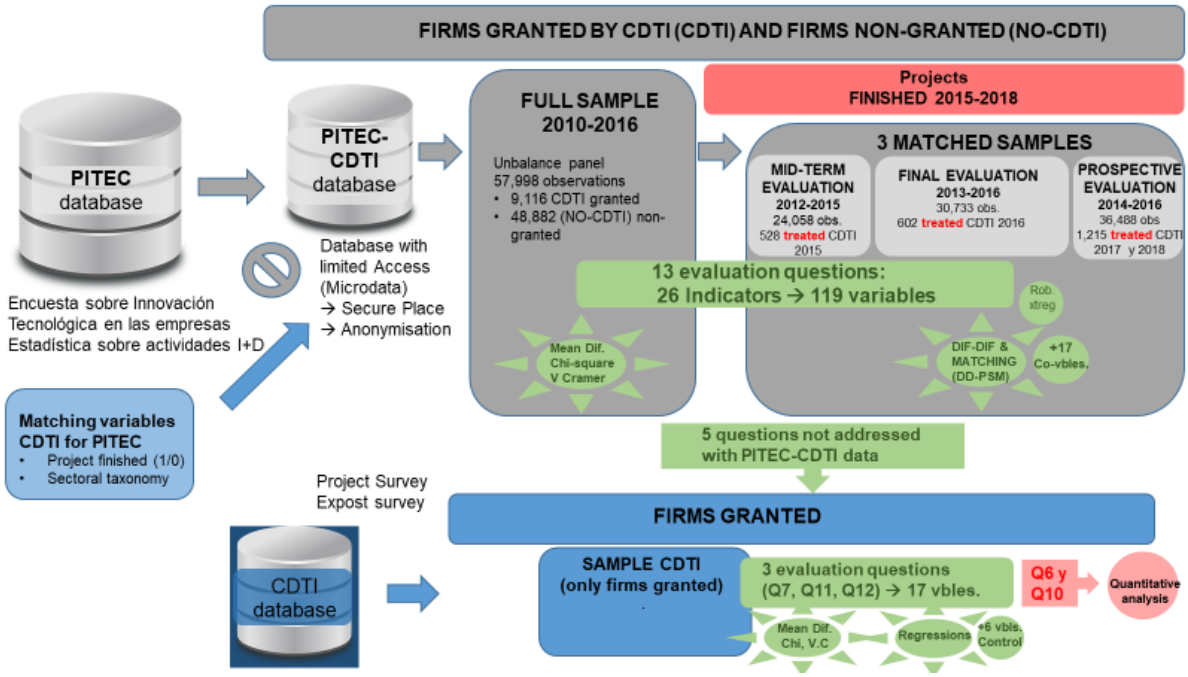
- (I) carry out the final evaluation (**matched sample of the final evaluation**);
- (II) to compare results with the mid-term evaluation (**matched sample of the mid-term evaluation**);
- (III) and to forecast some result for 2017 and 2018 (**prospective matched sample**).

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 allow us to increase the comparison points over the required period to be evaluated (2015-2020). Diagram 1 and Diagram 2 provides information of these samples.

In order to build the first two matched samples, we consider companies that have finished a CDTI project in 2015 and 2016 and follow their activities from 2012 and 2013 onwards (up to 2016), respectively. This allow us to compare the situation of these companies before and after the treatment – being granted by CDTI (see next section). The prospective matched sample considers firms that have finished a CDTI project in 2017 and 2018, but we follow their activities up to 2016. Therefore, we have information for these latter firms before the treatment, but we are not able to track them until finishing the project (after the treatment). Despite this limitation, the prospective matched sample allow us to provide some results for firms that have finish a CDTI project in 2017 and 2018. However, the comparison points for these firms are different: “before” and “in the middle” of the treatment. The lack of information for 2016 onwards from PITEC database, force us to look for this “prospective” strategy.

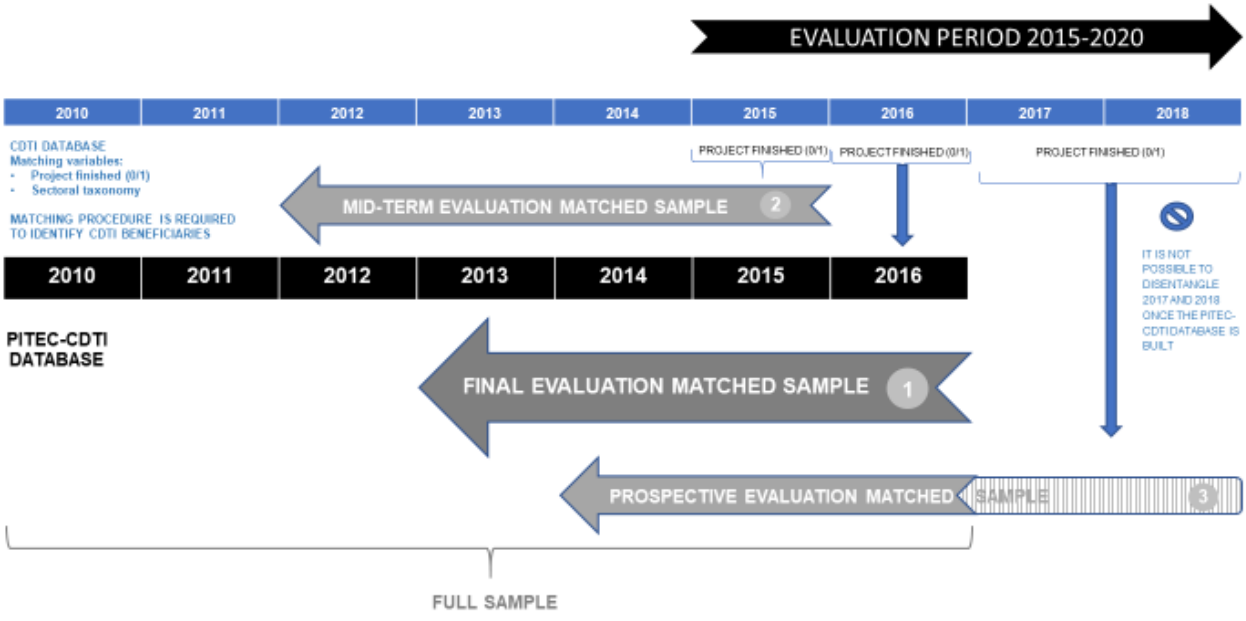
The software used for the analysis is STATA.

Diagram 1: Summary of the approach and the databases used



Source: Own compilation

Diagram 2: Summary of the approach and timeline



Source: Own compilation

Additionally, several questions (questions 7, 11 and 12) 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 R&D project (*project* survey) and 2) two years after the

launch 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.

Project survey includes 2,922 observations for the 2015-2018 period and considers information on the following instruments: PID – individual (ID) and in cooperation (CID) –; CIEN; ERDF-Innterconecta; Innoglobal; CDTI-Eurostars-2; and CDTI-Eranets. Ex-post survey includes 1,177 observations for the period 2010-2018[5] and considers PID – Individual (ID) and in cooperation (CID)- projects. It could be noted that mid-term expost evaluation data included information on six instruments. In order to be consistent with the PITEC-CDTI information and not to include biases arising from the use of multiple instruments, we present results based on CDTI surveys mainly considering ID projects (i.e. question 11). Then, we restrict the use of information on different instruments for the analysis that aims to answer the question on appropriateness (i.e. question 12). ID projects represent 65% of project survey observations (1,890 obs.), while ID projects represent 87% of exp-post survey observation (1,021 obs.). The unit of analysis for CDTI surveys is at project level.

5.1.2 Methods

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 (see Diagram 1).

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. More specifically, the evaluation faces the problem of econometric evaluation using not-experimental data in which there are no data on the counterfactual situation (what would the company have done if it had not received the subsidy?) and that summarises the problems of selection bias and endogeneity that could lead to an attribution of effects of public subsidy that are not adjusted. Among the methods to resolve this problem, indicated by the literature (e.g. Heckman et al. 1999, Blundell and Costa, 2000), and in light of the lack of experiments, the alternatives focus on the use of quasi-experimental methods (e.g. cross-sectional matching), use of instrumental variables (VI), selection models ("control function approach") and conditional estimates of Differences-in-Differences (conditional) (DD or DIF-DIF), which require panel data. Although the matching methods do not require assumptions on the form of the functions, they are sensitive to the unobserved effects (Heckman et al.,

[5] The database provided by CDTI included 2,339 observations. After cleaning the database excluding missing data regarding variables, such as, sales or R&D expenditures or employees, the number of observations decrease up to 1,177.

1999). The use of instrumental variables allows us to deal with the unobserved effects, but it is difficult to find suitable VI. The selection models take into account the observed and unobserved effects, but they need the application of instrumental variables and impose assumptions regarding the form of the equation.

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) in the common support** (see box for more details on the DD-PSM estimation framework)- that allows us to consider parametric, semi-parametric and covariate versions. In this sense, several recent articles use the methodology employed (e.g. Aranda, 2015; Asgari et al., 2016; Bakucs et al., 2018; Cerulli, 2015; Cosgrove and Olitsky, 2015; Cummins et al., 2014; Ferraresi et al., 2018; Ibanez and Blackmanb, 2016; Köppl-Turyna, 2016; Méndez et al., 2016; Olitsky and Cosgrove, 2016). 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).

In this sense, the variables considered were: size, turnover, age, to belong to a group, sectoral taxonomy, to be a R&D performer in a continuous way, to perform fundamental research, to carry out technological development, market structure (to be dominated by established companies), two variables that indicate if the company faces liquidity constraints, internal or external, the type of company ownership (foreign), if it is oriented towards a foreign market, or if it is an SME. These covariates are intended to control the various factors that may influence the likelihood of obtaining funding from the CDTI and carrying out R&D activities: including the structure and characteristics of the companies, the market structure, financial constraints, type of ownership, technological opportunities or orientation towards the external market. The covariates were used to estimate the probability of being treated "propensity score" and calculate the weights with an kernel estimate (Heckman, Ichimura and Tood, 1997, 1998), which, instead of building a control group with a limited number of units similar to those treated, used as a matching the entire control sample according to the "propensity score". The method uses a probit estimation to predict the probability of being treated ("propensity score") and then calculates the "kernel matching". In addition, we retrict the DD-PSM estimation to the common support of the propensity score for treated and control groups in order to increase the internal validity of the DD-PSM estimation (see box on the DD-PSM estimation framework below).

DD-PSM SPECIFICATION FRAMEWORK AND ASSUMPTIONS

Differences in differences (DD): single analysis

Following Villa (2016), the DD treatment effects estimated requires a a pair of before-and-after periods; one being the baseline (t=0) and the follow-up (t=1). It requires two groups of units i, being the treatment group (Z_i =1) and the control group (Z_i =0). It requires the absence of intervention in the baseline for either group ($D_{i,t=0}$ =0| Z_i=1, 0), and it requires the intervention to be positive for the treated group in the follow-up (($D_{i,t=1}$ =1| Z_i=1). For any outcome variable, Y_{it}, the DD treatment effect is given by the difference in the outcome variable for the treated and control units before and after the intervention.

Then, the single DD is given by:

$$DD = \{E(Y_{it=1} \mid D_{it=1} = 1, Z_i = 1) - E(Y_{it=1} \mid D_{it=1} = 0, Z_i = 0)\} - \{E(Y_{it=0} \mid D_{it=0} = 0, Z_i = 1) - E(Y_{it=0} \mid D_{it=0} = 0, Z_i = 0)\} \quad (1)$$

DD with covariates

As mentioned, DD can be combined with other nonexperimental evaluation methods. Further control covariates can be included in order to control for observed heterogeneity, confounding factors that could lead to an overestimation of the relationship. Then, observed covariates could be relieved form the effect of the treatment.

The DD analysis with observed covariates (X_i) added is as follows:

$$DD = \{E(Y_{it=1} \mid D_{it=1} = 1, Z_i = 1, X_i) - E(Y_{it=1} \mid D_{it=1} = 0, Z_i = 0, X_i)\} - \{E(Y_{it=0} \mid D_{it=0} = 0, Z_i = 1, X_i) - E(Y_{it=0} \mid D_{it=0} = 0, Z_i = 0, X_i)\} \quad (2)$$

DD covariates (controls) and kernel propensity-score weights

Observed covariates can be also used to estimate the propensity score, or the likelihood of being treated, and to calculate kernel weights following Heckman et al. (1997, 1998). This method matches treated and controls according to their propensity score, matching each treated unit to the whole sample of control units instead of on a limited number of nearest neighbours.

The propensity score (p_i) is given by:

$$p_i = E(Z_i = 1 \mid X_i)$$

Following Heckman et al. (1997), kernel weights are given by the following expression that considers propensity scores, given the covariates,

$$w_i = \frac{K(\frac{p_i - p_k}{h_n})}{\sum K(\frac{p_i - p_k}{h_n})}$$

K () is the kernel function and h_n bandwidth. The kernel propensity score matching DD treatment effect is given by,

$$DD = \{E(Y_{it=1} \mid D_{it=1} = 1, Z_i = 1) - w_i \times E(Y_{it=1} \mid D_{it=1} = 0, Z_i = 0)\} - \{E(Y_{it=0} \mid D_{it=0} = 0, Z_i = 1) - w_i \times E(Y_{it=0} \mid D_{it=0} = 0, Z_i = 0)\} \quad (4)$$

DD covariates (controls) and kernel propensity-score weight common support

In addition, we can increase the internal validity of the DD estimation, by restricting the previous setting (4) to the common support of the propensity score for treated and control groups. The common support is the overlapping region of the propensity for treated and control groups defined by,

$$(i : p_i \in \left[\max\{\min(p_i \mid Z_i = 1), \min(p_i \mid Z_i = 0)\}, \min\{\max(p_i \mid Z_i = 1), \min(p_i \mid Z_i = 0)\} \right])$$

DD ASSUMPTIONS

The correct interpretation of the DD estimator requires that (Khandker et al., 2010):

1. The correct specification of the model in equation (outcome).

2. The error term is uncorrelated with other variables in the equation.

The last of these assumptions is the most critical for the DD strategy. It is also known as the parallel-trend assumption. It implies that the outcome in the treatment and control group would follow the same time trend in the absence of the treatment. In other words, it implies that unobserved characteristics affecting program participation do not vary over time. We present visual representation of outcome variables from the 2010-2016 period to check this assumption, indicating similar pre-treatment trends (section 6, Figure 2).

Therefore, we use a double difference (DD) method refined with a propensity score matching (PSM) (DD-PSM) on the common support (see box above). 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 (see section 6.2 the results of the quality of the balance before and after the matching). Then, the observable heterogeneity in the initial conditions can be dealt with. Following this approach, the criteria indicated in the previous section, we build three matched samples (see Diagram 1 and Diagram 2).

(I) **Matched sample of the mid-term evaluation**. It includes firms that have finished a project granted by CDTI – our treatment- in 2015 (the starting year of the evaluation period 2015-2020). We follow the activities of these companies ("treated") and their matches ("controls") from 2012 to 2015 in order to be able to compare pre-treatment and post-treatment conditions. The average treatment lasts two years. This matched sample allow us to compare the results of the mid-term evaluation with the final 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. Results for indicators and variables can be checked either in the text or in the Annex. We limit the presentation in the text to a limited set of indicators in order to make the results more meaningful.

(II) **Matched sample of the final evaluation**. Following the same procedure, this sample includes firms that have finished a project granted by CDTI in 2016 (the last year with available information in the PITEC-CDTI panel). We follow the activities of these treated firms and their controls from 2013 and 2016. This matched sample is the core of the final evaluation in which we apply the indicated approach (DD-PSM) and additional tests (e.g. robustness checks).

Over this core evaluation sample, we apply the general approach and the following additional analysis:

- We calculate DD-PSM with and without robust standard errors to get results for the 26 indicators requested in the evaluation for which we calculate a total of 119 variables. Results for indicators and variables can be checked either in the text or in the Annex.
- 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 (see next table).
- check the consistency of the results when covariates are considered across the treatment period (not only at the baseline year). We use the xtreg stata module. We perform Hausman tests on each 12 indicators-variables and we present the fixed effect or random effects model, accordingly.

(III) **Prospective matched sample**. It includes firms that have finished a project granted by CDTI in 2017 and 2018. We follow the activities of these companies ("treated") and their matches ("controls") from 2014 to 2016 (last year available in the PITEC-CDTI panel). Therefore, in this sample we compare the conditions before the treatment with the conditions in the middle of the treatment. We consider projects finished in 2017 and 2018 jointly in order not to decrease the number of observations in the merging process of the PITEC-CDTI database due to statistical confidentiality rules (see Diagram 2). Despite this limitation, this approach allows us to forecast some results for projects granted in 2017 and 2018.

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. Results for indicators and variables can be checked either in the text or in the Annex

Despite the controls applied in the second approach (control samples), several limitations remain. In the first place, the limitations of the original sample (PITEC[6]) 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 (see previous section). For example, we couldn't use geographical data of firms. Similarly, it prevents the disaggregation of the variables. For example, the sectoral taxonomy was reduced in order to increase the number of observations. In addition, the final cross-sample eliminates observations with the additional aim of safeguarding anonymity. These limitations prevent a more detailed characterisation of the beneficiary companies and of those that have completed projects. It was also impossible to take into account the difference between the probability of applying for a subsidy and receiving it, or the difference between the probability of receiving a subsidy and finishing the project granted. 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. As mentioned, this last point is the main drawback of the methodology applied. However, as indicated above,

6 As seen in section 7. Evaluation results, the existing limitations have made it impossible to use the PITEC database for analysing the indicators relating to the indirect impacts of dissemination of knowledge, proportionality and appropriateness of the subsidies. For these cases, the CDTI database has been used (CDTI Survey for project objective and ex-post survey) that contains 2,690 observations of projects completed during the 2011-2015 period.

selection models would have required the use of instrumental variables. The lack of information regarding possible instruments (e.g. number of projects won by a firm, Lichtenberg, 1988; Wallsten, 2000) in the database and other limitations of alternative approaches favoured our chosen methodological approach. In any case, the relative short period of time considered in our DD-PSM approach decreases the possibilities of expecting unobserved dynamic responses of firms (behavioural and choices of targeted firms) to the funding (treatment). In addition, qualitative information did not indicate the presence of conditions (or macroeconomic changes) where treated and control groups would respond differently. Similarly, qualitative information did not indicate the presence of other unobserved characteristics that could be correlated with treatment placement. Therefore, selection biases due to unobserved characteristics that change over time appear not to be very serious in the context of this evaluation.

As indicated, data coming from CDTI's surveys (project and ex-post surveys) is used when information is not available in PITEC-CDTI database (see Diagram 1). We apply multivariate methods, such as, probit models over 13 outcome variables. The different specifications of the model include controls on financial contribution, non-reimbursable contribution, budget, size, and sectoral taxonomy. In addition, type of instrument is included when this information is relevant (i.e. appropriateness). These analyses are approximate for several reasons. Firstly, CDTI surveys only include beneficiary companies, being impossible to build a control group. Secondly, other data issues need to be taken into account. For example, CDTI report with ex-post survey data for projects finished in the 2011-2013 period indicates that the response rate is between 60% and 65%, depending on each year (CDTI, 2018: 9). Moreover, the cleaning process lead to an important reduction of observations (50% of the observations provided for the ex-post survey).[7]

[7] An important part of the cleaning process is due to missing information. This information could be completed with other sources of information, such as SABI, but this was out of the scope of this evaluation. Two main drivers have guided the cleaning process. Firstly, having a temporary balanced database including all the evaluated CDTI instruments (IDI and non-IDI). For the "final project" database (survey) this has imply keeping just the observations for the 2015-2018 period as previous years only provided information on the IDI projects. Secondly, limiting the cleaning process at crucial variables. Then, we have deleted the of firms having missing values in their responses to expenditures, employment and R&D expenditures information. A more detailed information on this issue has been facilitated to the CDTI.

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. This taxonomy based on technological intensity, technological dynamism and technological advantage revealed a taxonomy reduced to five categories by limitations on access to INE data to ensure the anonymity of the companies and which reduces the original taxonomy proposal (Molero and García, 2008; García and Molero, 2010, and García, Molero and Rama, 2016). 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. INE reviews all the results conducted in the secure place in order to assure anonymity. For example, all categories which results are based on less than ten observations have to be deleted. This was frequently the case in the construction section and, therefore, it had to be deleted.

- **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-Garcia 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.

Table A 1 shows the sectoral correspondence of the reduced taxonomy that has been used with both sectors included in PITEC and the CNAE 2009 classification.

5.2 Qualitative methods and data sources

5.2.1 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 techniques 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). In order to ensure enough participants, a replacement sample of other 500 additional project was created.

The selected project 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), plus 25 projects for the replacement sample. Those projects were selected in based on the type of instrument

requested, while the rest of the criteria were random. Therefore, the original and replacement samples were the following:

- Group 1: Beneficiary companies of PID aids.
- Group 2: Beneficiary companies of CIEN aids.
- Group 3: Beneficiary companies of ERDF-INNTERCONECTA aids.
- Group 4: Beneficiary companies of INNOGLOBAL aids.
- Group 5: Beneficiary companies of CDTI-Eurostars-2 aids.
- Group 6: Beneficiary companies of CDTI-Eranets aids.

5.2.2 Methods

To achieve 100 participants for the **in-depth interviews and case studies**, it was necessary to contact 188 companies, which in percentage terms implies a response rate of **53.19%**.

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.

Table 7: 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

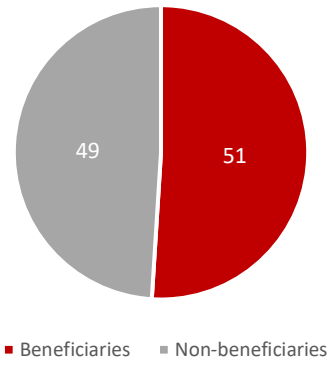
Source: Own compilation

It should be noted that the interviewees in no case had access to the questionnaire nor to the key issues. In the vast majority of the interviews, the consultants had to use probing techniques for some of the questions. The interviewees were not asked directly about the key issues, but based on the development of the interview they were asked different questions. This allows to address issues of greater importance for the interviewee, avoiding bias on the part of the interviewer in the framework of a semi-structured methodology.

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.

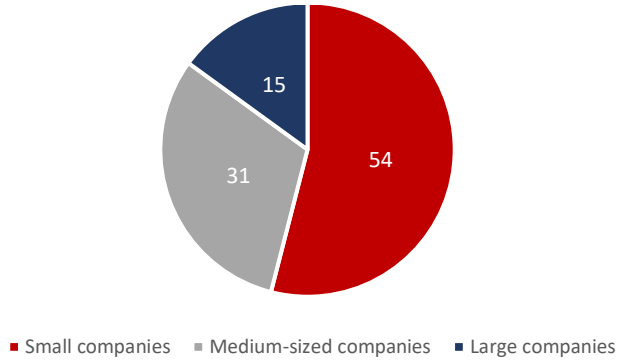
On the other hand, 57 applicant companies of PID aids, 30 of ERDF INNTERCONECTA aids, 7 OF CIEN aids, 4 OF CDTI Eurostars-2 aids and 2 of INNOGLOBAL were interviewed. No CDTI-Eranets aid applicant companies were interviewed as they were not statically significant in relation to the overall number of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

Chart 3: Distribution of interviewees by resolution of the funding



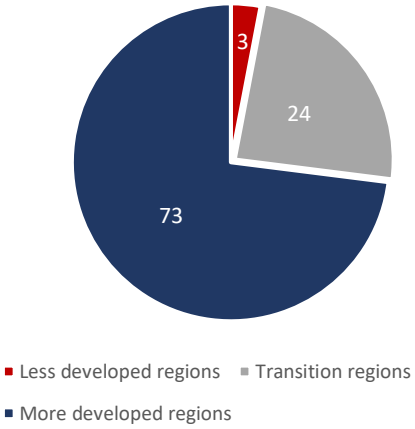
Source: Own compilation

Chart 4: Distribution of interviewees by company size



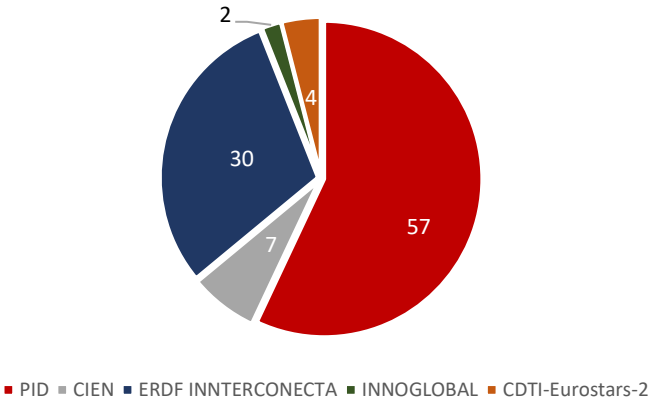
Source: Own compilation

Chart 5: Distribution of interviewees by registered office of the company



Source: Own compilation

Chart 6: Distributions of interviewers by type of instrument requested

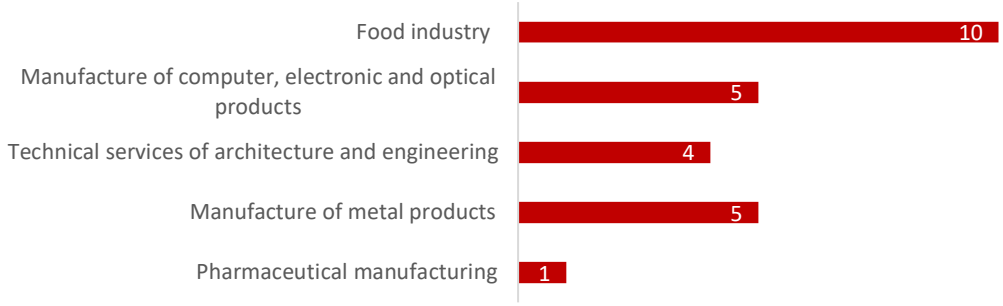


Source: Own compilation

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. As it is shown below, only a pharmaceutical manufacturing company was interviewed, as it was one of the sectors with more participant companies during the mid-term evaluation in comparison with the weight of sector. The companies interviewed in each sector are shown in the following chart.

Chart 7: Distributions of interviewers by sector



Source: Own compilation

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.

To ensure the generation of debate among the participants, they were informed that they could ask the moderator to intervene at any point of the meeting. In addition to the rounds of structured questions, probing techniques were used to increase the participation and debate, asking the members of the groups for their opinion regarding the comments that had been raised by their peers.

As a result of these techniques, productive discussions were generated and enjoyed the participation of all the representatives of the companies.

Each working group benefited from the presence of two consultants: the moderator and the secretary. The role of the moderator is to ask questions from the working groups in accordance with the predefined script. During the course of each working group, the secretary took live notes of the participant's responses. After their completion, the secretary consulted the videos of the recordings of each working group again, thus completing the information that could not be taken while the working groups took place.

As a result of these works, the secretary of each group prepared the relevant report, compiling the interventions and conclusions obtained.

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.

It was attempted to count with approximately five interviewees by working group. As it is shown below, the overall percentage of response rate was **67,35%**.

Table 8: 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%

Working group	Companies that refused to participate	Participant companies	Response rate
CDTI Eurostars-2	1	7	87,5%
CDTI-Eranets	6	7	53,85%
TOTAL	16	33	67,35%

Source: Own compilation

The transcribed interviews and case studies were processed using the ATLAS.ti software (qualitative analysis programme), while the working groups have given rise to a number of logical records. In all cases, the recorded videos and audios were destroyed in order to ensure anonymity and protection of data provided during the course of the same.[8]

5.3 Triangulation methodologies

The triangulation methodology used in this study is defined by Denzin (1970) as: "*the application and combination of several research methodologies in the study of the same phenomenon"*.

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).

> Structural triangulation

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. The quantitative methodology uses the techniques, statistical and econometric instruments (STATA programme) and, the qualitative methodology uses questionnaires, case studies and working groups (business ethnography, probing techniques, specific software for qualitative analysis -ATLAS.ti-, internal workshops, documentary analysis, etc.). Likewise, this type of triangulation can be done within a same method using different samples or techniques (intra-method) or among different methods (inter-method).

[8] For both the audio files and videos recorded we requested the relevant authorisation, with an emphasis on the confidentiality and anonymity of the data.

> Triangulation by stages

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). Subsequently, *qualitative intra-method triangulation* is used (cumulative, sequential, and by strata), supplementing and combining the results obtained thanks to different techniques (interview questionnaires, case studies and working groups), which enables to perform a content analysis having identified the questions to be answered and establishing the criteria for generating the sample of the texts to be analysed. This text, in the first place, is filtered to separate the valid and non-valid information for the purpose of the study, and then encodes the valid information into several categories that, on the one hand, must be mutually exclusive and, on the other hand, must gather parts of text that is consistent between both. These categories are words or groups of less than three words. This allows to build categories with binary language (0,1) that point towards the presence and absence of the same and its frequency, indicating the degree of importance within the overall text.

   After having performed the content analysis, the following relationships are studied:

   - Intensity of the relationship. Referring to the number of times that two or more concepts are related.
   - Sign of the relationship. Referring to the relationship, positive or negative, established between the concepts.
   - Directionality of the relationship. Referring to the type of relationships between two concepts (X includes Y, X occurs before Y; if X, then Y; X complements Y, etc.).

   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. As a complementary technique, an internal workshop is organised between the quantitative and qualitative evaluators to integrate and synthesise the overall results of the evaluation. It will be structured into several stages, where the evaluators set out the results obtained with each methodology, indicator by indicator, and agreed the common findings of the evaluation (using the internal review techniques in pairs), which serve to advance the conclusions and recommendations of the later stage.

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, that on the basis of their experience in the

evaluation of public programmes and of the overall results of the report, designed the conclusions and recommendations for the preliminary phase.

- 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

6

The following section presents the main results of the quantitate analysis. We have structured the fundamental messages of the analysis according to the following guidelines:

- We have gone through the structure of the questions expressed in the contract conditions. Thus, it is easy to understand the main results of the evaluation research.
- For each of the questions we have selected a number of indicators. This selection has been done according to:
  - First, the consistency of the results across samples and tests (e.g. robustness checks)
  - Second, meaningfulness the variable-indicator in terms of the conceptual formulation of the indicator.
  - However, in some points we have commented other indicators and variable as well. This has been carried out when they offer important nuances to the general finding.
- Then:
  - Section 6.1 summarises the outcomes of the systematic comparison of the behaviour of the two general samples: CDTI beneficiaries and the rest of the firms included in the basic PITEC Panel (non-beneficiary companies). These comparisons are based on the total values of 26 indicators for the whole period 2010-2016 (25 indicators excluding I24 not available in PTEC-CDTI database).
  - Section 6.2 includes results on the matching procedure.
  - Section 6.3[9] includes results of the matched samples of beneficiaries (treated) and non-beneficiaries (controls). The presentation of the results focuses on the final evaluation matched sample (2013-2016), but we complement it in three main directions:
    i. Firstly, we compare the results with the mid-term evaluation to see the stability of the findings.
    ii. Secondly, we analyse the results breaking down by sectoral taxonomy, following the methodology explained in section 5.2. This breakdown is particularly important to understand some remarks on the findings.
    iii. Thirdly, we foresee some results for 2017 and 2018 based on the prospective matched sample, for the reasons explained above. This is the best alternative that aims to mitigate the absence of data.

6.1 Summary of the behaviour of beneficiary and non-beneficiary companies (Full sample)

As has indicated, the full sample is an unbalanced panel made up by a total of 57,988 observations, of which 9,116 (16%) belong to the CDTI beneficiary companies[10] and 48,882 (84%) to the rest of companies (non-beneficiaries) for the 2010-2016 period.

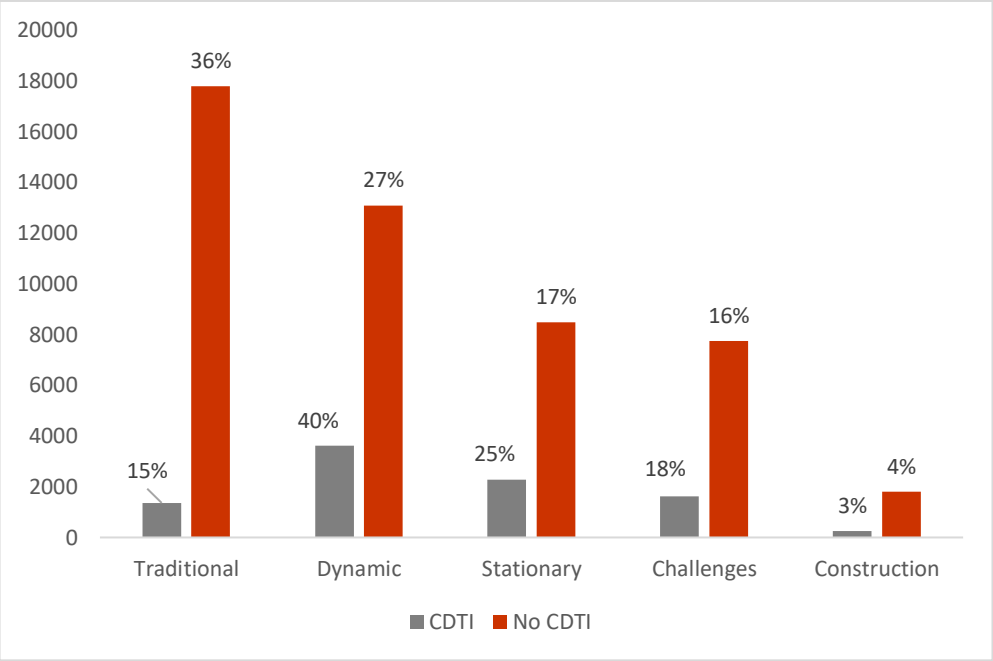
The distribution of observation across sectors is shown in Figure 1. The beneficiary companies are more concentrated in certain sectors, particularly in the dynamic and

[9] Qualitative analysis is included in this section through the triangulation method (PID projects).

[10] As indicated above, it refers only to beneficiary companies of PID projects, since there is a significant number of completed projects in other instruments.

stationary ones, while the non-beneficiary companies have greater presence in the traditional sector. 40% of the beneficiary companies are concentrated in the dynamic sector compared to 27% of the non-CDTI (3,611 CDTI observations compared to 13,079 non-CDTI). The stationary sector concentrates 25% of the beneficiary companies compared to 17% of the non-CDTI (2,283 CDTI observations compared to 8,48 non-CDTI). On the other hand, the traditional sector represents 36% of the non-beneficiary companies compared to 15% of the CDTI companies (17,788 observations of non-beneficiary companies compared to 1,1361 of the CDTI observations) (Figure 1).

Figure 1: Total number of observations of beneficiary companies and non-beneficiary companies by sectoral taxonomy, expressed in numerical terms (left axis) and relative percentage (tags)



Source: Own compilation

> **R&D and Innovation effort (I1 –I2).**

Beneficiary companies show a positive general behaviour with a significant high propensity to carry out R&D activities compared to non-beneficiary companies (Indicator I1a) (Table 9 and Figure 2). All the variables estimated on the R&D activity show this general behaviour. This is particularly the case for the variable on internal R&D. However, the intensity of the relation is moderate or even slight, according to the Cramer's V values (at the maximum, 0.29). The variables estimated on R&D intensity also show the positive general behaviour for beneficiary companies (Indicator I1b) (Table 10).

When we consider innovation activities (other non-R&D activities included in Table 9), the situation is less clear. Thus, innovative activity appears to be higher for beneficiaries albeit the size of the difference is reduced, according to the very low V Cramer values (around or below 0.1). The consideration of Innovative intensity (I1-I2) also confirms the higher performance of beneficiaries, although some nuances exist in different innovation variables.

Even in some cases - i.e. effort in expenditure for introducing innovations- differences are not statistically significant.

> **R&D jobs creation (I3-I4)**

A first overview on the indicators on R&D job creation indicate again a high performance of beneficiary companies over non-beneficiaries (Table A 7). However, although the association is statistically significant, the magnitude of this relationship is limited, as proved by the low V Cramer (0.10). Results for the comparison of the intensity of R&D jobs creation percentage of firms creating R&D employment (I4) do not allow us to confirm a clear higher performance of beneficiaries either.

> **Product and/or process innovation (I5-I8)**

Regarding product innovation (I5), the incorporation of these innovations in the last period in significantly higher for beneficiaries than for non-beneficiaries, albeit the intensity of the association is low, (V Cramer 0.20) (Table A 8). The difference is even lower in the case of process innovation (I6).

The indicator of new product for the market (I7) does no prove convincingly the existence of better results for beneficiaries than for non-beneficiaries. In the case of new products for the firms (I8) (Table A 8), there are not significant differences between the samples.

> **Patent applications and other IPP (I9-I12)**

A third group of indicators has to do with Patents and other IPP (Table A 9). The general picture is clear, there are elements which show a higher performance of beneficiary companies than for non-beneficiaries: number of firms patenting, number of patents per firm (I9, I10)), other IPR (I11, I12), but usually the intensity of the difference is low (V Cramer < 0.20). Moreover, the superiority is not always in favour of beneficiaries, as for example in types of IPR used.

> **Economics Results (I13-I18)**

The comparison of different indicators on economic results throws results which in general terms do not permit to establish conclusions in one single direction (Table A 10: and Table A 11). Starting from the measures of the percentage of new products, both for the market and for the firm (I13) there is higher positions of beneficiaries compared with non-beneficiaries. However, there is a worse behaviour respect to unmodified products because the position of beneficiaries is higher (worse) than for non-beneficiaries.

Other indicators of economic results – sales increase, productivity growth, exports growth- are even less conclusive. Practically in all cases (I14, I15, I16, I18) either there are not significant differences or the magnitudes of the association are low (V Cramer below 0.1). One exception is the access to international markets (I17) which shows a higher V Cramer (0.17), although still low.

> **Innovation organization (I19-I25)**

The comparison between beneficiaries and non-beneficiaries in innovation organization (Table A 12) shows a positive performance of beneficiaries in the cooperation with research centres (I19), while it is the opposite in the case of the propensity of beneficiaries to cooperate

with international partners (I20), although for the number of cooperation beneficiaries perform better. Anyway, the intensity of the relationship is weak as V Cramer indicates.

Other indexes measuring organizational changes show heterogeneous results. Thus, Innovations in work procedures (I21), in social responsibility (I22) or management of external and institutional relationship (I23) present some better data for beneficiaries, although the magnitudes of the association are little (V Cramer < 0.10). The most significant favourable result for beneficiaries is referred to their capacity to find other financial resources (I26).

Table 9: Variables considered for the indicator 1a on expenditure on R&D and other innovation expenses carried out by beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

			CDTI		NO CDTI						Total	
			%	N	%	N		*Chi2*	*p*	*Cramér's V*	%	N
I.a) Expenditure on R&D and innovation (idin)												
1	innid	Expenditure on R&D (external or internal)	75.78	6,908	36.4	17,794	***	4900.00	0.000	0.2898	42.59	24,702
2	innotro	Performs other innovation expenditure	39.41	3,593	23.75	11,611	***	974.25	0.000	0.1296	26.21	15,204
3	idin	Internal R&D expenditure	73.44	6,695	33.94	16,589	***	5000.00	0.000	0.2933	40.15	23,284
4	Idex	External R&D expenditure	36.10	3,291	13.79	6,743	***	2700.00	0.000	0.2146	17.3	10,034
5	maqui	Expenditure on acquisition of machinery, equipment and software	15.59	1,421	10.6	5,182	***	189.40	0.000	0.0571	11.38	6,603
6	tecno	Expenditure on external knowledge acquisition	2.31	211	1.25	609	***	62.96	0.000	0.0329	1.41	820
7	prep	Preparatory expenditure for production/distribution	7.42	676	4.14	2,025	***	185.36	0.000	0.0565	4.66	2,701
8	form	Training expenses	16.03	1,461	9.37	4,580	***	364.93	0.000	0.0793	10.42	6,041
9	market	Expenditure for introduction of innovations	23.38	2,131	11.84	5,790	***	866.42	0.000	0.1222	13.66	7,921
		Total		**9,116**		**48,882**						**57,998**

Note: * p<0.1, **p<0.05, *** p<0.01.

Source: Own compilation

Table 10: Variables considered for the indicator 1b on expenditure on R&D and other innovation expenses and I2 expenditure on innovation as a percentage of the turnover by beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

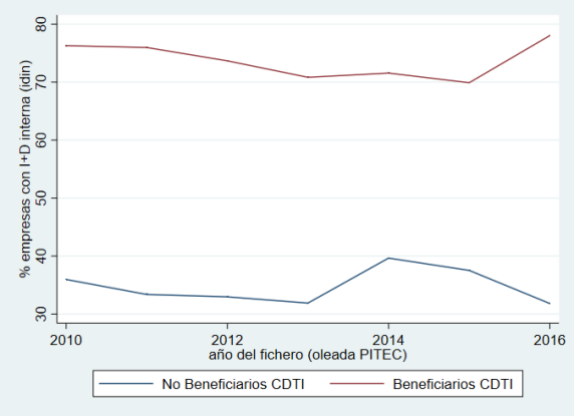
			CDTI			NO CDTI							Total		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.	*St. Dev*	.	*t*	Mean	St. Dev.	N
I.b) Effort in internal R&D expenditure (esfgintid and esfgintidtam)															
11	esfginnidtam	R&D expenditure (staff)	10,227.98	31,289.83	9,116	4,267.15	42,133.70	48,882	-5960.83	463.43	***	-12.9	5,204.06	40,679.14	57,998
13	esfginnotrotam	Other innovation expenses (staff)	2,160.82	39,052.50	9,116	817.54	11,629.84	48,882	-1343.28	214.56	***	-6.3	1,028.68	18,812.82	57,998
16	esfgintidtam	Effort in internal R&D expenditure (staff)	8,315.07	23,062.34	9,116	3,471.04	12,694.46	48,882	-4844.03	168.99	***	-28.7	4,232.41	14,917.07	57,998
20	esfgextidtam	Effort in external R&D expenditure (staff)	1,912.91	14,421.88	9,116	796.12	38,842.10	48,882	-1116.79	412.02	***	-2.7	971.65	36,116.79	57,998
24	esfgmaquitam	Expenditure on acquisition of machinery, equipment and software (staff)	1,626.10	38,816.03	9,116	431.27	5,739.82	48,882	-1194.83	185.57	***	-6.4	619.07	16,271.19	57,998
28	esfgtecnotam	Effort on expenditure for external knowledge acquisition (staff)	37.98	568.50	9,116	54.31	6,924.47	48,882	16.33	72.57		0.2	51.74	6,361.02	57,998
32	esfgpreptam	Effort in spending in preparation for prod./distribution (staff)	166.13	1,442.12	9,116	102.68	2,836.80	48,882	-63.45	30.42	**	-2.1	112.65	2,666.44	57,998
36	esfgformtam	Effort in training costs (staff)	40.26	350.94	9,116	28.11	571.89	48,882	-12.15	6.2	**	-2.0	30.02	543.17	57,998
40	esfgmarkettam	Effort in expenditure for introducing innovations (staff)	290.35	1,483.40	9,116	201.17	5,151.33	48,882	-89.18	54.37		-1.6	215.19	4,765.72	57,998
Indicator I2 expenditure on innovation as a percentage of the turnover/staff															
42	esfinn	Total effort in innovation (turnover)	156.38	6,439.40	9,105	16.25	762.79	48,808	-140.13	30.22	***	-4.6	38.28	2,647.94	57,913
44	esfinntam	Total effort in innovation (staff)	12,390.70	55,433.95	9,116	5,085.35	44,016.07	48,882	-7,305.35	524.78	***	-14	6,233.59	46,075.06	57,998

Note: * p<0.1, **p<0.05, *** p<0.01. Methodological note: indictors 1.b show different values, compared to those in the mid-term evaluation, as we have detected an error in the mid-term calculation that has been addressed in the final evaluation. Indicator 42 (esfinntam) has been multiplied by 100 in this final evaluation in order to have values in a high scale.

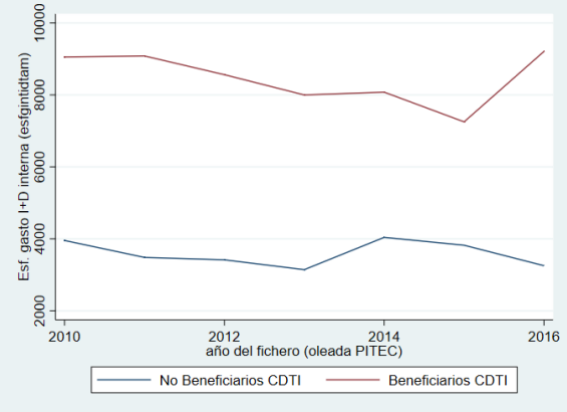
Source: Own compilation

Figure 2. Evolution of selected indicators across beneficiary (red) and non-beneficiary (blue) companies over the period 2010-2016.

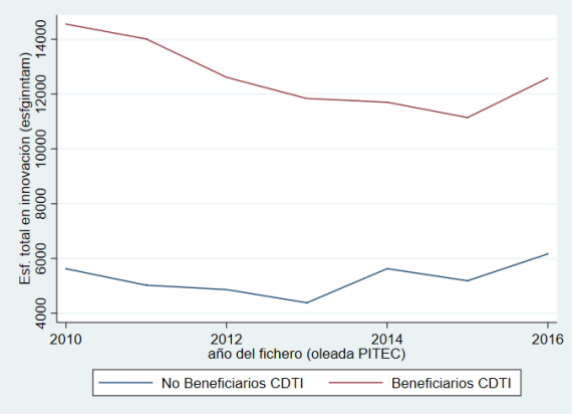
I1a 3 (idin)



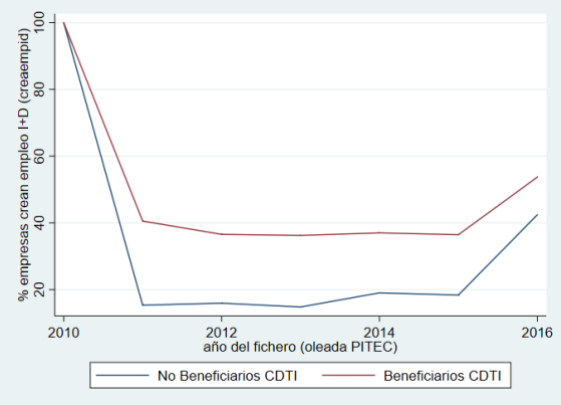
I1b 16 (esfgintidtam)



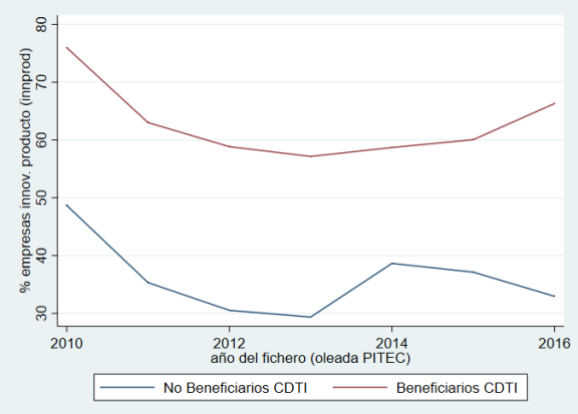
I2 44 (esfinntam)



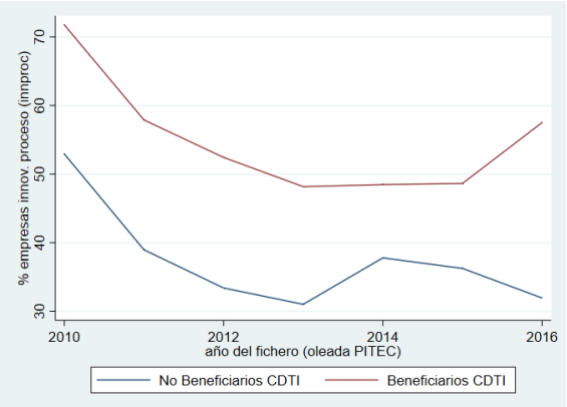
I3 46 (creaempid)



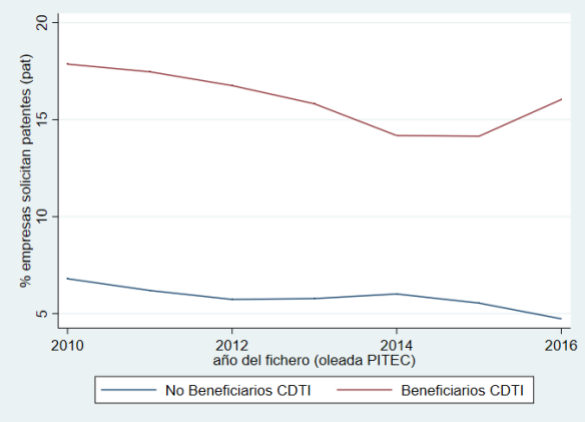
I5 52 (innprod)



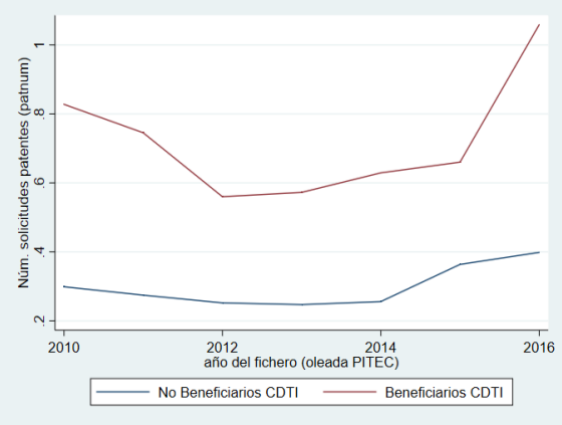
I6 53 (innproc)



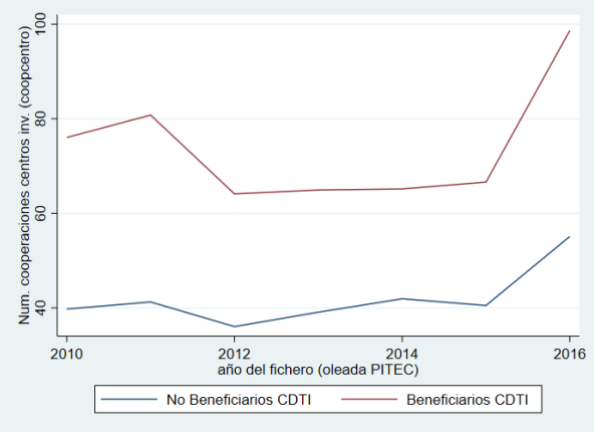
I9 63 (pat)



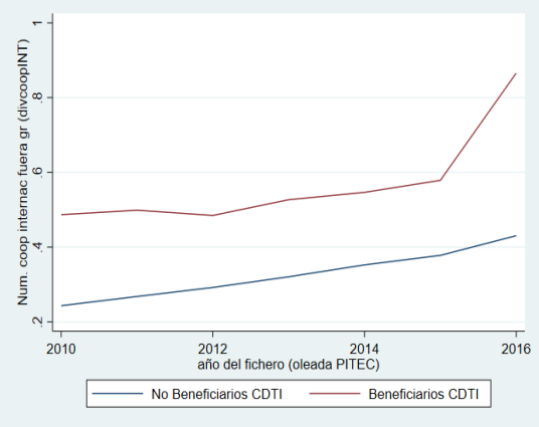
I10 65 (patnum)



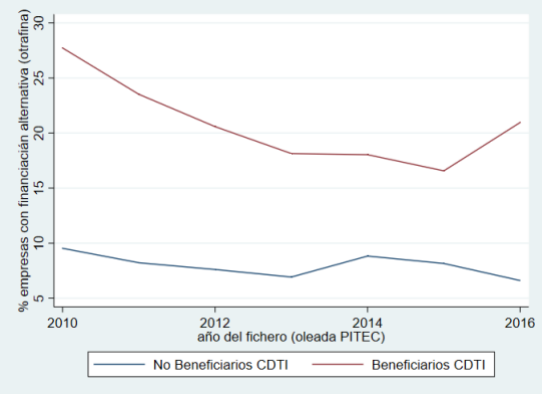
I19 99 (coopcentro)



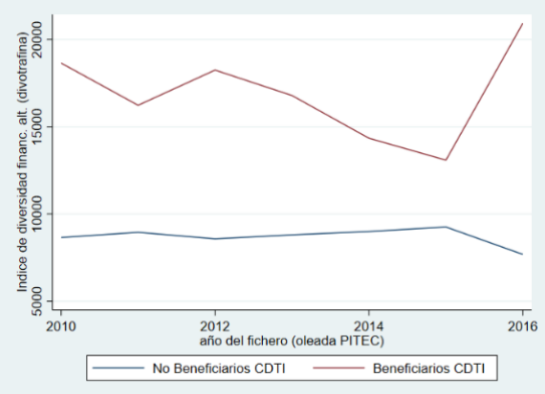
I25 107 divcoopINT



I26 117 (otrafina)



I26 119 (divotrafina)



Source: Own compilation

6.2 Matching procedure

Before matching, in the full sample there are 57,988 observations of with 16% belong to CDTI beneficiary companies for the 2010-2016 period. Treated group (firms that have finished a project in 2016) consists of a set of observations that are matched with firms that are equivalent but have not receive funds from CDTI. This section presents the results of the likelihood of being treated (propensity score) and assesses the quality of the matching procedure of our approach (see section 5.1.2).

Table 11 presents the results of the probability of being treated estimated with a probit model across samples. Regardless of the samples, being a continuous R&D performer increases the likelihood of being treated. Continuous R&D performers appears to have specific experience and skills that might allow them to apply and finish a CDTI project. This result is consistent with previous results, such as, Czarnitzki and Hausinger (2004), Huergo et al. (2016) and Barajas et al. (2017). Firms with foreign capital have lower probability of being treated, similarly to previous evidence (Huergo and Moreno, 2017 and Barajas et al., 2017). However, exports (lexportt_eu) increases the probability of being treated. This result is also consistent with previous findings (e.g. Barajas et al., 2017). It appears that domestics firms are more prone to apply and finish a CDTI project than foreign firms, but the international experience of firms appears to provide with the skills or the need to access to a CDTI programme. In addition, the probability of being treated for the final evaluation sample increases for firms that present higher turnover, carry out technological developments; and firms that face internal liquidity constrains, but decreases for firms that belong to a group and face external liquidity constraints. These effects are quite similar considering the prospective evaluation sample, but there is a loss of significance for variables, such as, belonging to a group. The probability of being treated is significantly higher for the final sample for firms belonging to dynamic or challenge sectors than to firms belonging to the traditional sector. The lower number of observations considered in the estimation used in the mid-term evaluation might explain some inconsistence's across samples.

Table 11: Probability of being treated (propensity score matching) by samples

	MID-TERM EVALUATION SAMPLE			FINAL EVALUATION (2013-2016)			PROSPECTIVE SAMPLE (2017-2018)		
ltamano	0,041		(.060)	-0,014		(.038)	-0,030		(.029)
lcifra	0,076		(.054)	0,127	***	(.035)	0,052	*	(.028)
edad	-0,004	**	(.002)	-0,001		(.001)	0,002	**	(.001)
grupo	-0,053		(.078)	-0,155	***	(.055)	0,005		(.040)
tradicional	-0,172		(.131)				-0,164	***	(.061)
dinamico	0,057		(.087)	0,395	***	(.080)	0,073		(.047)
estacionario	0,161	*	(.093)	0,392		(.079)	0,162	***	(.049)
reto				0,341	***	(.084)			
idcont	0,183	**	(.091)	0,710	***	(.056)	0,475	***	(.041)
infun	0,000		(.003)	-0,002		(.003)	0,001		(.002)
destec	0,001		(.001)	0,001	**	(.001)	0,004	***	(.000)
mdodom	0,151	*	(.078)	-0,033		(.024)	-0,015		(.018)
fcinter	-0,083		(.082)	0,130	***	(.032)	0,093	***	(.025)
fcexter	0,202	**	(.080)	-0,175	***	(.031)	-0,142	***	(.024)
extranjera	-0,413	***	(.102)	-0,313	***	(.068)	-0,443	***	(.055)
lexportt_eu	0,063	**	(.026)	0,063	***	(.019)	0,107	***	(.015)
pyme	-0,113		(.116)	-0,113		(.079)	0,256	***	(.064)
cons	-4,275	***	(.575)	-5,140	***	(0.375)	-4,449	***	(.575)
Log. Likelihood	-901,24			-1832,40			-3.272,38		
Pseudo R2	0,0607			0,1557			0,1315		
Num. Observations	4168			14654			17894		

*** p<0,01; ** p<0,05; * p<0,1. Standard Errors in brackets

Source: Own compilation

We assess the matching quality by testing: the standardised biases (Rosenbaum and Rubin, 1985); the difference of means (t-test) (Rosenbaum and Rubin, 1985); and the Pseudo R2 (Sianesi, 2004) before and after matching the limited sample (Table 12 and Table 13). The different tests indicate that the matching procedure is able to balance the distribution of the covariates quite well in both the control and treated group. The standardised biases of the different covariates (% bias) are quite high before matching, but quite low after the matching procedure, being "estacionario" the variable with the highest percentage biases (-11.1) (Table 12).[11] Accordingly, the difference of means before matching are statistically significant at 0.001 p-level, while any of the covariates shows this significance level after matching. Variance ratio are "of concern" for eight variables before matching –edad, tradicional, idcont, destec, fcinter, fcexter, lexportt_eu; pyme-, but only one after the matching procedure –infun. Finally, Table 13 shows a close to zero Pseudo-R2 after matching, suggesting that the covariates do not explain the probability of participation well after matching. See Tables in the Annex (Table A 2, Table A 3, Table A 4, Table A 5) for the results of the tests for the mid-term and prospective matched samples, indicating similar balances after matching (i.e. low pseudo-R2), but less optimal (i.e. three variables with "of concern" variance ratio after matching).

In addition, balance and density plots of the propensity scores before and after matching (Figure 3 and Figure 4). The graphs confirm that our approach balances the covariates (see Figure A 1 and Figure A 2 in the Annex for the balance boxes and density plots on the mid-term and prospective samples).

[11] A possible limitation of the standardised bias approach is that there is no clear indication of the success of the matching procedure (Caliendo and Kopeining, 2008).T-test is preferred when the statistical significance of the results is a concern, but the reduction bias before and after matching is not clearly visible (Caliendo and Kopeining, 2008).

Table 12: Balancing test. Mean differences (Final evaluation matched sample)

Variable	Unmatched Matched	Mean Treated	Mean Control	% bias	%Reduction bias	T-Test t	T-Test p>|t|	V(T)/VI)
Final evaluation sample								
ltamano	U	4.84	4.00	52.1		15.59	0.000	0.82
	M	4.84	4.88	-2	96.1	-0.53	0.594	0.98
lcifra	U	17.08	15.64	70.8		21.74	0.000	0.83
	M	17.08	17.19	-5.3	92.5	-1.33	0.184	0.94
edad	U	34.43	29.15	24.4		8.28	0.000	1.25*
	M	34.43	32.91	7	71.2	1.63	0.104	1.21
grupo	U	0.57	0.41	31.7		10.57	0.000	0.97
	M	0.57	0.58	-2	93.6	-0.46	0.645	1.04
tradicional	U	0.11	0.38	-67.6		-18.98	0.000	0.50*
	M	0.11	0.08	7.3	89.3	2.32	0.02	1.08
dinamico	U	0.37	0.28	19.6		6.78	0.000	1.1
	M	0.37	0.33	8.2	58.3	1.82	0.069	0.97
estacionario	U	0.32	0.18	32.6		12.01	0.000	1.18
	M	0.32	0.36	-11.1	65.9	-2.29	0.022	0.89
reto	U	0.21	0.16	11.6		4.03	0.000	1.04
	M	0.21	0.23	-5.2	55	-1.12	0.264	0.95
idcont	U	0.78	0.26	119.5		38.74	0.000	0.80*
	M	0.78	0.82	-9	92.5	-2.18	0.03	0.93
infun	U	1.84	1.01	13		4.38	0.000	0.98
	M	1.84	1.78	1	92.3	0.2	0.839	0.76*
destec	U	49.37	17.68	84.4		30.14	0.000	1.33*
	M	49.37	50.35	-2.6	96.9	-0.54	0.586	0.85
mdodom	U	2.40	2.75	-34.6		-10.9	0.000	0.8
	M	2.40	2.43	-2.7	92.2	-0.65	0.514	0.9
fcinter	U	2.22	2.33	-10.2		-3.13	0.002	0.77*
	M	2.22	2.25	-2.6	74.5	-0.65	0.518	0.96
fcexter	U	2.14	2.45	-27.7		-8.47	0.000	0.74*
	M	2.14	2.16	-1.6	94.3	-0.39	0.699	0.82
extranjera	U	0.14	0.13	1.5		0.5	0.619	0.81
	M	0.14	0.14	-0.7	51.7	-0.16	0.872	1.03
lexportt_eu	U	15.90	14.47	62.7		18.14	0.000	0.77*
	M	15.90	15.99	-4	93.7	-0.9	0.366	0.98
pyme	U	0.68	0.79	-24.7		-8.78	0.000	1.39*
	M	0.68	0.69	-3.9	84.1	-0.85	0.397	1

* 'f 'of conc'rn', i.e. variance ratio in [0.5, 0.8) or (1.25, 2]
** 'f ''ad', i.e. variance ratio <0.5 or >2

Source: Own compilation

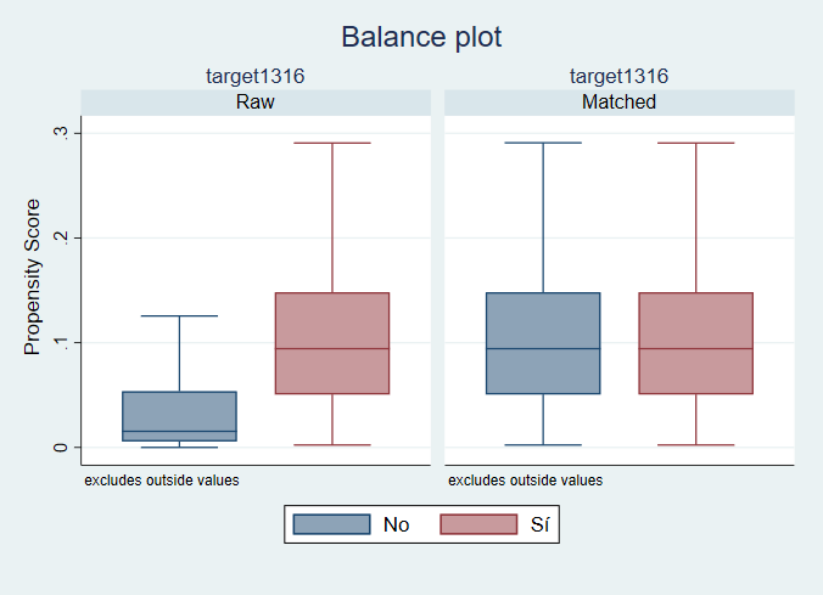
Table 13: Overall measures of covariate balancing (Final evaluation matched sample)

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%concern	%bad
Unmatched	0.163	1305.98	0.00	40.5	31.7	131.3*	0.65	47	0
Matched	0.004	9.47	0.89	4.5	3.9	14.1	0.87	6	0

* if B>25%, R outside [0.5; 2]

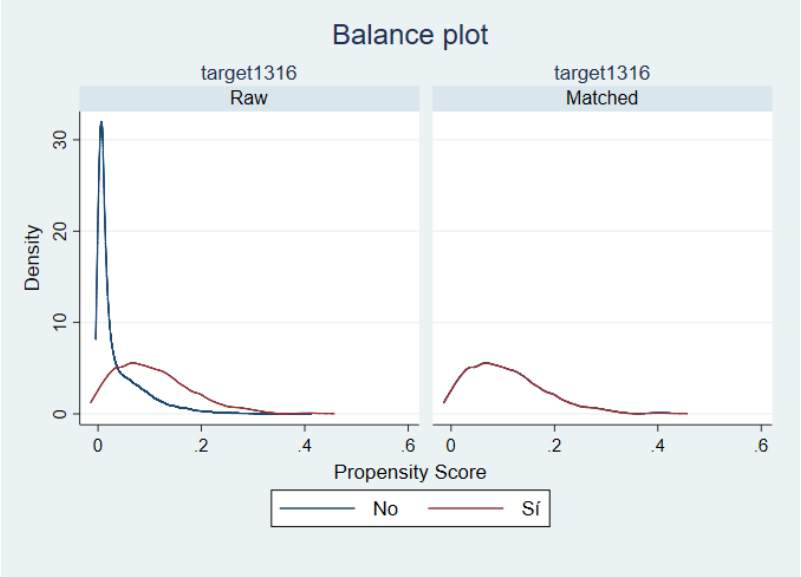
Source: Own compilation

Figure 3: Balance plot before and after matching propensity score (Final eval. matched sample)



Source: Own compilation Note: Outliers were excluded for anonymity reasons

Figure 4: Density plot before and after matching propensity score (Final evaluation matched sample)



Source: Own compilation

6.3 Specific results on the matched samples: trends and dynamics of the treated (beneficiary companies) and their controls (non-beneficiary matched companies)

Table 14 includes results of the double difference combined with propensity score matching (DD-PSM) analysis for the three matched samples (mid-term, final and prospective evaluation samples) for a selected number of indicators (See Table A 6 for the results for the full list of indicators in the Annex). In addition, Table 14 includes additional results for the final evaluation matched sample, including results of the DD-PSM with robust standard errors and DD-PSM results across the sectoral taxonomy. It is important to highlight that the process of selecting the indicators included in this basic table has been based on the significance and strength of results in the three categories of exercises. This method of showing results is clearer and easier to understand than the full incorporation of all indicators which reduces the possibility of having a guideline for the analytic evaluation of results.

The different columns across matched samples indicate:

- **Baseline**. Considers the situation of beneficiary companies (treated) and non-beneficiary companies (control) at the beginning of the period. A positive sign (+) indicates that treated companies outperform their controls in the corresponding indicator. A negative sign (-) indicates the reverse situation. Significant results are indicated in bold. Colours aim to facilitate the reading of the table: green indicates a positive and significant difference (T-C); red indicates a negative and significant relationship, while yellow corresponds to non-significant positive or negative results of the treated versus control difference.
- **Follow-up**. Shows the difference of the treated versus controls companies at the end of the period considered for the different indicators.
- **Diff-Diff.** This shows whether the evolution of the beneficiary companies regarding the non-beneficiaries has been better (+) or the worse (-). Bold font and colours follow the pattern indicated above.

In addition, Table 15 and Table 16 provide some outcome variable means and impact measures for the list of selected indicators across matched samples (mid-term, final and prospective evaluation samples. The difference of the results when using the full sample (without controlling some biases) and the matched samples is important. For example, full sample indicated that beneficiary firms tend much more frequently than non-beneficiary firms to carry out R&D activities internally (idin) (73,44% against 33,94%) for the whole period (see Table 9 and Figure 2). This difference of about forty percentual points could be partially explained by the characteristics or behaviour of the beneficiary companies, the market structure in with firms operate, etc. (see section 6.1.2). When we consider these covariates (balance the distribution of the covariates across treated and control groups), beneficiary companies tend to carry out R&D activities more often than non-beneficiaries, but to a lesser extent (87% against 77% at the baseline of 2013) (see Table 15). This is generally the behaviour for all the selected indicators at the baseline (2013) and follow-up (2016) of the final evaluation. Table 16 provides impact values of the difference-in-differences, being *idin*, *creaempid*, *coopcentro*, *divcoopINT*, *otrafina* the variables with a positive, significant and consistent results cross matched samples. For example, the results of *idin* indicate that firms

that have received CDTI funding increased the likelihood of carrying out internal R&D activities in 13 percentual points compared to their controls in the 2013-2016 period. *Coopcentro* results indicates that beneficiary firms increase the number of partnerships with research centres by about 0.26 [Final Evaluation sample], becoming more internationally oriented in their cooperation with research centres. The total value of this variable for 2016 is 1.189 indicating that collaboration remains on mainly at national level (see Table 15). Similarly, *divcoopINT* results indicate that beneficiary firms increase the number of international partnerships outside the group of by about 0.3 [Final Evaluation sample], diversifying international partnerships. However, the total number of international partnerships outside the group is low.

Table 14: Difference in difference results across mid-term, final, and prospective evaluation matched samples for selected indicators (DD-PSM) (See Annex for full list of indicators). (I)

			MID-TERM EVALUATION TREATED - CONTROL			FINAL EVALUATION (2013-2016) TREAED - CONTROL						PROSPECTIVE EVALUATION (2017-2018) TREATED - CONTROL		
			BASELINE	FOLLOW-UP	DIFF-DIFF	BASELINE	FOLLOW-UP	DIFF-DIFF	Robust	TAXONOMY	DIFF-DIFF	BASELINE	FOLLOW-UP	DIFF-DIFF
Indicator I1: Companies that decide to invest in R&D														
3	idin	Internal R&D expenditure	(-)***	(+)***	(+)***	(+)***	(+)***	(+)***	R(***)	Tradicional Dinámico Estacionario Reto	(+)*** (+)*** (+)*** (+)***	(+)***	(+)***	(+)***
16	esfgintidtam	Effort in internal R&D expenditure (staff)	(-)**	(-)	(+)	(+)***	(+)***	(+)***	R(**)	Tradicional Dinámico Estacionario Reto	(+)*** (+)*** (+)*** (+)***	(+)*	(+)***	(+)***
Indicator I2: Expenditure on innovation as a percentage of the turnover/staff														
44	esfinntam	Total effort in innovation (staff)	(-)**	(+)	(+)**	(+)***	(+)***	(+)	R	Tradicional Dinámico Estacionario Reto	(+) (-) (+)*** (+)**	(+)	(+)	(-)
Indicator I3: Companies that have created jobs in R&D														
46	creaempid	Has created jobs in R&D with respect to t-1	(-)	(+)*	(+)**	(+)***	(+)***	(+)***	R(***)	Tradicional Dinámico Estacionario Reto	(+)*** (+)*** (+)*** (+)***	(+)***	(+)***	(+)***

Indicator I5: Companies that develop product innovations															
52	innprod	Product innovation from (t-2) to t	(-)	(-)	(-)	**(+)*** **	**(+)*** **	(+)	R	Traditional	(-)	**(+)*** **	**(+)*** **	(+)
										Dynamic	**(+)***			
										Stationary	**(-)***			
										Challenges	(+)			
Indicator I6: Companies that develop process innovations															
53	innproc	Process innovation from (t-2) to t	(-)	**(+)*** **	**(+)***	**(+)*** **	**(+)*** **	(+)	R	Traditional	**(+)*** **	**(+)***	**(+)*** **	**(+)*** **
										Dynamic	(-)			
										Stationary	(+)			
										Challenges	(-)			
Indicator I9: Companies that patent															
63	pat	Patent application	**(+)*** **	**(+)*** **	(-)	**(+)*** R**	**(+)*** R**	**(+)** **		Traditional	**(+)*** **	**(+)*** **	**(+)*** **	(-)
										Dynamic	(+)			
										Stationary	(+)			
										Challenges	(+)			
Indicator I10: Number of patents registered															
65	patnum	Number of patent applications	(-)	(+)	(+)	**(+)R*** **	**(+)R** **	(-)		Traditional	**(+)*** **	**(+)***	(-)	**(-)** **
										Dynamic	**(+)** **			
										Stationary	**(-)** **			
										Challenges	(-)			
Indicator I19: Companies that cooperate with research centres															
99	coopcentro	Number of partnerships with research centres	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **	**R(**)**	Traditional	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **
										Dynamic	(-)			
										Stationary	**(+)*** **			
										Challenges	**(+)*** **			
100	coopcentroNAC	Number of partnerships with national research centres	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **	**R(**)**	Traditional	**(+)*** **	**(+)*** **	**(+)*** **	**(+)*** **

Indicator I25 diversity in the network of cooperation															
107	divcoopINT	No. of international partnerships Outside of the group	**(-)***	**(+)*****	**(+)*****	**(+)*****	**(+)*****	**(+)*****	**R(*)**	Traditional	**(+)*****	**(+)*****	**(+)*****	**(+)*****
										Dynamic	(+)			
										Stationary	**(+)*****			
										Challenges	(+)			
Indicator I26: Companies that find alternative sources of funding [to the company:f1 (own funds); the group: f2 (other group companies); and subsidy: f5 (AGE grants) and f6 (AGE contracts)]															
117	otrafina	Has obtained alternative financing	**(+)*****	**(+)*****	**(+)***	**(+)***R**	**(+)***R**	**(+)*****		Traditional	**(+)*****	**(+)*****	**(+)*****	**(+)***
										Dynamic	**(+)****			
										Stationary	**(+)*****			
										Challenges	**(-)****			
119	divotrafina	Diversity index alternative financing	**(+)****	(+)	(-)	(+)	**(+)*****	**(+)*****	**R(***)**	Traditional	**(+)*****	(+)	**(+)*****	**(+)*****
										Dynamic	**(+)****			
										Stationary	**(+)*****			
										Challenges	**(+)*****			

Note: * p<0.1, **p<0.05, *** p<0.01. Significant results are indicated in bold. Green colour indicates a positive and significant difference (T-C); red indicates a negative and significant, while yellow corresponds to non-significant positive or negative results.* (&): esfgintidtam values show different values for 2015. We have detected an error in the mid-term calculation that has been addressed in the final evaluation.

Source: Own compilation

Table 15: Outcome variable means, treated (CDTI) and control (NO-CDTI) for selected indicators

			2013		2015		2016		Prospective (2017-2018)	
			Treated (CDTI)	Control (NO CDTI)	Treated (CDTI)	Control (NO CDTI)	Treated (CDTI)	Control (NO CDTI)	Treated (CDTI)	Control (NO CDTI)
	R&D and innovation resources									
	R&D expenditure and R&D effort (I1, I2)									
3	idin	Internal R&D expenditure	87%	77%	0.908	0.827	0.928	0.694	0.87	0.677
16	esfgintidtam	Effort in internal R&D expenditure (staff)	11,000.00	6,221.92	660,000.00 *(&)*	700,000.00 *(&)*	15,000.00	5,734.21	7,731.41	7,152.88
44	esfinntam	Total effort in innovation (staff)	26,000.00	8,827.06	9,307.57	8,975.05	26,000.00	8,521.94	8,613.68	8,224.55
	R&D job creation (I3)									
46	creaempid	Has created jobs in R&D with respect to t-1	0.743	0.562	0.344	0.315	0.706	0.384	0.653	0.386
	Innovation results									
	Product and process innovation (I5, I6)									
52	innprod	Product innovation from (t-2) to t	0.795	0.656	0.689	0.695	0.765	0.624	0.684	0.594
53	innproc	Process innovation from (t-2) to t	0.705	0.62	0.616	0.575	0.648	0.555	0.566	0.514
	Patenting activity (I9, I10)									
63	pat	Patent application	0.243	0.17	0.222	0.174	0.247	0.146	0.204	0.129
65	patnum	Number of patent applications	2.11	1.025	1.406	1.384	2.678	1.867	0.939	1.163
	Other results (I19, I25, I26)									
99	coopcentro	Number of partnerships with research centres	0.881	0.625	0.939	0.542	1.189	0.67	0.966	0.641
107	divcoopINT	No. of international partnerships Outside of the group	0,749	0.55	0.832	0.545	1.117	0.676	0.945	0.611
117	otrafina	Has obtained alternative financing	0.266	0.162	0.23	0.143	0.296	0.143	0.211	0.123
119	divotrafina	Diversity index alternative financing	148.56	141.958	149.129	129.174	243.728	128.547	185.468	113.984

Source: Own compilation

Table 16: Impact values for selected indicators

				MID-TERM EVALUATION		FINAL EVALUATION (2013-2016)			PROSPECTIVE EV. (2017-2018)	
				DIFF-DIFF	t-ratio	DIFF-DIFF	t-ratio	Time Series	DIFF-DIFF	t-ratio
	R&D and innovation resources									
	R&D expenditure and R&D effort (I1, I2)									
3	idin	Internal R&D expenditure		0.131	11.08	0.132	12.85		0.093	8.35
			Std. Errors	(0.012)***		(0.01)***		YES **	(0.011)***	
						0.125	6.12			
			Robust Std. Errors			(0.020)***				
16	esfgintidtam	Effort in internal R&D expenditure (staff)		59000.00(&)	0.88	4455.343	5.86		505.959	2.07
			Std. Errors	(66000)		(760.940)***		YES ***	(1104.944)	
						4455	2.03			
			Robust Std. Errors			(2193.183)**		YES **		
44	esfinntam	Total effort in innovation (staff)		2001	2.07	519.447	0.17		-387	-0.34
			Std. Errors	(965.322)**		(3109.888)			(1145.164)	
						889.826	0.1			
			Robust Std. Errors			(8885.983)				
	R&D job creation (I3)									
46	creaempid	Has created jobs in R&D with respect to t-1		0.048	2.21	0.141	9.67		0.075	4.84
			Std. Errors	(0.022)**		(0.015)***		YES *	(0.016)***	
						0.138	4.09			
			Robust Std. Errors			(0.034)***		YES *		
	Innovation results									
	Product and process innovation (I5, I6)									
52	innprod	Product innovation from (t-2) to t		-0.002	-0.1	0.002	0.16		0.006	0.43
			Std. Errors	(0.020)		(0.012)		YES *	(0.014)	
						0.012	0.45			
			Robust Std. Errors			(0.028)				
53	innproc	Process innovation from (t-2) to t		0.042	1.96	0.008	0.57		0.038	2.67
			Std. Errors	(0.022)*		(0.013)		YES *	(0.014)***	

			MID-TERM EVALUATION		FINAL EVALUATION (2013-2016)			PROSPECTIVE EV. (2017-2018)	
			DIFF-DIFF	t-ratio	DIFF-DIFF	t-ratio	Time Series	DIFF-DIFF	t-ratio
					0.006	0.19			
		Robust Std. Errors			(0.031)				
	Patenting activity (I9, I10)								
63	pat	Patent application	-0.007	-0.39	0.029	2.56		-0.016	-1.47
		Std. Errors	(0.019)		(0.011)**			(0.011)	
					0.031				
		Robust Std. Errors			(0.029)				
65	patnum	Number of patent applications	0.066	0.16	-0.274	-0.65		-0.424	-2.03
		Std. Errors	(0.402)		(0.422)		YES *	(0.208)**	
					-0.261	-0.23			
		Robust Std. Errors			(1.131)				
	Other results (I19, I25, I26)								
99	coopcentro	Number of partnerships with research centres	0.271	5.48	0.263	5.7		0.157	3.59
		Std. Errors	(0.049)***		(0.046)***		YES ***	(0.044)***	
					0.24	2.4			
		Robust Std. Errors			(0.100)**		YES ***		
107	divcoopINT	No. of international partnerships Outside of the group	0.312	4.37	0.241	3.79		0.193	3.18
		Std. Errors	(0.072)***		(0.064)***		YES ***	(0.061)***	
					0.253	1.79			
		Robust Std. Errors			(0.141)*		YES **		
117	otrafina	Has obtained alternative financing	0.035	1.89	0.049	4.23		0.021	1.94
		Std. Errors	(0.018)*		(0.012)***			(0.011)*	
					0.046	1.53			
		Robust Std. Errors			(0.030)				

			MID-TERM EVALUATION		FINAL EVALUATION (2013-2016)			PROSPECTIVE EV. (2017-2018)	
			DIFF-DIFF	t-ratio	DIFF-DIFF	t-ratio	Time Series	DIFF-DIFF	t-ratio
119	divotrafina	Diversity index alternative financing	-22.92	-0.9	108.578	6.94		64.509	4.15
			(25.568)		(15.639)***		YES ***	(15.553)***	
					116.18	2.92			
					(39.734)***		YES **		

**** p<0,01; ** p<0,05; * p<0,1.* (&): esfgintidtam values show different values for 2015. We have detected an error in the mid-term calculation that has been addressed in the final evaluation

Source: Own compilation

6.3.1 Direct impacts

6.3.1.1 Input additionality

Question 1. Do the companies that receive support from the aid scheme increase their effort in innovation?

INDICATOR I1: COMPANIES THAT DECIDE TO INVEST IN R&D AND INDICATOR I2: EXPENDITURE ON INNOVATION AS A PERCENTAGE OF THE TURNOVER/STAFF

The analysis of the differences in the behaviour of beneficiary against non-beneficiary companies confirms the higher performance of beneficiaries over non-beneficiaries with regard to the propensity to carry out R&D activities (internal R&D expenditures, (1) both at the baseline (before being treated or being granted with CDTI funding for project) and along the process of carrying out the project. The **result is similar to the one obtained in the mid-term evaluation.** The difference in difference analysis done with the matched samples confirms the existence of a positive additionality: **beneficiary companies carry out R&D activities to a higher and significant extent than non-beneficiaries.** The additionality is confirmed across the four types of sectors considered. The estimated projection allows us to foreseen that the overperformance of beneficiary companies will probably continue until the end of the treatment - finished the financed project.

As far as the intensity of the effort is concerned (internal R&D expenditures per employee, (indicator I2) **we show also the confirmation of positive additionality due to the availability of CDTI´s aids. This result is different from the one got in the mid-term evaluation, in which we could not confirm that additionality**. Similarly, to what we see for R&D propensity, the additionality is verified in all the four types of sectoral activity. As for the former indicator, the projection foresees the continuation of the mentioned additionality.

Moving to innovation instead of R&D, indicator (Total innovation expenditures per employee, I2) **does not confirm the existence of the additionality as a consequence of CDTI aids to beneficiary firms; the difference is not statistically significant. This is somehow different of what we obtained for mid-term evaluation.** The lack of significance is better understood with the results by sectoral categories. Thus, in two cases –Traditional and Dynamic- there is not the additionality we wanted to measure. Nevertheless, in other two cases -Stationary and Challenges- the additionality is confirmed. It is a first case which allows us to assert the existence of heterogeneous behaviour of firms according the sector of activity, so the effectiveness of the measure can differ significantly. Furthermore, the projection estimated casts serious doubts about the maintenance of the additionality as far as innovation as a whole is concerned.

In line with the mid-term evaluation, the qualitative analysis strengthens, expands and complements the results obtained in the quantitative analysis. In this sense, the beneficiary companies have a better trend innovative behaviour than non-beneficiaries highlighting the following strength lines:

- 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.

As specified by one of the beneficiary companies interviewed: "…*thanks to this aid, it was possible to cover different areas in R&D, which we could not have done with our own financial resources" and "we are increasingly innovative and a greater turnover percentage is allocated to R&D.* Furthermore, a company highlights*: "Yes, it was our first R&D project, that is to say, it has encouraged us to start industrial research and technological development activities".*

The increase in R&D investment has generated a greater number and variety of projects in this area. In line with these results, a firm states: "*Financial aid has allowed the development of new technologies. In fact, this has improved our projects portfolio. In line with the company´s strategy, the R&D investment is increasing".*

Additionally, one of the beneficiary companies explains: *"We develop market-oriented projects with a high level of risk and complexity, in which financial support is important so that the project can be carried out and obtain the result we want. This additional push allows us to venture into R&D activities".*

On the other hand, non-beneficiary companies suffer from a lack of innovative intensity due to not obtaining CDTI funding. As a company interviewed indicates: "*The project was carried out, but a few more instrumentation and process control kits could have been purchased. More investment would have been made in equipment", or, "we would have devoted more effort to researching a section that interested us for a line of business".* Another of the companies interviewed states: *"With public aid, more investment would have been allocated to complementary assets, which would have allowed us to advance more quickly in the R&D process".*

Finally, the qualitative analysis allows us to obtain some interesting conclusions concerning the size of the company, regions and business sectors.

For small companies (for which the market failures are more intense) this public support has been fundamental to start and develop themselves in the field of R&D: "*Our company has not only been able to start R&D projects, but has also to survive thanks to financial aid of the CDTI*", and, "*We can tackle more innovation projects and continue to grow. We are getting more involved and it is forcing us to evolve further".*

In general, public aid has had a greater impact, related to these indicators, in developed regions, and as one company belongs to Pharmaceutical manufacturing sector points out: "*It has allowed us to tackle high risk projects and, at the same time, a greater number of such projects.".* Likewise, in the Metal products manufacturing sector a firm notes: "*We have been able to carry out R&D projects with higher quality and technical performance".*

INDICATOR I3: COMPANIES THAT HAVE CREATED JOBS IN R&D AND INDICATOR I4: JOBS CREATED IN R&D[12]

A third point to take into account is the creation of R&D employment (I3). In this case the comparison of matched firms (treated against control group), clearly shows beneficiary companies to have better results both at the beginning of the period as well as along the years considered than non-beneficiary companies. More importantly, **the DD-PSM study confirms the existence of additionality as far as the creation of R&D jobs is concerned. This result is coincident with our previous results of the mid-term evaluation.** Moreover, the additionality is confirmed in all the four type of sectors in which we have broken down our matched sample. The results of our projections for 2017-18 give us more reasons to confirm the additionality. However, the results on the intensity of job creation (see I4 in the Table A 7 in the Annex) show a negative trend, becoming the results not significant in the robust specification.

Regarding the qualitative analysis, which confirms and develops the above results, the beneficiary companies perform better on the following aspects:

- 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.

Beneficiary companies hire more R&D personnel than non-beneficiary companies. One of the firms interviewed points out: "*R&D personnel have been increased. There are personnel who were already in the company and who are now involved in the R&D department" and "employment is specifically created in all projects".* It is very common within companies to take advantage of internal expertise, as stated by a beneficiary company: "*We assign internal personnel for the use of previous knowledge and experience".* Besides, the new hiring strategy is shared by many companies: "*New R&D personnel are hired, which provides a better structure to the R&D department and sizes it to carry out more R&D projects in the near future."*

The hired staff usually ranges from 35 to 45 years and the composition of the teams according to gender is variable, without a defined pattern. There are some cases where the percentage is higher for men and sometimes it is higher for women. In other cases, the R&D teams have a balanced composition.

On the other hand, multidisciplinary and specialised personnel is considered a strategic variable into the highly qualified teams. As stated by one of the companies: "*A multidisciplinary R&D staff has been hired, with special emphasis on STEM personnel. In complex R&D projects, we consider that it is very important to use synergies among different specialities and fields".*

[12] See Table A 7 in the Annex for I4: Jobs created in R&D (quantitative analysis).

With respect to non-beneficiary companies, they have more difficulties in increasing the size of their staff without financial aid. As a firm indicates: "*We would have hired more staff in the R&D department and thus tackle a larger project, but without financial aid we could not develop it.", and, "…In addition to having dedicated more internal personnel to carry out R&D projects, more external personnel would also have been hired."*

The qualitative analysis based on company size shows us the great significance of the funding to improve the innovative process through the incorporation of R&D personnel, especially in small companies. As a firm points out: "*We have hired an R&D person and we have the prospect of hiring more to work exclusively on R&D projects.", and, "We have hired because the company is rising and, among other departments, the R&D department has also grown".*

Once more, the impact is greater in developed regions[13]. Regarding the sectoral analysis, although the employment created has been a key factor in most sectors, the companies in the Computer, electronic and optical products manufacturing sector and Food industry show a positive impact of funding in the creation and consolidation of R&D teams.

6.3.1.2 Output additionality

Question 2. Do the companies that receive support obtain better technological results thanks to the subsidies?

INDICATOR I5: COMPANIES THAT DEVELOP PRODUCT INNOVATIONS, INDICATOR I6: COMPANIES THAT DEVELOP PROCESS INNOVATIONS, INDICATOR I7: COMPANIES THAT SIMULTANEOUSLY DEVELOP PROCESS AND PRODUCT INNOVATIONS AND INDICATOR I8: COMPANIES THAT INTRODUCE NEW PRODUCTS ON THE MARKET[14]

Although the results for these indicators are similar, and generally positive for beneficiary firms, to the ones found in the mid-term Evaluation, the final evaluation points towards a decreasing level of significance . Final evaluation results indicate that beneficiary firms outperform their controls in product and process innovation (I5, I6), both at the beginning ang at the end of the period, but the difference becomes not significant. Different impact across sectors indicates that the lack of significance could be due to an heterogenous impact across sectors . So, for Product innovation we can confirm positive additionality in the Dynamic type of sectors, while in Stationary, there is a worse result for beneficiary companies. In two cases, Traditional and Challenges the differences between samples are not significant enough to confirm the existence of positive Additionality. In the case of process innovation, it is just in Traditional type of sectors where we find positive additionalities, while in the other three cases there are not significant differences between samples.

[13] These results should be considered with caution because, in general, the most competitive companies are usually in developed regions and obtain better results. Besides, the data available for this evaluation mainly comes from developed or transition regions.

[14] See Table A 8 in the Annex for I7: Companies that simultaneously develop process and product innovations (quantitative analysis).

See Table A 8 in the Annex for I8: Companies that introduce new products on the market (quantitative analysis).

We observe interesting differences from the prospective estimations for the two indicators. Thus, while for Process Innovations we find a possible positive behaviour in favour of beneficiary companies, so sustaining the possibility of reinforcing the Additionality, in the case of product innovations the result is less clear to support that argument.

The qualitative analysis shows a positive impact on process innovations in terms of:

- 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.

Beneficiary companies optimize their processes in different ways. As a company states: "*Reducing the cost (up to 8%) in order to improve operating profit margin is a fundamental aspect. In other words, the type of process innovation is incremental, and in that sense, it has been quite efficient.", and, "In our company we have carried out process innovations through integration of existing technologies, reducing the consumption of raw materials, increased energy efficiency and reduction of environmental impact".*

Moreover, as a company points out: *"In logistics management, the impact has been very positive. It has allowed us to improve different processes. And in infrastructure too. Savings were both time and money".*

On the other hand, the non-beneficiary companies have not been able to obtain the benefits of automating and improving their processes: *"Maybe the experimentation period would have been more efficient and less costly in time. The research focused on 2 aspects when it could have focused on 4, we had to delimit it".*

Once again, the impact is greater in developed regions. However, no significant results are observed depending on the business size or sector.

With respect to product innovation, according to qualitative analysis, beneficiary companies show better results in terms of:

- 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.

As stated by a company belongs to Computer, electronic and optical products manufacturing sector: "*An internal power generator with better qualities was developed. We have offered a product update on the market, creating a pioneering product*". And a firm from Food industry expands product varieties: *"We have developed different range of wines. They are being commercialized".*

With respect to development of product innovations through integration of existing technologies and improvement of the characteristics/quality of existing products, one company points out: *"We offer a better functionality, with innovative products such as artificial intelligence or neural networks".* In the same way, one company specialized in medical technology indicates: *"Since the company was founded, it has always been committed to*

technology focused on diagnosing diseases. This has contributed and will contribute to reducing diagnosis times for children, in order to diagnose them at the age that they should be diagnosed. We have reduced the diagnostic time from 10-20 hours to 1 hour".

Non beneficiary companies have more difficulties carrying out product innovation, mainly of developing of new products not existing on the market.

Again, the impact is greater in developed regions. Besides, the qualitative analysis based on company size show a positive impact in small companies, which more often perform product innovation thanks to CDTI aid. Regarding the sectoral analysis, it is worth highlighting the product innovations in the Food sector in terms of expanding the product line.

In contrast, there is no evidence in companies that simultaneously develop process and product innovations.

INDICATOR I9: COMPANIES THAT PATENT, INDICATOR I10: REGISTERED PATENTS, INDICATOR I11: COMPANIES THAT USE OTHER INDUSTRIAL PROTECTION INSTRUMENTS (IPP) AND INDICATOR I12: OTHER IPP INSTRUMENTS[15]

Moving to IPP there is a significant change with respect to the mid-term Evaluation, basically consisting of a significant difference favourable to beneficiary companies in the number of firms which apply for patents (I9). This allows us to support the existence of positive Additionality in this part of the technological behaviour of the firms. Once again, the situation varies depending of the sector of activity. Thus, while it is clear in Traditional sectors, it is not the case in the rest of sectors. Projections are not sufficiently clear to assert the possible reinforcing of additionality in this element.

Considering the number of patents per firm (I10) is less evident the superiority of beneficiary companies, so the existence of Additionality is more uncertain. Again, clear differences across sectors arise. Additionality exists in two cases – Traditional and Dynamic- it is clearly opposite for Stationary kind of sectors, while for Challenges, results are not statistically significant. Projections seem to show the possibility of reversing the better behaviour of beneficiary companies.

According to the qualitative analysis, in line with the mid-term evaluation, the beneficiary companies tend to patent to a greater extent thanks to the CDTI aid. In general, companies patent in order to anticipate and mitigate competitors (strategic decision).

However, the companies have some obstacles and difficulties when patenting (economic costs, bureaucracy, likelihood of litigation, software, etc.). For these reasons, they also use other means of protection for industrial property (industrial secrecy, confidentiality agreements, etc.).

As stated by one of the beneficiary companies interviewed: "*It is studied internally to decide the option of patenting. For many small companies it is very expensive, so industrial secrecy is often preferred".*

[15] See Annex for I11: Companies that use other industrial protection instruments -IPP- (quantitative analysis). See Annex for I12: Other IPP instruments (quantitative analysis).

In other cases, the companies have complications of defending a patent. As a firm interviewed points out*: "It is easy to patent, but it is very difficult to deter our competitors so that not to use this technology. Sometimes we have patented, but then our competitors have made modifications to use it".*

On the other hand, the non-beneficiary companies consider that funding is an essential element when it comes to patenting the results of the project carried out.

The qualitative analysis based on company size shows us small companies seem to have more difficulties to patent and has not provided substantial significant differences by sector.

Question 3. Do the companies that receive support obtain better economic results thanks to the subsidies?

INDICATOR I13: TURNOVER GENERATED BY NEW PRODUCTS FOR THE MARKET, INDICATOR I14: ANNUAL GROWTH IN TURNOVER INDICATOR AND I15: ANNUAL GROWTH IN LABOUR PRODUCTIVITY

We have not found clear robust results for or against the existence of economic additionality consistent across variables and samples. Considering the different measures on the company sales due to new products (I13), our results do not confirm the existence of a positive behaviour for beneficiary companies. On the contrary, some estimations of DD-PSM, show better results for non-beneficiary companies against beneficiary companies. Due to information restrictions we have not been able to calculate the indicators across sectors. The results for the prospective sample, do not clarify a positive or negative behaviour.

As far as the evolution of sales figures is concerned (I14), the conclusions are very similar to what have said. There is not any confirmation of higher results for beneficiary companies and the projection does not improve the situation either. It has been not possible to detail results by sectors.

Considering productivity (I15), our results can be summarized as in the case of the former two indicators; it is not possible to confirm the superiority of beneficiary companies neither in the period under analysis nor in the remaining years.

With respect to productivity, the results found by the qualitative analysis are similar to the one obtained in the quantitative analysis. Nevertheless, the **conclusions obtained by the qualitative analysis point to an impact in sales and the trend is similar to the one found in the mid-term evaluation.** The beneficiary companies interviewed tend to look upon the impact on sales positively (annual sales growth and maintenance of sales growth in the medium and long term) in some aspects:

- New products (technological outputs).
- Expansion into new markets or customers.
- New commercialization strategies.

For several beneficiary companies, this better performance is related to the impacts on the technological outputs: *"The launching of a new product with breakthrough technological components may mean a sales increase by 20%".*

A few companies associate it, more specifically, with the expansion into new markets or new customers: *"We have increased sales thanks to entering new business areas related to the industrial and tourism sectors. All of them allow us to get new clients both to sell new products and traditional ones that we already sold".*

Likewise, as stated by a company: "*Product innovation has prompted us to design and implement new marketing strategies that have had a great positive impact on our sales in the medium and long term".* In this sense, the beneficiary companies conclude that it is possible that the improvements in marketing and commercialization would have produced a lasting impact in their sales thanks to CDTI aid.

On the other hand, as a non-beneficiary company indicates: "*Our objective was to diversify our product (software), but faced with the impossibility of doing so, we found ourselves with a reduced market. It is likely we would have improved our sales with CDTI aid".*

Regarding company size, medium and small companies tend to obtain more sales based both on the expansion into new markets and customers and new products. Once again, the impact is greater in developed regions and there are no significant differences by sector of activity.

INDICATOR I16: EXPORT GROWTH RATE AND INDICATOR I17: ANNUAL GROWTH OF GROSS INVESTMENT IN MATERIAL GOODS

In the case of the evolution of exports (I16) we can distinguish between the period 2013-2016, in which there is not a positive association in favour of beneficiary companies and the projections which defines a more positive trend for these companies.

The measurement of the behaviour of Investment in material goods (I17) drives us to similar conclusion: The absence of positive additionality due to beneficiary companies conduct for the basic period and it is also confirmed by the worsening of beneficiary companies' perspective.

According to the qualitative analysis, the beneficiary companies interviewed, in general, observe an increase in exports without attributing a clear relationship of cause and effect with the CDTI funding and relating them more to strategic and competitive reasons (market diversification, market risks, etc.).

As a company points out: "*R&D projects are conditioned by the international market. 80% of the demand is international (Europe and the United States)".* Another company affirms*: "…our company has a long export tradition, CDTI aid have allowed us to sell a product with more added value. The truth is that we are exporting a lot but not only for this project, but also in our general activity. Above all, to Mexico."*

Concerning company size, small business results are the most substantial and there are no significant differences by sector of activity.

On the other hand, the qualitative analysis shows how the beneficiary companies increase the gross investment in material goods. As stated by a firm: "*Our projects have often an investment not only in machinery or process modifications, but also both in software (licensing) and hardware (storage, telecommunications)".*

Similarly, a firm belongs to Computer, electronic and optical products manufacturing sector points out: "*To make a specific piece, for example, we need a precise mould. We also had to buy a low-pressure mould to generate the prototypes", and, "…we increase investment in material goods, as well as everything related to ultrasound, electrical and electronics".*

With respect to investment location, a firm indicates:" *Our strategic investment is carried out in Europe (80%), mainly in Ireland and Germany. Although we also make investments in the United States or China.*"

Investments in productive assets and R&D are related. As mentioned by a company: *"In general, R&D projects combine investments in production processes to implement this R&D. The R&D component is a prelude to invest in productive assets".*

However, the non-beneficiary companies have difficulty to invest without CDTI aid. As a firm states: "*If we had developed this technology, we would have implemented it first on our plant and subsequently expanded it to others plants. We would have had to buy all the equipment necessary to implement this technology".* In this sense*: "We were already focused on the international market. For this reason, this aid would have supported us to invest more in the same countries".*

Relating to company size, small companies have a tendency to increase the investments in productive assets due to CDTI aids. Once more, the impact is greater in developed regions and there are no significant differences by sector of activity.

Question 4. Do the companies that receive support increase their presence on international markets thanks to the subsidies?

INDICATOR I18: COMPANIES ENTERING INTERNATIONAL MARKETS

As it was shown in the mid-term evaluation, the new estimations do not prove any superior performance by beneficiary companies compared with non-beneficiary companies (I18). Nevertheless, the projections seem to anticipate a probable better behaviour for the last years of the projects in which beneficiary companies are involved.

In relation to the qualitative analysis, the findings of interviews concerning the beneficiary companies complement the results obtained in the quantitative analysis. In general, these companies do not assign a clear relationship of cause and effect with the CDTI funding.

Nevertheless, the companies have a high level of international market penetration. As stated by a small business: "*We are in Latin America, the United States, Canada, North Africa and South Africa. In total, in 55 countries. Also, in Russia, northern China, Taiwan and Hong Kong".* Another company affirms*: "Yes, we have taken our construction system to other countries in Latin America. We have established on-site factories and pre-cast concrete. Our system has been presented in Mexico and also in Colombia".*

Besides, the companies interviewed also have a high level of European market penetration. For instance, as mentioned by a firm: *"The European Union is our most important client, we are present in all 27 countries".*

Once again, the impact is greater in developed regions and there are no significant differences by sector of activity. Relating to company size, the results are more significant in small companies.

6.3.1.3 Behavioural additionality

Question 5. Do the companies that receive support change their operating and strategic behaviour thanks to this subsidy?

INDICATOR I19: COMPANIES THAT COOPERATE WITH RESEARCH CENTRES AND INDICATOR I20: COMPANIES THAT COOPERATE WITH INTERNATIONAL PARTNERS[16]

[16] See Table A 12 in annex for I20: Companies that cooperate with international partners (quantitative analysis).

This a complex question with different angles to consider. In a first place it is the important issue of cooperation. **Following the same pattern, we showed in the mid-term evaluation, there is a higher cooperative performance of beneficiary companies with research centres (I19).** It is so at the starting point of the comparison as well as along the period of analysis and is robustly confirmed by the DD-PSM analysis. The sectoral breakdown confirms that pattern for all kind sectors with the exception of Dynamic, for which the difference in difference are not statistically significant. The estimated projections confirm the continuation of this clear point in favour of firms having the benefit of CDTI aids.

In line with the mid-term evaluation, the qualitative analysis provides results that converge with those previously obtained. The beneficiary companies cooperate with research centres and international partners to a greater extent than non-beneficiary companies, thanks to the CDTI aid. This fact is 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 capacity for learning and absorption of knowledge.
- More likely to cooperate and form alliances with international partners.

The beneficiary companies show a greater capacity to collaborate with public research organizations, universities and technological centres, at national and international level. As mentioned by a firm: *"It depends on the type of R&D project. We have always contracted technology centres and we have also collaborated with universities, such as the Polytechnic University of Madrid or Polytechnic University of Valencia.", and, "…from the beginning of the creation of R&D department, we have collaborated with universities, and this collaboration has been maintained until now. We have greatly enhanced collaboration with public research organizations. In this case, with the Spanish National Research Council".*

These companies are more likely to cooperate and form alliances with international partners (existing and new ones), as a firm points out: "*CDTI aid encourages cooperation with research centres in the same R&D areas, generating projects of mutual benefit and important synergies. In addition, it promotes alliances with other national and international partners in order to tackle new areas", and, "..we have carried out some international collaboration, both with Europe and with Japan through other international cooperation programs. Earlier this year, we started working with other companies in the United States, which improves our image abroad".*

On the other hand, non-beneficiary companies do not collaborate with the same intensity without public aid. As stated by a firm: "*If we had obtained CDTI aid, we would have collaborated with a research centre to analyse specific bacteria. In addition, to subcontracting an institute from the Polytechnic University of Valencia, we would have looked for other centres, it would have been more successful".*

Regarding company size, the small and medium business have greater access to collaborative projects. At the same time, the impact is greater in developed regions and there are no significant differences by sector of activity.

INDICATOR I21: COMPANIES THAT INTRODUCE INNOVATIONS IN TERMS OF WORK PROCESSES, INDICATOR I22: COMPANIES THAT INTRODUCE INNOVATIONS IN TERMS OF RESPONSIBILITY AND DECISION MAKING AND INDICATOR I23: COMPANIES THAT INTRODUCE INNOVATIONS IN TERMS OF MANAGING EXTERNAL AND INSTITUTIONAL RELATIONS

In other indicators – Introduction of new work processes (I21), improvement in social responsibility (I22) management external and institutional relations (I23)- the results we have obtained point to the same direction: there is not a clear tendency neither in favour nor against beneficiary companies. It is so considering the situation at the beginning of the period along the period and through the calculation of dif-dif. The only shade has to do with the introduction of innovation in institutional relationships where some trend in favour of beneficiary companies, although neither dif-dif results nor the projection cast sufficient significant results to achieve to a clear conclusion.

Notwithstanding, the qualitative analysis incorporates a set of findings to consider. In this sense, the perception of the beneficiary companies is positive in terms of changes in their organizational structures, methods and strategies in several facets:

- New organizational structures (R&D department, etc.)
- New working methods and procedures.
- New business strategies.
- Modification of the processes: responsibility management and decision making.
- Strategic R&D plans (medium and long term).

As stated by some companies: "*A specific R&D unit was created as planned in order to manage and carry out the projects. As a result of this, 4 technological lines of the company were defined.", and, "…some working methods and procedures have been modified to integrate R&D into the company's strategy".*

In this line, in terms of efficient management, a firm affirms: "*It also requires having a more advanced management. Knowing that there is administrative control makes you more operationally efficient.".* And, this allows you to reallocate resources*: "…a lot of resources have been provided to the R&D department and its structure has been improved. In addition, R&D personnel have been reallocated"."*

Likewise, one firm belongs to Pharmaceutical sector points out: "*We are in a long process of implementing quality standards, because we work with international pharmaceutical companies" and, "…An R&D financing plan has been integrated into the company's business strategy. Therefore, a new work methodology will be developed to know which projects are going to be more effective."*

Regarding company size, medium and small companies tend to improve their organizational structures, methods and strategies. Over again, the impact is greater in developed regions and there are no significant differences by sector of activity.

6.3.2 Indirect impacts

6.3.2.1 Dissemination of knowledge: externalities and collaborations

The indicators relating to the dissemination of knowledge cannot be assessed directly using the PITEC database, either because they do not directly exist or because they could not be offered by the INE on the grounds of statistical confidentiality. In these cases, the results used are those obtained from the qualitative analysis and data from the CDTI Surveys, as an approximation. As indicated in section 5.1.2, CDTI surveys only include beneficiary companies, being impossible to build a control group. Similarly, other data availability issues could be mentioned. For example, the ex-post data provided includes a reduced variability by the type of instrument. Similarly, the cleaning process of the ex-post survey data used for the final evaluation lead to an important reduction of the data provided.[17]

Question 7. Are technological innovations disseminated to other companies or sectors?

This point cannot be addressed directly from INE data. Other data from the project an ex-post surveys of CDTI have been used.

INDICATOR I24: COMPANIES THAT DISSEMINATE TECHNOLOGICAL INNOVATION TO OTHER COMPANIES

The starting point is that very few companies license their technology to third parties -12 companies out of 1177 (1.02%)-. This percentage is somewhat higher in the case of companies which claim to have had commercial success with the project, even so, the impact of the subsidies on the propensity to license technology is very low. The existence of differences based on types of sectors has been analysed, resulting in very low absolute values, so it is concluded that the differences lack statistical significance[18].

The results of the qualitative analysis converge with those obtained in the mid-term evaluation: the beneficiary companies tend not to use formal mechanisms for dissemination of knowledge (sale of licenses, etc.). As one of beneficiary companies explained, "*we do not commercialize our know-how, it remains in the company. Only when a new production line is designed and must be implemented, the know-how is transferred to our partner companies, but in a way that allows you to protect your knowledge".*

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.

As a company belongs to Computer, electronic and optical products manufacturing sector (Challenges sector) states: "*We have participated in international missions (with The Spanish Institute for Foreign Trade) and attended trade fair or congress (e.g. Mobile Congress).*

[17] An important part of the cleaning process is due to missing information. See secton 5.1.2. This information could be completed with other sources of information, such as SABI, but this was out of the scope of this evaluation. A more detailed information on this issue has been facilitated to the CDTI.
[18] The table of the analysis performed is in Annex (Table A 12).

Likewise, with our international partners we participate in fairs focused on the field of artificial intelligence in Japan and China", and, "...we have attended international conferences held here in Spain and also in other parts of the world. Besides, we have been to the Iberoamerican Academy of Neuropediatrics that took place in Peru in October. We are going to be in an International Congress of Neuropediatrics and Neuropedagogy that will be held in San Diego next October, about the use of new technologies for diagnosis".

Furthermore, *as* a firm indicates: "*The results are shown on the project's website, and Electronics Department researchers attend international congresses (e.g. Germany), where new developments are usually disseminated. There is also a "newsletter" in the company, which is sent to clients to report progress and news. It is also usual to attend fairs regularly.", and, "…we have users who enter our platform every month and get to know us through our online content and the Google market place. In the last year, we got 100,000 new users".*

There are companies that carry out international publications, as a company notes*:" I think we have about 8 or 10 publications in specialist journals that have a great impact internationally".*

As stated by one Metal products manufacturing sector firm (Challenges sector) indicates: *"We organize events in collaboration with universities (e.g. the Polytechnic University of Madrid), in which companies from different sectors, both private and public, can attend.", and, "..we have agreements with Chinese companies with high technological component".* In the last case, the promotion of technological innovation and the effect of knowledge transfer also takes place "from-the bottom-up", from their suppliers.

On the other hand, no significant differences have been found on the basis of sector of activity, although the influence is greater in developed regions and small and medium companies.

Question 8. Do beneficiary companies consolidate partnerships thanks to the project?

INDICATOR I25: COMPANIES THAT CONSOLIDATE ALLIANCES

As we commented in the mid-term evaluation, PITEC data does not offer the possibility of analysing this point of "consolidation" of collaborations. Together to what has been shown in question 5, we add now the results of measuring the number of international cooperation carried out with companies not belonging to the group in which the firm is included (I25). It is a partial but interesting measure of the diversification of cooperation activities.

As in the mid-term evaluation we have found positive and significant results for beneficiary companies. Nevertheless, there are interesting differences by sector. Thus, the favourable situation for beneficiary companies is clearly shown in Traditional and Stationary sectors although it is no significant in Dynamic and Challenges. The projection indicates the probable continuation of the favourable behaviour of beneficiary companies in the remaining years of the projects.

Consistent with the quantitative analysis, **the qualitative analysis confirms the findings obtained in the mid-term evaluation.** In this sense, some companies have consolidated previously existing partnerships: *"Alliances have been consolidated, mainly with research centres and with suppliers from the Basque Country who end up being partners",* and, *"…we have strengthened the relationship with public centres. In general, CDTI aids catalyse collaboration with public and private research organizations".*

In addition, others have consolidated new relationships: "*We have collaborated with a new sector, the cosmetic sector, and from there more collaborations will emerge in the future. We have also worked with the Tecnalia Foundation and with which we can collaborate on other projects, as well as with some cosmetic institutes that have helped us in some market studies".*

Lastly, no significant differences have been found concerning sector of activity. However, the influence is greater in developed regions and small companies.

6.3.2.2 Alternative sources of funding

Question 9. Do beneficiary companies find alternative sources of funding?

INDICATOR I26: COMPANIES THAT FIND ALTERNATIVE SOURCES OF FUNDING

All indicators used for this question confirm beneficiary companies find more and more diversified alternative financial sources. Two complementary indicators measure both the number and percentage of alternative financial sources (I26). In both cases our **final results confirm what was shown in the mid-term evaluation in the sense that beneficiary companies do have more and more important alternative sources.** This is confirmed for the starting year of the period under consideration, along the period and, more importantly, dif-dif analysis we can assert there exist a superior behaviour of beneficiary companies in order to find alternative financial resource. The participation in the CDTI Programmes implies an interesting point in this regard. Moreover, the breakdown by sectors show the positive association is present in three of the four types of sectors: Traditional, Dynamic and Stationary. It is just for Challenges that we find a worse behaviour of beneficiary companies in comparison with non-beneficiary companies. The results of the projections indicate the better performance of beneficiary companies will continue till the end of the projects in 2017-2018.

Another indicator captures the diversity of alternative funding sources. Here we find **results which modify what was obtained in the Mid-term evaluation in the sense that in this Final Evaluation is much clear the better performance of beneficiary companies in order to obtain more diverse financial resources.** These positive results for beneficiary companies are particularly true in the analysis along the period and, above all, in the dif-dif exercise. Furthermore, this positive behaviour is confirmed for all types of sectors. Even the projection predicts the results for more recent years will confirm the superiority of beneficiary companies at the time to obtain a more differentiate range of financial resources.

The qualitative analysis confirms the results obtained by the beneficiary companies in relation to find alternative financial resource. A firm points out: "*Yes, in fact the most interesting instrument is the tax deduction, which is automatic. Our projects have made it easier for us to join a public-private financing platform", and, "…having a project supported by the CDTI allows us to tackle other lines with greater efficiency, such as the tax deduction part. It has also allowed us to learn about other public funding calls, both at the national and international level".*

In fact, the firms could obtain private funding, too. As a company affirms*: "All the funding we have got has been public aid, although we have conversations with a possible private and national investor".*

Non-beneficiary companies have more problems accessing alternative financial sources, but they positively value the possibilities of CDTI aid. As mentioned by one of them: *"It improves*

the financial reputation of your company and gives us a greater projection both nationally and internationally".

Finally, no significant differences have been found on the basis of sector of activity, although the influence is greater in developed regions and small and medium companies.

Multi-instrument nature qualitative results

The heterogeneity between the different financial instruments used by CDTI is analysed through the qualitative analysis carried out by the working groups and interviews.

As already explained above, companies can access CDTI aids on equal terms through a fair and transparent process. However, while several companies tend to prefer subsidies, in some cases they would value the complementary nature of both instruments if the non-reimbursable tranche were increased and the demands for guarantees were eliminated.

In general terms, the objectives of the different financial instruments have been successfully achieved for all of them. Despite of it, it is necessary to take into account that some of them are transversal objectives without having detailed and proper specifications for each instrument.

Direct impact

In general, the input additionality tends to be higher in the case of partially reimbursable loans (PID, CIEN) and ERDF-INNTERCONECTA (subsidies) than in the case of other subsidies (Innoglobal, Eranet y Eurostars-2), mainly because PID, CIEN and ERDF-INNTERCONECTA are projects that are further from the market and need a greater contribution of human and financial resources to carry them out. Nevertheless, in many cases it is also an impulse to increase resources and capacities for companies that have obtained ERANET, Eurostars-2 or Innoglobal subsidies.

As stated by a firm with ERDF-INNTERCONECTA subsidies: "*When we started the project, we were a company that collaborated with two partners. From there, we doubled the workforce and now carry out our own R&D and technology projects. Likewise, our financial capacity increased considerably. CDTI aid has had a very relevant impact for us".* And, as a firm with ERANET aids points out: "*When the project arrived in 2017, we were around 4 employees and now we are 20 people. It has certainly contributed to the growth of the company".*

On the other hand, we have not found significant differences in technological results, although there is a greater emphasis on economic results in PID, CIEN and ERDF-INNTERCONECTA. Perhaps, it is due to commercialization is an aspect that becomes more important among the objectives of these instruments.

As mentioned by a firm: *"These projects are clearly focused on the market. Within our sector, process improvement and research focused on facing new challenges such as climate change are quite common. In our case, thanks to this project we opened a research line and obtained a direct impact on applications in various existing products".*

In addition, a company affirms*: "In our case, internally, we do not develop projects that do not have a commercial focus. I think that CDTI is giving more and more prominence to commercialization. Thus, as a result of the R&D project, new ideas have been generated to*

apply it to other vehicle components, a line of development that will have future applications in the automotive sector".

Besides: *"The development and production of microorganisms is one of our main pillars. These projects allow us to tackle situations that are important to our clients, since in the wine sector there are not as many collaborations. This has been very fruitful for our company, because the results of this project allowed us to accelerate the commercialization processes".*

Likewise, the international requirement in ERANET, Eurostars-2 and INNOGLOBAL projects implies a greater international market penetration of companies that obtain this kind of aid.

For example: *"We already have an international presence. However, it is still positive that thanks to national funds we can promote our services. The project was a success story in Spain, and we were even able to offer it in the US and Europe. Thanks to these aids and based on these results, the company expanded more internationally".*

As a firm points out: *"Our company is international, it has not directly contributed to increasing our sales. It has influenced to establish a network of international contacts that allows us to have partners around Europe who contribute to our development".*

On the other hand, there is a greater behavioural additionality in companies that have received funding from the CIEN and ERDF-INNTERCONECTA programs, probably due to a greater complexity of the projects developed under these modalities (minimum budgetary amount, human and financial resources, advanced R&D structures and units, substantial collaboration requirements with research organizations and companies, etc.) y and consequently this has a greater impact on these companies.

In fact: *"When you have a strategy focused on promoting operational changes, it is when you participate in this type of programs. In this sense, developing R&D projects requires having a very professional team and adequate infrastructure".*

In contrast, as a firm with Eurostars-2 aids states: *"In our case, we have not had to change the working method on R&D projects. In almost all projects we work the same way".*

Indirect impact

The results of the PID, CIEN and ERDF-INNTERCONECTA projects have greater dissemination capacity than the rest of projects. This fact is influenced because a part of the funding may come from ERDF funds, partially (PID and CIEN) or in the wholeness (ERDF-INNTERCONECTA), where there are several communication and dissemination obligations of the results obtained.

In this way: "*We have taken advantage of the prestige of participating in the CIEN project for the dissemination of our results. The consortium itself was very enriching because we have used and shared knowledge among all".* And*: "In our case it was crucial, he even promoted the creation of a new company in which 10 people now work, focused on R&D and which has invoiced a total of € 400,000 the last year".*

Moreover, *"CDTI selected us as the best communication practice. A specific event was organized to disseminate the results with great multisectoral attendance".*

Once again, in coherence with the greater degree of collaboration in complex projects derived from the CIEN and FEDER INNTERCONECTA programs, the companies that obtain these aids consolidate alliances and collaborations more frequently.

As stated by a company*: "In our case, it is one of the most interesting aspects of participating in this project. In the wine sector, these initiatives promote the collaboration among wine cellars, and this allows you to establish a much more direct and lasting relationship at the level of innovation. Several future collaborations have emerged thanks to this project*". And, "*We have had a working relationship with technology centres on a regular basis. This type of project helps to give continuity to that collaboration".*

However, in ERANET and INNOGLOBAL there are several companies that have consolidated long-term alliances and collaborations. As some firms point out: *"We had partners in Turkey, Sweden, etc. The years of project duration allowed for new collaborations with the participants. The long-term impact of the collaboration is very positive. Besides, much knowledge is shared".*

In addition: "*For us it meant collaborating with universities in the Netherlands, Sweden and Switzerland. We understand that without these aids we would not have been able to have access to these partners, even for future collaborations and to have a broader network of contacts".*

Furthermore, companies participating in CIEN, ERANET and Eurostars-2 projects have more access to other sources of funding. It is likely that the reason for this is due to the greater prestige and international impact of the projects, which gives them greater visibility and a better image.

As a firm with CIEN aid indicates: "*When we present new consortium projects both nationally and internationally, the fact of having participated in these projects is an important guarantee and improves our image*", and, "*…it is a prestigious point that contributes when applying for aid. We usually apply for European Investment Bank funding on a recurring basis and one of the evaluation points is the number of innovation projects carried out".*

Finally: "*Yes, we have obtained both public and private funding thanks to ERANET. In addition, it has allowed us to obtain private investment in the medium term*", and, "*…Eurostars-2 has provided both public (H2020) and private financing".*

6.3.2.3 Distorting effect on the market

Question 10. Does the CDTI's support have any distorting effect on the market?

There is not quantitative information for this question, it has to be answered just with qualitative information.

After the qualitative analysis, **in line with mid-term evaluation, it can be said 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. In particular, the following general conclusions are extracted for the set of beneficiary companies:

1. 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. There are no significant differences between beneficiary and non-beneficiary companies. As stated by the companies:

"It is a very open market, globally. It is quite atomized. There are 2 or 3 big companies and a multitude of small companies".

"We compete with large companies such as Google and Amazon, which we try not to be our competitors but our clients".

"The competition in product differentiation is quite exhaustive. Our company is a large company and competes both with small and medium companies"

"Therefore, being a mature market, there are quite large companies. We are a medium-sized company that competes internationally with differentiated products, where there are also small and medium-sized companies".

2. 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:

As mentioned by a beneficiary firm: "*Both the generic and non-prescription pharmacy products market is very competitive, there are many companies and many products", and, "…the international component is essential, the scope falls if we limit ourselves at the regional level. Now there is much more competition, more companies operating within this sector of herbal medicine or special food".*

"What allows the market to choose for one competitor or another is the R&D component. It is the competitive variable to differentiate itself from the rest. Most of the competitors are at the international level. Two thirds of the United States and a third of Europe are in eastern Europe, in England, France, Portugal and Spain".

"It is usually a sector where the product innovation is a key feature, where if you do not innovate you die".

Although non-beneficiary companies also compete internationally, their competition is more often concentrated at the national level.

3. 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. As a company affirms:

"CDTI aid does not impose barriers to entry. On the contrary, it promotes that the markets are more competitive by providing financial resources to small and medium-sized companies to develop R&D projects and thus compete in better conditions with large companies".

In fact, in many cases non-beneficiary companies need CDTI aid to compete successfully: *"The truth is that it is more difficult for us to compete, because we could not develop the project or the technology and so we had to finally buy it. Therefore, we have not been able to open that business line and that places us at a disadvantage".*

4. 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. As pointed out by the companies:

"It is a market that is evolving quite a bit, especially due to the growth in consumer demands. We operate in the environmental sector and we are the only Spanish company that competes with German, Italian and Dutch companies".

"When we started there were only about 20 companies and now there are about 200. It is growing at a very high rate. It is a very dynamic market, where technology changes a lot. The market is growing because every time there are new products".

"The telecommunications market has grown a lot but is now stable and even slowly declining. It does not grow steadily. For this reason, we are developing a platform to access other market niches such as electricity, which is a smaller market but grows faster".

5. Positive impacts for society in different areas. CDTI aids have had beneficial effects for society in different fields:

- Emission reduction, renewable energy and energy efficiency. As mentioned by several companies:

"The energy used is much cleaner than other methods that can make use of fossil fuels. There is a positive effect at the environmental level in terms of a lesser amount of gas emissions".

"Our production of biodegradable packaging has a great impact on the circular economy and the environment"

"One of the reasons to carry out the R&D project was the optimization of the use of salt and other materials on roads, which has a great deal environmental benefit"

"It is a system that allows you greater energy efficiency. It is in line with sustainability in buildings".

- Improvement of public health and combating diseases. As pointed out by quite a few companies:

"The nutritional level of the product is improved in order to develop the compounds known to be more beneficial to health".

"We are eradicating a carcinogenic product in food".

"It is a generic medicine for diabetes and that allows greater accessibility to medicines, that is to say, treating a greater number of patients with the same budget and, on the other hand, contributes to the sustainability of the country's health system".

- Increase of professional retraining and vocational training:

"Thanks to this project everyone will be part of the 'cloud revolution'. Workers can easily learn to use cloud systems and create intelligence without having to know how to code or program. We are approaching to basic users to empower them so that they don't run out of work in the future".

- Fight against social exclusion and facilities for disadvantaged groups. As stated by a firm:

"Thanks to the CDTI aid, we developed a project to manufacture wheelchairs adapted for sports such as basketball. We organised a game in Madrid, in the Paseo del Prado, and I

was very exciting to see how there were a lot of people playing thanks to the wheelchairs, with or without disabilities, but showing that these wheelchairs allow people who need them to live a normal life".

"It breaks the traditional idea of autism, reduces costs and time. We could have children diagnosed very early, treating brain plasticity, which is when the brain is more likely to change how it performs at the functional level (this is usually up to 7 years old). Thus, they could be given all the necessary intervention."

6. 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:

"On the contrary, a drag effect is created that benefits the other companies (knowledge, competitive pressure, aid search, etc.). It motivates other companies to tackle new projects".

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

Many of the calls of the programmes are open all year round, allowing eligible companies to access at any time.

As firmed stated:

"We believe that CDTI allows equal access and it is a transparent process. Different companies have different capacities. As far as I know, for small companies you have a much greater incentive than for a large company".

8. 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.[19]

6.3.3 Proportionality and suitability

As in the case of the indicators relating to the dissemination of knowledge, proportionality and suitability of the subsidies, these cannot be assessed directly using the PITEC database, either because they do not directly exist or because they could not be offered by the INE on the grounds of statistical confidentiality. In these cases, the results used are those obtained from the CDTI surveys. In this point nuances explained apply as well.

[19] Noted that the location is only conditional on ERDF INNTERCONECTA due to the requirement of developing projects in a certain ERDF region.

Question 11. Is there a positive, linear and significant relationship between financial support and the additional effect of the subsidies?

INDICATOR I27 ON PROPORTIONALITY: CORRELATION BETWEEN PUBLIC FUNDING AND THE ADDITIONALITY INDICATORS

It is not possible to provide a strict answer to this question using the PITEC data. As mentioned in section 5.1.2, some of the results of the ex post Survey of the CDTI have been used (this data includes only IDI projects due to data availability). Table 18 reflects the results of the estimates relating to the effect of the most significant variables on the evolution of about 12 different types of outcomes displayed in the rows of Table 17 and Table 18. These include the results relating to the independent variables: percentage of the contribution of the CDTI to the projects' budget (contribution), percentage of the non-reimbursable share of funds granted, volume of the budget and size of the companies. In addition, we have used the estimates corresponding to the companies in the PID programme since, despite being practically identical to those obtained using the estimating models with all companies in all programmes, they reflect the results sought in a clearer manner.

The sector control is incorporated through the inclusion of the sectoral categories prepared by the research team and outlined above (in the form of *Dummy* variables) in relation to a base sector which in this case is defined as "traditional". In this way, the significant positive results (marked in green), denote that the companies in the sector in question confirm they have seen better results in the variables mentioned in comparison to what is generally seen in the sector. The opposite occurs if the result is significant, but with a negative sign and marked in red. When there is not any significant result, the word NO appears in yellow.

Regarding to the variables that measure the proportionality of the subsidies in a more direct manner - the percentages of subsidies in relation to the budget, non-reimbursable tranche- we obtain the following results, according to the project survey (or Final Project survey):

- A high contribution appears to be positively related to the indicators of commercial activity (except for international markets) and with the R&D effort (expenditure and staff). Little or null significant effects have appeared regarding important issues such as productivity, technological leadership, patents or the acquisition of new knowledge. Moreover, the comparison of final project and ex post surveys indicates some of the expected results expressed in the project survey (at the end of the project) are nor confirmed by the ex-post information survey. It is particularly the case for commercial activity. Some positive effect is confirmed for R&D personnel and patents, that is for technological results. While for economic impact the incidence is scarce or null.
- A greater proportion of the non-reimbursable tranche does not reflect any positive effect on the variables. There is a predominance of cases where there are no significant differences and two commercial type variables, especially international, where the impact is significant but negative. Again, ex-post results are below the expectations showed in the final project survey. To this regard, it should be borne in mind that the greater non-reimbursable tranches correspond to conditions that are less favourable for the projects.

With regard to the size of the project budget and the size of the companies, the results can be summarised as follows:

- The increase in the budget -associated to large-scale projects- has significant positive effects on commercial aspects, especially in international markets, on human and economic resources devoted to R&D and on an increase in technological leadership. As in other cases ex-post results do not confirm that association in commercial aspects; Again, the clearest impact arises when examining technological inputs or outputs, and not for economic results.
- In the case of the size of the companies, there is a prevalence of cases in which there are either no significant results or in which these results are negative. The impact of the company size is particularly evident in the case of the R&D resources: larger companies state they have better results in this aspect[20].

Lastly, pending comments are the differences due to the type of sector in which the companies operate. The most notable aspects are the following:

- Companies belonging to the group of Dynamic sectors expected better results in relation to the financial resources dedicated to R&D and in a number of commercial indicators. However, ex-post survey does not confirm it.
- Companies within the Specialised Stationary group of sectors record worse behaviour in regarding the percentage of sales and exports due to the project and also in relation to any increases in technological leadership. The most positive finding is related to the access to new knowledge, where the results are over the average.
- The results obtained by the companies included in the category of Challenge sectors are better in terms of increased market share in international markets, an increase in access to new knowledge and for the augmentation of technological assets. Once again ex-post results are less clear, and it is just for the access to new knowledge and in a lesser extend for increasing international markets share.
- Construction companies show worse results in many aspects, except for in the case of access to new knowledge and patents.

[20] Results of the estimates are available in a separate document that contains all the evaluation results obtained through Stata. This document is overly extensive to be annexed to this Final evaluation report, but it can be requested to the CDTI.

Table 17: Results with contribution, non-reimbursable contribution, budget, size and sector. Ex-post survey

Results variables	Contribution (%)	Non-refundable share (%)	Budget	Size	Type of sector (only if relevant)
Increased market share	(+)	(-)	(+)	**Turnover (-)(*)**	**Construction (-) (***)**
Increased domestic market share	(+)	(-)	(+)	F(-) E(+)	**Construction (-) (**)**
Increased international market share	(-)	(-)	(+)	**Turnover (-)(*)**	**Challenge (+) (*)**
				E(+)	**Construction (-) (***)**
% of sales due to the project	(+)	(+)	(-)	F(-)	**Stationary (-) (***)**
				E(-)	**Construction (-) (***)**
% of exports due to the project	(+)	(+)	(-)	F(-)	**Stationary (-) (**)**
				E(-)	**Construction (-) (**)**
Increased labour productivity	**YES (-) (**)**	(-)	(+)	**Turnover (+) (***)**	**Dynamic (-) (***)**
					Stationary (-) (***)
				Employment (-) (***)	**Challenge (-) (***)**
					Construction (-) (*)
Increased technological leadership	(-)	(-)	**YES (+) (*)**	F(-) E(+)	**Stationary (-) (***)**
Increased access to new knowledge	(-)	(+)	(+)	F(+) E(+)	**Stationary (+) (**)**
					Challenge (+) (***)
					Construction (+) (***)
Patents	**YES (+) (**)**	(-)	**YES (+) (***)**	F(+) E(+)	**Construction (+) (*)**
Increased R&D personnel	**YES (+) (***)**	(-)	**YES (+) (***)**	**Employment (-) (*)**	**Stationary (-) (**)**
Increased R&D expenditure	(+)	(-)	**YES (+) (***)**	**Employment (+) (***)**	NO

In green the positive and significant results; in orange the negative and significant results; in yellow the non-significant results. *** p<0.01; ** p<0.05; * p<0.1

Source: Own compilation based on the CDTI Survey data (Project survey Beneficiary companies, 2015-2018).

Table 18: Results with contribution, non-reimbursable contribution, budget, size and sector. Project survey

Results variables	Contribution (%)	Non-refundable share (%)	Budget	Size	Type of sector (only if relevant)
Increased domestic market share	(+)	(-)	(+)	**Employment (-)(**)**	NO
Increased international market share	(-)	(-)	(+)	F(-) E(-)	NO
% of sales due to the project	**YES (+) (***)**	(+)	**YES (+) (***)**	**Employment (-) (*)**	**Stationary (-) (***)**
% of sales due to the project (t+2)	**YES (+) (*)**	(+)	**YES (+) (***)**	**Employment (-)(***)**	**Stationary (-) (***)**
% exports due to the project	(+)	**YES (+) (*)**	(+)	F(-) E(+)	**Dynamic (+) (**)**
% exports due to the project (t+2)	**YES (+) (*)**	(+)	(+)	F(-) E(+)	**Dynamic (+) (***)** **Challenge (+) (*)**
Increased labour productivity	**YES (-) (***)**	(-)	**YES (+) (*)**	**Turnover (+) (***)** **Employment (-) (***)**	**Dynamic (-) (**)**
Patents	(-)	**YES (-) (***)**	**YES (+) (**)**	F(-) E(+)	**Challenge (+) (**)**
Increase in R&D personnel	**YES (+) (***)**	(+)	**YES (+) (***)**	**Employment (-)(**)**	**Stationary (-) (***)** **Challenge (+) (**)**
Increase in R&D expenditure	(-)	**YES (+) (***)**	**YES (+) (***)**	**Employment (+) (***)**	**Dynamic (+) (**)**

In green the positive and significant results; in orange the negative and significant results; in yellow the non-significant results. *** p<0.01; ** p<0.05; * p<0.1

Note: t = expected year of commercialisations; t+2 = 2 years after the year (t) in which the firms expects to have commercial results of the project granted

Source: Own compilation based on the CDTI Survey data (ex-post beneficiary companies, 2010-2016).

Question 12. Are the various financial instruments of the CDTI aid scheme suitable for each type of beneficiary and project?

INDICATOR I28 ON SUITABILITY: CORRELATION BETWEEN PUBLIC AID AND THE ADDITIONALITY INDICATORS FOR EACH TYPE OF FUNDING

It is not possible to answer this question in a strict manner, since the PITEC data accessed does not provide data based on the types of instrument. Instead, an initial approach is carried out using the data sourced from the CDTI surveys, which reflects some data of interest such as the following (Table 19, Table 20).

The analysis performed includes the ID (individual PID), CID (in cooperation PID), CIEN, CDTI-Eurostars-2, INNOGLOBAL, ERDF-INNTERCONECTA and CDTI-Eranets of the FP survey, while for Ex-post one it is just possible to analyse ID and CID projects, due to the fact for the rest of instruments there are no projects that have so far reached the time in which the ex-post survey is sent (two years after the expected date of commercialization). The analysis has been carried out using Dummy variables for each of them, comparing them with the basic R&D instrument (ID). In this way, the results with a positive sign (marked in green in the table), means that the companies that have participated in the programme in question have had better results in the aspect measured by the variable indicated. By way of example, the significant and positive value of CIEN in relation to the increase in R&D personnel indicates that the companies benefiting from subsidies in this programme confirm they have obtained better results in regard to hiring of workers than those which have received subsidies from the ID programme. The opposite occurs in the case of companies with subsidies granted through the CDTI-Eurostars-2 programme in relation to the increase in labour productivity marked with a red sign. When there is no significant evidence one way or the other, the results appears in yellow.

Well, the results presented synthetically in the table, tell us that, in general, the positive effects have been originated through the ID programme subsidies. These are at a higher level than those resulting from the participation in other programmes. This is very clear on issues relating to the markets of all types and in relation to the increase in staff dedicated to R&D. The most notable exception is the effect of the ERDF-INNTERCONECTA subsidy programme on the subsequent increase of commercial activities and R&D personnel.

Other exceptions are the effect of the CDTI-Eurostars-2 subsidy programme in relation to the increase in exports and R&D personnel. In this case, the beneficiary companies of these programmes claim to have had better results than the companies which have received subsidies under the main ID programme. There are no significant differences regarding the rest of variables and programmes.

The more reduce information of the Ex-post survey confirm the better behaviour of ID programme with exception of productivity creasing where CID programme appears to have had better results.

Table 19: Results by type of instrument. Ex post survey

Results variables	CID vs ID
Increased market share	**YES (-) (***)**
Increased domestic market share	**YES (-) (***)**
Increased international market share	**YES (-) (***)**
% of sales due to the project	**YES (-) (***)**
% exports due to the project	**YES (-) (***)**
Increased labour productivity	**YES (+) (**)**
Increased technological leadership	**YES (-) (***)**
Increased access to new knowledge	(+)
Patents	
Increased R&D personnel	**YES (-) (***)**
Increased R&D expenditure	(+)

In green the positive and significant results; in orange the negative and significant results;
in yellow the non-significant results. *** p<0.01; ** p<0.05; * p<0.1

Source: Own compilation based on the CDTI survey data (Beneficiary companies Project survey, 2015-2018)

Table 20: Results by type of instrument. Project survey

Results variables	PID	CIEN	CDTI - Eurostars-2	Innoglobal	ERDF- Innterconecta	CDTI- Eranets
Increased domestic market share	**YES (-) (*)**	**YES (-) (**)**	(-)	(+)	**YES (+) (***)**	(+)
Increased international market share	**YES (-) (***)**	**YES (-) (***)**	(-)	(+)	(+)	(+)
% of sales due to the project	**YES (-) (**)**	**YES (-) (**)**	(-)	(-)	(+)	(+)
% of sales due to the project (t+2)	**YES (-) (***)**	**YES (-) (*)**	(+)	(-)	(+)	(+)
% exports due to the project	**YES (-) (**)**	(-)	(+)	(+)	(+)	(+)
% exports due to the project (t+2)	**YES (-) (**)**	(-)	**YES (+) (**)**	(+)	**YES (+) (**)**	(+)
Increased labour productivity	(+)	(-)	**YES (-) (***)**	**YES (-) (**)**	**YES (-) (**)**	(-)
Patents	**YES (-) (*)**	(-)	(+)	(+)	(+)	(+)
Increase in R&D personnel	(-)	**YES (+) (***)**	**YES (+) (**)**	**YES (+) (**)**	**YES (+) (***)**	(-)
Increase in R&D expenditure	(+)	(-)	(-)	(-)	(+)	(-)

In green the positive and significant results; in orange the negative and significant results;
in yellow the non-significant results. *** p<0.01; ** p<0.05; * p<0.1

Source: Own compilation based on the CDTI survey data (Beneficiary companies ex-post, 2010-2016)

According to the results using project survey information, it is clear that companies engaged in ID programme subsidies obtain better results than those engaged in the other programmes. Some nuances could be pointed out to this general behaviour. More importantly, we can mention increments on R&D personnel, which is high for firms benefiting from other programmes. In other two cases – CDTI-EUROSTARS-2 – and ERDF Innterconecta, show positive performances in relation to exports derived from CDTI aids. Ex-post data survey only include and, therefore, compare ID and CID programmes. Again, ID program aid presents better results in all the parameters except for productivity increments which is higher for CID programme aids.

In other words, positive results are found for the program that probably better represents the CDTI “core activity” in project number, funds and trajectory. On the other hand, 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.

Conclusions

7

As a general conclusion, it may be stated that, 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 former conclusions can be summarised, grouping them in five kinds of impact and other qualitative and strategic aspects.

> Input additionality

Generally speaking, we can corroborate the existence of positive inputs additionality, that is, CDTI firms do increase their resources devoted to innovation in a more intensive way that non CDTI companies. This is fully confirmed for R&D inputs, both economic and personnel inputs and both as the propensity (probability) of using them and for the intensity of that use.

The qualitative analysis strengthens, expands and complements the results obtained in the quantitative analysis. In this sense, 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, an important nuance arises when we compare other innovative inputs. Here the additionality cannot be confirmed.

> Technological output additionality

Things are less clear when we move to output consideration. Thus, for technological output a heterogeneous picture arises. Thus, some indicators seem to confirm the existence of this additionality, as it is the case of patent data. Nevertheless, even for patents, the situation is not homogeneous for all sectors; it is robustly corroborated for Traditional type of sectors.

For other indicators of innovation outputs, the additionality is far for being confirmed. So, both for products and process innovation the additionality in favour of CDTI firms cannot be

generally confirmed. The sectoral heterogeneity is a fundament aspect of these results. Thus, while the additionality can be confirmed for Dynamic sectors (those with technological advantages and a world positive evolution), it is not the case for other sectors, and even in firms operating in Stationary kind of sectors (see Table A 1) the situation is opposite: there exists a negative additionality. An important debate could be brought: many without doubting about the positive effect on Dynamic sectors (see Table A 1).

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.

On the other hand, the beneficiary companies tend to patent to a greater extent thanks to the CDTI aid. However, the companies have some obstacles and difficulties when patenting (economic costs, bureaucracy, likelihood of litigation, costs of litigation, software, etc.). For these reasons, they also use other means of protection for the industrial property (industrial secrecy, confidentiality agreements, etc.).

> Economic output additionality

As for technological outputs, in this case it is not possible to achieve a single homogeneous result. In most of the cases, (i.e. sales from new products, productivity, and material goods investments) the results do not cast statistical findings to corroborate the existence of additionality. It is just for projections in exports and international markets that we can see some positive signals

Although some beneficiary companies interviewed obtain positive results on some economic output variables (sales from new products, expansion into new markets or customers, new commercialization strategies, exports, investment in material goods, etc.), in general, these companies do not assign a clear relationship of cause and effect with the CDTI funding.

> Strategies and operational behaviour

We can observe some positive elements of the CDTI´s firms conduct. It is clearly the case of cooperation to innovate where CDTI´s firms have improved more than the rest, mainly as far as cooperation with public bodies is concerned.

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: 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**

The beneficiary companies tend not to use formal mechanisms for the 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.).

Additionally, it can be said that the CDTI funding, during the period considered, does 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. 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 on society in different fields:
  - Emission reduction, thanks to encouraging the use of renewable energy and fostering energy efficiency.
  - Improvement of public health and combating deseasesIncrease 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 on 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.[21]

> Proportionality and suitability

The main findings concerning the **proportionality of the aid** are summarised as follows. The percentage of CDTI aid contribution is positively related to the indicators of commercial activity (i.e. the percentage of sales due to the project) 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, as a larger non-reimbursable tranche usually also corresponds to projects with a higher risk.

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

[21] Noted that the location is only conditional on ERDF INNTERCONECTA due to the requirement of developing projects in a certain ERDF region.

Regarding the **suitability of the aid**, positive results are found mainly for ID programme. The data shows that instruments that seek to achieve specific objectives, 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.

> Overall conclusions

In any case, although the funding shows a positive impact in indicators related to the input additionality, the results obtained have room for improvement in several 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.

The fact that no signs of distortion of competition of the funding have been found, does not mean that the CDTI does not need to be alert and implement prevention measures and mechanisms with the aim of monitoring the funding granted.

Anyway, it is not to avoid intervening in the market, but to do so to compensate for market failures (positive externalities, imperfect and unbalanced information) and coordination failures and existing network[22] 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.

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

Recommendations to users of the evaluation

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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 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 channels 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 (policy maker) and not just a mere implementer of programs.

> National policy-makers

Therefore, it is necessary to define a joint strategy with national policy-makers in order to obtain and value the data. 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 (CDTI) 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. 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, their different characteristics and needs. 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 there are sometimes 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.

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Annex

10

Table A 1: Sectoral correspondence between reduced taxonomy, CNAE 2009 and PITEC sectors

REDUCED TAXONOMY		CNAE 2009	ACTIN (PITEC)
1	TRADITIONAL	• Agricultura, livestock, forestry and fishing (01, 02, 03). • Extractive industries (05, 06, 07, 08, 09). • Manufacture of wood and of products of wood and cork, except furniture; basketmaking and wickerwork (16). • Manufacture of other non-metallic mineral products (23). • Shipbuilding (301). • Electricity, gas, steam and air conditioning supply (35). • Water supply, sewage, waste management and remediation activities (36, 37, 38, 39). • Wholesale and retail trade; repair of motor vehicles and motorcycles (45, 46, 47). • Transportation and storage (49, 50, 51, 52, 53). • Hostelry (55, 56). • Information and communications (58, 59, 60, 63). • Financial and insurance activities (64, 65, 66). • Real estate activities (68). • Administrative and support service activities (77, 78, 79, 80, 81, 82). • Education (85). • Human health and social work activities (86, 87, 88). • Arts, entertainment and recreation activities (90, 91, 92, 93). • Repair of computers and personal and household good (95). • Other personal services (96).	00,01,07,13,20,26,27,29,30, 31,34,35,36,39,40,41,42,43
2	DYNAMIC	• Textile industry (13). • Leather and footwear industry (15). • Metallurgy; manufacture of iron, steel and ferro-alloy products (24). • Manufacture of electrical material and equipment (27). • Manufacture of machinery and equipment n.e.c. (28). • Manufacture of air and spacecraft and related machinery (303). • Telecommunications (61). • Computer programming, consultancy and other activities related to IT (62). • Professional, scientific and technical activities (69, 70, 71, 72, 73, 74, 75).	04,06,14,17,18,21,32,33,37, 38
3	STATIONARY	• Food industry (10). • Manufacture of beverages (11). • Tobacco industry (12). • Paper industry (17). • Graphic arts and reproduction of recorded media (18). • Manufacture of coke and refined petroleum products (19). • Chemical industry (20). • Manufacture of pharmaceutical products (21). • Manufacture of rubber and plastic products (22).	02,03,08,09,10,11,12
4	CHALLENGES	• Manufacture of garments (14). • Manufacture of fabricated metal products, except machinery and equipment (25). • Manufacture of computer, electronic and optical products. • Manufacture of motor vehicles, trailers and semi-trailers. • Railway equipment (302). • Manufacture of military fighting vehicles (304). • Manufacture of other transport equipment (309). • Manufacture of furniture (31). • Other manufacturing industries (32). • Repair and installation of machinery and equipment (33).	05,15,16,19,22,23,24,25
5	CONSTRUCTION	• Construction industry (41, 42, 43).	28

Source: Own compilation

Table A 2: Balancing test. Mean differences (Mid-term evaluation matched sample)

		Mean				T-Test		
Variable	Unmatched Matched	Treated	Control	% bias	%Reduction bias	t	p>|t|	V(T)/V(C))
Mid-Term evaluation sample								
ltamano	U	4.43	4.00	26		7.59	0.000	0.64*
	M	4.43	4.58	-9.7	62.8	-2.36	0.018	1.03
lcifra	U	16.51	15.64	42.3		12.65	0.000	0.72*
	M	16.51	16.81	-14.8	65	-3.48	0.001	1.03
edad	U	30.17	28.73	7.1		2.2	0.028	0.82*
	M	30.17	30.24	-0.4	94.8	-0.09	0.93	1.39*
grupo	U	0.48	0.41	13.3		4.31	0.000	.
	M	0.48	0.51	-6.3	53	-1.33	0.184	.
dinamico	U	0.42	0.28	29.6		9.96	0.000	.
	M	0.42	0.36	11.3	61.6	2.34	0.019	.
estacionario	U	0.30	0.18	29.4		10.38	0.000	.
	M	0.30	0.37	-14.4	51	-2.79	0.005	.
reto	U	0.17	0.16	1.1		0.35	0.724	.
	M	0.17	0.19	-5.1	-362.8	-1.06	0.29	.
idcont	U	0.67	0.28	85.2		28.11	0.000	.
	M	0.67	0.68	-3.8	95.5	-0.81	0.42	.
destec	U	46.06	18.39	70.1		24.98	0.000	1.49*
	M	46.06	47.12	-2.7	96.2	-0.52	0.602	0.99
mdodom	U	2.34	2.74	-38.7		-11.91	0.000	0.82*
	M	2.34	2.38	-3.4	91.2	-0.76	0.445	0.98
fcinter	U	2.03	2.31	-26		-7.57	0.000	0.62*
	M	2.03	2.01	1.6	93.9	0.38	0.707	0.85*
fcexter	U	1.94	2.41	-43.2		-12.52	0	0.62*
	M	1.94	1.96	-1.2	97.1	-0.29	0.771	0.84*
extranjera	U	0.09	0.13	-12.5		-3.75	0	.
	M	0.09	0.11	-6	52	-1.34	0.179	.
lexportt_eu	U	15.55	14.48	46.7		12.6	0	0.86*
	M	15.55	15.60	-2.2	95.3	-0.46	0.649	0.96
pyme	U	0.78	0.79	-0.8		-0.26	0.794	.
	M	0.78	0.75	8.5	-954	1.78	0.075	.

* if variance ratio outside [0.89; 1.13] for U and [0.89; 1.13] for M

Source: Own compilation

Table A 3: Overall measures of covariate balancing (Mid-term evaluation matched sample)

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.106	723.50	0.00	31.5	29.4	101.2*	0.74	100
Matched	0.004	8.68	0.89	6.1	5.1	14.7	1.01	38

* if B>25%, R outside [0.5; 2]

Source: Own compilation

Table A 4: Balancing test. Mean differences (Prospective evaluation matched sample)

Variable	Unmatched Matched	Mean Treatment	Control	% bias	%Reduction bias	T-Test t	p>|t|	V(T)/V(C))
Prospective evaluation sample								
ltamano	U	4.42	4.00	27		9.83	0.000	0.62*
	M	4.46	4.39	5	81.6	1.59	0.111	0.75*
lcifra	U	16.52	15.64	44.5		16.54	0.000	0.60*
	M	16.69	16.64	2.6	94.1	0.82	0.41	0.71*
edad	U	33.27	29.15	20.2		8.09	0.000	1.09
	M	34.76	34.51	1.2	93.9	0.31	0.753	0.83
grupo	U	0.52	0.41	21.7		9.07	0.000	1
	M	0.53	0.52	2.1	90.4	0.53	0.595	0.98
tradicional	U	0.12	0.38	-63.4		-22.6	0.000	0.55*
	M	0.10	0.10	0.3	99.6	0.1	0.923	1.01
dinamico	U	0.39	0.28	25		10.81	0.000	1.09
	M	0.36	0.35	1.4	94.6	0.34	0.733	1.02
estacionario	U	0.30	0.18	28.7		13.02	0.000	1.18
	M	0.34	0.35	-3.3	88.6	-0.74	0.458	1.02
reto	U	0.19	0.16	6.3		2.67	0.008	0.99
	M	0.20	0.20	1.7	73.6	0.4	0.689	1.03
idcont	U	0.73	0.26	106.6		44.23	0.000	0.88
	M	0.74	0.69	12.4	88.3	3.13	0.002	0.81
infun	U	1.77	1.01	11.5		4.98	0.000	0.98
	M	1.73	1.59	2.1	81.6	0.52	0.603	0.99
destec	U	52.46	17.68	90.5		41.06	0.000	1.31*
	M	52.21	49.21	7.8	91.4	1.79	0.074	0.85
mdodom	U	2.49	2.75	-26.2		-10.25	0.000	0.79*
	M	2.46	2.42	4.5	82.7	1.24	0.215	0.96
fcinter	U	2.15	2.33	-17.4		-6.65	0.000	0.75*
	M	2.17	2.18	-1.5	91.2	-0.43	0.668	0.88
fcexter	U	2.07	2.45	-34.7		-13.15	0.000	0.70*
	M	2.10	2.16	-5.6	83.8	-1.56	0.118	0.79*
extranjera	U	0.11	0.13	-8.4		-3.33	0.001	0.71*
	M	0.12	0.13	-2.5	69.6	-0.64	0.523	0.96
lexportt_eu	U	15.58	14.47	50.7		17.22	0.000	0.66*
	M	15.58	15.47	5.2	89.8	1.42	0.155	0.81
pyme	U	0.82	0.79	9.5		3.82	0.000	1.04
	M	0.82	0.85	-6.1	35.5	-1.67	0.094	0.99

* if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2]
** if 'bad', i.e. variance ratio <0.5 or >2

Source: Own compilation

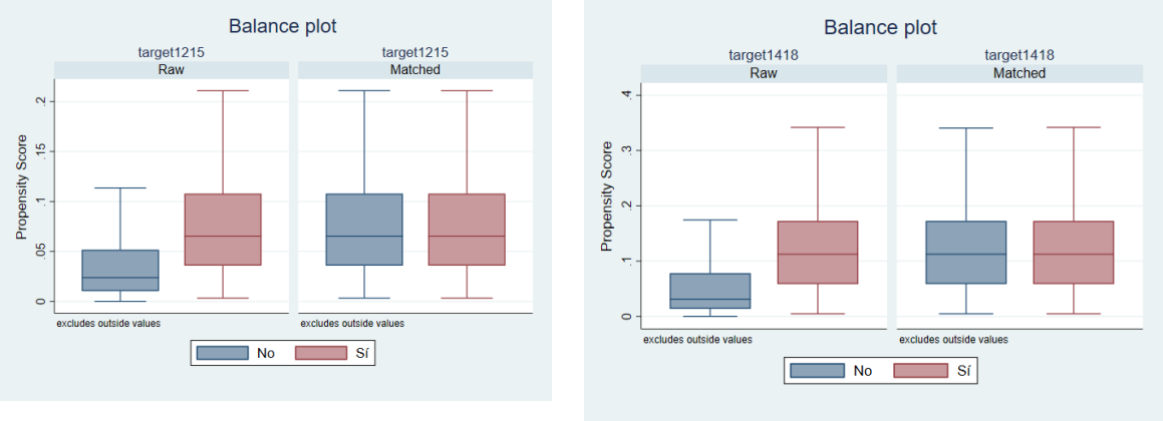
Table A 5: Overall measures of covariate balancing (Prospective evaluation matched sample)

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%concern	%bad
Unmatched	0.131	1.430.92	0.00	34.8	26.2	111.7*	0.68	53	0
Matched	0.006	22.73	0.12	3.8	2.6	18.6	0.93	18	0

* if B>25%, R outside [0.5; 2]

Source: Own compilation

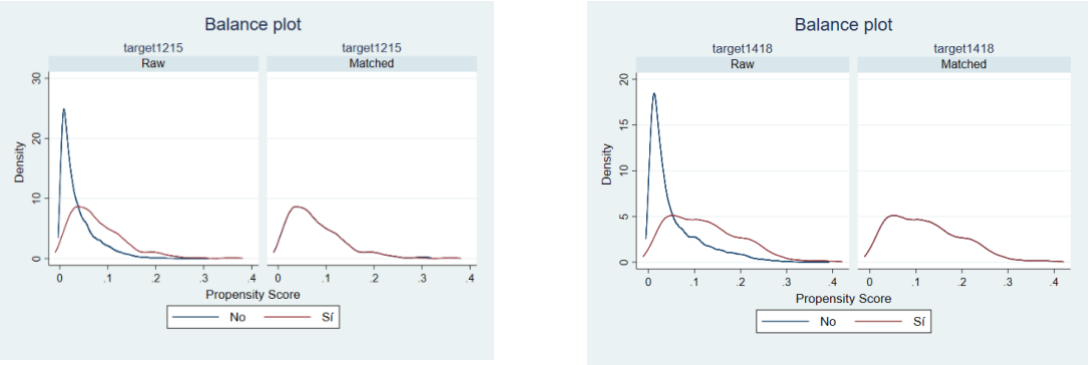
Figure A 1: Balance plot before and after matching propensity score (Mid-term (left) and prospective (right) evaluation matched sample)



Note: Outliers were excluded for anonymity reasons

Source: Own compilation

Figure A 2: Density plot before and after matching propensity score (Mid-term (left) and prospective (right) evaluation matched sample)



Source: Own compilation

Table A 6: Difference in difference results matched samples (DD-PSM): Mid-term, final, and prospective evaluation. Full list of Indicators and variables.

			MID-TERM EVALUATION TREATMENT - CONTROL			FINAL EVALUATION (2013-2016) TREATMENT - CONTROL						PROSPECTIVE EVALUATION (2017-2018) TREATMENT - CONTROL		
	Indicator I1: Companies that decide to invest in R&D		BASELINE	FOLLOW-UP	DIFF-DIFF	BASELINE	FOLLOW-UP	DIFF-DIFF	Robust	TAXONOMY	DIFF-DIFF	BASELINE	FOLLOW-UP	DIFF-DIFF
	1.a) idin:													
1	inndin	Performs R&D expenditure (external or internal)	(-)***	(+)***	(+)***	(+)***	(+)***	(+)***	R(***)			(+)***	(+)***	(+)***
2	innotro	Performs other innovation expenditure	(+)	(+)	(-)	(+)***	(+)***	(+)	R			(+)***	(+)	(-)***
3	idin	Internal R&D expenditure	(-)***	(+)***	(+)***	(+)***	(+)***	(+)***	R(***)	Traditional Dynamic Stationary Challenges	(+)*** (+)*** (+)*** (+)***	(+)***	(+)***	(+)***
4	idex	External R&D expenditure	(+)***	(+)***	(+)***	(+)***	(+)***	(-)	R			(+)***	(+)***	(-)**
5	maqui	Expenditure on acquisition of machinery, equipment and softw are	(+)*	(-)**	(-)***	(-)	(+)	(+)	R			(-)**	(-)	(+)
6	tecno	Expenditure on external know ledge acquisition	(+)**	(+)	(-)	(-)*R**	(-)	(+)**				(+)***	(-)	(-)**
7	prep	Preparatory expenditure for production/distribution	(-)**	(+)	(+)**	(+)***	(+)*R**	(+)				(+)***	(+)*	(-)
8	form	Training expenses	(+)	(+)*	(+)	(+)*R**	(+)***R	(+)***				(+)***	(+)	(-)
9	market	Expenditure for introduction of innovations	(+)	(+)	(-)	(+)***R	(+)**R*	(-)***				(+)***	(+)	(-)
	Effort in internal R&D expenditure (esfgintid and esfgintidtam)													
11	esfginnidtam	R&D expenditure (staff)	(-)**	(+)	(+)	(+)***	(+)***	(+)***	R(*)			(+)	(+)	(+)
13	esfginnotrotam	Other innovation expenses (staff)	(-)**	(-)	(+)	(+)*R**	(+)*R**	(-)*				(+)***	(-)	(-)**
16	esfgintidtam	Effort in internal R&D expenditure (staff)	(-)**	(-)	(+)	(+)***	(+)***	(+)***	R(**)	Traditional Dynamic Stationary Challenges	(+)*** (+)*** (+)*** (+)***	(+)* (+)*	(+)*** (+)***	(+)*** (+)***
20	esfgextidtam	Effort in external R&D expenditure (staff)	(-)	(+)*	(+)**	(+)	(+)	(+)	R			(-)	(-)	(-)
24	esfgmaquitam	Expenditure on acquisition of machinery, equipment and softw are (staff)	(-)	(-)	(+)	(+)*R**	(+)*R**	(-)*				(+)***	(-)	(-)***
28	esfgtecnotam	Effort on expenditure for external know ledge acquisition (staff)	(-)***	(-)	(+)*	(-)R**	(-)*R*	(+)				(-)***	(-)***	(-)
32	esfgpreptam	Effort in spending in preparation for prod./distribution (staff)	(-)	(-)	(-)	(+)	(+)	(+)	R			(+)**	(+)**	(+)
36	esfgformtam	Effort in training costs (staff)	(-)***	(+)**	(+)***	(+)R***	(+)**R*	(+)**				(-)	(+)	(+)
40	esfgmarkettam	Effort in expenditure for introducing innovations (staff)	(-)	(-)	(+)	(+)	(+)	(+)				(-)	(-)	(-)
	Indicator I2: Expenditure on innovation as a percentage of the turnover													
42	esfinn	Total effort in innovation (turnover)	(-)	(-)*	(-)	(+)	(+)R***	(+)**				(-)	(-)	(+)
44	esfinntam	Total effort in innovation (staff)	(-)**	(+)	(+)**	(+)***	(+)***	(+)	R	Traditional Dynamic Stationary Challenges	(+) (-) (+)*** (+)**	(+)	(+)	(-)

	Indicator I3: Companies that have created jobs in R&D																
46	creaempid	Has created jobs in R&D w ith respect to t-1	(-)	**(+)***	**(+)****	**(+)*****	**(+)*****	**(+)*****	**R(***)**	**Traditional** **Dynamic** **Stationary** **Challenges**	**(+)*** **(+)*** **(+)*** **(+)***	**(+)*****	**(+)*****	**(+)*****
47	creaempid_pc	Percentage of job creation in R&D	**(+)***	(+)	(-)	(-)	(+)	(+)	R			**(+)*****	(+)	(-)
	Indicator I4: Jobs created in R&D													
49	crecempid	Employment grow th in R&D (number of people)	(+)	(+)	(-)	**(+)R*****	(-)	**(-)****				(+)	**(+)***	(+)
50	esfcreaempid	Effort in job creation in R&D	(+)	(+)	(+)	(+)	**(-)R*****	**(-)*****				(-)	**(+)***	**(+)***
	Indicator I5: Companies that develop product innovations													
52	innprod	Product innovation from (t-2) to t	(-)	(-)	(-)	**(+)*****	**(+)*****	(+)	R	**Traditional** **Dynamic** **Stationary** **Challenges**	(-) **(+)*** **(-)*** (+)	**(+)*****	**(+)*****	(+)
	Indicator I6: Companies that develop process innovations													
53	innproc	Process innovation from (t-2) to t	(-)	**(+)*****	**(+)***	**(+)*****	**(+)*****	(+)	R	**Traditional** **Dynamic** **Stationary** **Challenges**	**(+)*** (-) (+) (-)	**(+)***	**(+)*****	**(+)*****
	Indicator I7: Companies that simultaneously develop process and product innovations													
54	innprodproc	Simultaneous product and process innovations from (t-2) to t	(+)	(+)	(+)	**(+)*****	**(+)*****	(+)	R			**(+)*****	**(+)*****	(+)
	Indicator I8: Companies that introduce new products on the market													
55	novedad	Introduction of new products on the market	(-)	(+)	(+)	**(+)*****	**(+)*****	(+)	R			**(+)*****	**(+)*****	(+)
56	novedemp	Introduction of new products only for the company	(+)	**(+)****	(+)	**(-)R****	(-)	(+)				**(-)*****	**(-)***	(+)
57	new mercifra	Novelty index for the market	(-)	(+)	(+)	(+)	(+)	(+)	R			**(+)*****	(+)	(-)
58	intnew mercifra	Intensive company novelty for the market	**(-)***	**(+)**	**(+)***	**(+)*****	**(+)*****	(-)	R			**(+)*****	**(+)*****	(+)
63	pat	Patent application	**(+)*****	**(+)*****	(-)	**(+)***R**	**(+)***R**	**(+)****		**Traditional** **Dynamic** **Stationary** **Challenges**	**(+)*** (+) (+) (+)	**(+)*****	**(+)*****	(-)
65	patnum	Number of patent applications	(-)	(+)	(+)	**(+)R*****	**(+)R****	(-)		**Traditional** **Dynamic** **Stationary** **Challenges**	**(+)*** **(+)**** **(-)**** (-)	**(+)***	(-)	**(-)****
67	esfpat	Effort in patent application	**(-)*****	(+)	**(+)****	**(-)****	(+)	**(+)****	**R(**)**			(+)	(+)	(-)
						(+)*R**	**(+)***R**	**(+)****				**(+)*****	**(+)*****	**(-)****
	Indicator I11: Companies that use other IPP													
70	ipp	Use of other IPP instruments	**(+)****	**(+)****	(+)	**(+)***R**	**(+)***R**	**(-)****				**(+)*****	**(+)*****	(-)
71	intipp	Intensive company IPP types used	**(-)*****	**(-)***	**(+)***	**(+)R*****	**(+)R****	(-)				**(+)*****	(+)	(-)
	Indicator I12: Number of other IPP used													
72	ippnum	No. (types) of IPP used	(-)	(+)	(+)	**(+)***R**	**(+)**R***	**(-)*****				**(+)*****	**(+)*****	**(-)***
74	esfipp	Effort in types of IPP used	**(-)****	(-)	(+)	(-)	**(+)R*****	**(+)*****				**(+)*****	(-)	**(-)*****

	Indicator I13: Turnover generated by new products for the market															
58	intnew mercifra	Intensive company novelty for the market	(-)*	(+)	(+)*	(+)***	(+)***	(-)	R			(+)***	(+)***	(+)		
62	intoldcifra	Intensive company resistance regarding innovation	(+)***	(+)	(-)	(+)	(+)***	(+)				(+)**	(+)*	(+)		
60	intnew empcifra	Intensive company novelty for the company	(-)	(+)***	(+)***	(+)***	(-)***	(-)***	R(**)			(+)*	(-)*	(-)**		
77	new mer	New products for the market (% figure)	(-)*	(-)	(+)	(+)***R	(+)***R	(+)*				(+)***	(+)***	(-)		
57	new mercifra	Novelty index for the market	(-)	(+)	(+)	(+)	(+)	(+)	R			(+)***	(+)	(-)		
78	new emp	New products for the company (% figure)	(-)	(+)**	(+)**	(+)***	(-)	(-)***	R(*)			(+)***	(-)	(-)*		
59	new empcifra	Novelty index for the company	(-)	(+)	(+)	(+)	(-)***	(-)***	R(**)			(+)	(-)	(-)		
79	old	Unaltered products (% figure)	(+)	(-)	(-)	(+)***R	(+)***R	(+)***				(+)***	(+)***	(+)		
80	oldcifra	Innovation resistance index	(+)***	(-)	(-)*	(-)**R*	(-)**R*	(+)	R			(-)**	(-)	(+)		
	Indicator I14: Annual growth in turnover															
81	intcreccifra	Intensive growth or annual sales figure	(-)*	(-)	(+)	(+)***	(-)	(-)***	R(*)			(+)	(-)	(-)		
82	creccifra	Annual growth rate sales figure	(-)	(+)	(+)	(+)	(+)	(+)	R			(-)	(-)	(+)		
	Indicator I15: Annual growth in labour productivity															
84	intcrecprodlab	Intensive in annual production growth, work apparent	(-)***	(-)	(+)	(+)R**	(+)	(-)				(-)	(-)	(+)		
85	crecprodlab	Annual production growth rate, work apparent	(-)	(+)*	(+)*	(-)	(-)	(+)	R			(-)	(-)	(-)		
	Indicator I16: Rate of growth for exports															
87	intcrecexport	Intensive in growth of annual exports	(-)***	(-)***	(-)	(+)	(-)	(-)	R			(-)**	(+)***	(+)***		
88	crecexport	Export growth rate	(-)	(+)	(+)	(-)	(-)R*	(-)				(-)***	(+)***	(+)***		
	Indicator I17: Annual growth of gross investment in material goods															
90	intcrecinver	Intensive in annual growth of material goods	(-)**	(-)***	(-)**	(-)	(-)	(+)	R			(-)	(-)	(-)		
91	crecinver	Rate of gross growth of investment in material goods	(+)***	(+)*	(-)**	(+)R***	(-)	(-)***				(+)	(-)	(-)*		
	Indicator I18: Companies entering international markets															
93	mdoext	Turns to international markets														
94	intcrecintracom	Intensive in annual growth of intra-community sales	(-)***	(-)***	(-)***	(-)R**	(-)R***	(-)				(+)	(+)***	(+)***		
95	crecintracom	Growth rate of intra-community sales	(-)	(+)	(+)	(-)	(-)	(-)				(-)***	(+)**	(+)***		
	Indicator I19: Companies that cooperate with research centres															
97	cooperacentro	Cooperates with research centres	(+)***	(+)***	(+)***	(+)***R	(+)***R	(+)***				(+)***	(+)***	(+)		
98	cooperacentroNAC	Cooperates with national research centres	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	R(**)			(+)***	(+)***	(+)		
99	coopcentro	Number of partnerships with research centres	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	R(**)	Traditional Dynamic Stationary Challenges	(+)*** (-) (+)*** (+)***	(+)***	(+)***	(+)***		
100	coopcentroNAC	Number of partnerships with national research centres	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	R(**)	Traditional Dynamic Stationary Challenges	(+)*** (+) (+)*** (+)***	(+)***	(+)***	(+)***		
	Indicator I20: Companies that cooperate with international partners (outside the group)															
101	cooperalNTnogr	Cooperates with international partners (not group)	(+)***	(+)***	(+)**	(-)	(+)R***	(+)**		Traditional Dynamic Stationary Challenges	(+) (+)** (+) (+)	(-)***	(-)	(+)		
	Indicator I21: Companies that introduce innovations working procedures															
102	inorgntrab	Inno org: work procedure or procedures (new business practice	(+)	(+)**	(+)	(+)**R*	(+)***R	(+)*				(+)**	(+)***	(+)*		

	Indicator I22: Companies that introduce innovations, management responsibility and decision making															
103	inorgnresp	Inno org: work places, distribution of responsibilities, decision making (new methods)	(+)	(+)	(+)	(+)***R	(+)**R*	(-)				(+)	(+)	(-)		
	Indicator I23: Companies that introduce innovations, management of external and institutional relations															
104	inorgnrel	Inno org: external relations (new methods for managing external relations)	(-)	(+)***	(+)***	(+)*R**	(+)***R	(+)***				(+)***	(+)***	(-)		
	Indicator I24: Companies that disseminate technological innovation to other companies															
	Not available in PITEC database															
	Indicator I25 diversity in the network of cooperation															
105	divcoopNAC	No. of national partnerships (excluding group)	(+)***	(+)***	(+)**	(+)***R	(+)***R	(+)***				(+)***	(+)***	(+)		
107	divcoopINT	No. of international partnerships Outside of the group	(-)*	(+)***	(+)***	(+)***	(+)***	(+)***	R(*)	**Traditional** **Dynamic** **Stationary** **Challenges**	(+)*** (+) (+)*** (+)	(+)***	(+)***	(+)***		
109	divcoopTOT	Total no. of partnerships (excluding group)	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	R(*)			(+)***	(+)***	(+)**		
111	esfdivcoopNAC	Diversity effort in national cooperation (turnover)	(+)	(+)	(-)	(-)	(+)*	(+)**				(-)	(-)	(-)		
113	esfdivcoopINT	Diversity effort in international cooperation (turnover)	(-)	(-)	(+)	(-)	(+)***	(+)***				(-)**	(+)	(+)**		
115	esfdivcoopTOT	Diversity effort in cooperation (turnover)	(-)	(+)	(+)	(-)	(+)***	(+)***				(-)	(+)	(+)		
	Indicator I26: Companies that find alternative sources of funding [to the company:f1 (own funds); the group: f2 (other group companies); and															
117	otrafina	Has obtained alternative financing	(+)***	(+)***	(+)*	(+)***R	(+)***R	(+)***		**Traditional** **Dynamic** **Stationary** **Challenges**	(+)*** (+)** (+)*** (-)**	(+)***	(+)***	(+)*		
118	otrafina_pc	Percentage of alternative financing	(+)	(+)	(+)	(-)R**	(+)***	(+)***	R(***)			(-)	(+)***	(+)***		
119	divotrafina	Diversity index alternative financing	(+)**	(+)	(-)	(+)	(+)***	(+)***	R(***)	**Traditional** **Dynamic** **Stationary** **Challenges**	(+)*** (+)** (+)*** (+)***	(+)	(+)***	(+)***		

Source: Own compilation

Table A 7: Variables considered for indicators 3 and 4 on the creation of jobs by beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

			CDTI		NO CDTI						Total	
			%	N	%	N		*Chi2*	*p*	*Cramér's V*	%	N
Indicator I3 companies that have created jobs in R&D												
46	creaempid	Has created jobs in R&D with respect to t-1	51.38	3,648	36.00	15,818	***	612.49	0.000	0.1096	38.14	19,466

			CDTI			NO CDTI						Total		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.	St. Dev	*t*	Mean	St. Dev.	N
47	creaempid_pc	Percentage of job creation in R&D	5.17	132.20	5,463	-3.62	115.41	13,293	-8.79	1.94	*** -4.5	-1.06	120.61	18,756
Indicator I4 jobs created in R&D														
49	crecempid	Employment growth in R&D (no. of people)	-0.20	21.62	7,383	-0.10	10.80	37,280	0.10	0.17	0.6	-0.12	13.21	44,663
50	esfcreaempid	Effort in job creation in R&D	0.00	0.05	7,379	-0.00	0.01	37,275	-0.00	0.00	*** -3.2	0.00	0.02	44,654

Note: * p<0.1, **p<0.05, *** p<0.01

Source: Own compilation

Table A 8: Variables considered for indicators 5-7 on product and process innovations and I8 on the introduction of new products on the market by beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

			CDTI		NO CDTI			*Chi2*	*p*	*Cramér's V*	Total	
			%	N	%	N					%	N
Indicator I5 companies that develop product innovations												
52	innprod	Product innovation from (t-2) to t	62.45	5,693	35.52	17,361	***	2300.00	0.000	0.2003	39.75	23,054
Indicator I6 companies that develop process innovations												
53	innproc	Process innovation from (t-2) to t	55.04	5,017	37.51	18,338	***	980.51	0.000	0.13	40.27	23,355
Indicator I7 companies that simultaneously develop process and product innovations												
54	innprodproc	Simultaneous product and process innovations from (t-2) to t	40.95	3,733	22.51	11,002	***	1400.00	0.000	0.1542	25.41	14,735
Indicator I8 companies that introduce new products on the market												
55	novelty	Introduction of new products on the market	62.64	3,566	53.6	9,305	***	142.11	0.000	0.0785	55.83	12,871
56	novedemp	Introduction of new products only for the company	75.50	4,298	76.69	13,314	*	3.38	0.066	-0.0121	76.39	17,612

			CDTI			NO CDTI						*t*	Total		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.				Mean	St. Dev.	N
57	newmercifra	Novelty index for the market	101.07	107.20	3,566	99.59	107.95	9,305	-1.48	2.12		-0.7	100.00	107.74	12,871
58	intnewmercifra	Novelty-intensive company for the market	0.13	0.34	9,116	0.07	0.25	48,882	-0.07	0	***	-22.5	0.08	0.27	57,998
59	newempcifra	Novelty index for the company	93.36	104.76	4,298	102.14	113.49	13,314	8.78	1.95	***	4.5	100.00	111.49	17,612
60	intnewempcifra	Novelty-intensive company for the company	0.14	0.34	9,116	0.09	0.29	48,882	-0.05	0	***	-13.6	0.10	0.30	57,998
61	oldcifra	Innovation resistance index	98.27	33.40	4,504	100.58	32.52	13,480	2.30	0.56	***	4.1	100.00	32.76	17,984
62	intoldcifra	Resistance intensive company regarding innovation	0.30	0.46	9,116	0.18	0.38	48,882	-0.12	0	***	-27.4	0.20	0.40	57,998

Note: * p<0.1, **p<0.05, *** p<0.01

Source: Own compilation

Table A 9: Variables on patents and other IPP (indicators 9-12) for beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

			CDTI		NO CDTI						Total	
			%	N	%	N		Chi2	p	Cramér's V	%	N
Indicator I9 company patenting												
63	pat	Patent application	16.19	1,476	5.79	2,829	***	1200.00	0.000	0.1445	7.42	4,305

Indicator I10 number of patents registered			CDTI			NO CDTI							Total		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.	St. Dev.		t	Mean	St. Dev.	N
65	patnum	Number of patent applications	0.72	4.82	9,116	0.29	4.89	48,882	-0.43	0.06	***	-7.8	0.35	4.88	57,998
67	esfpat	Effort in patent application	0.00	0.07	9,105	0.00	0.01	48,808	-0.00	0	***	-3.5	0.00	0.03	57,913

Indicator I11 companies that use other IPP			CDTI		NO CDTI						Total	
			%	N	%	N		Chi2	p	Cramér's V	%	N
70	ipp	Use of other IPP instruments	22.84	2,082	12.22	5,972	***	724.88	0.000	0.1118	13.89	8,054
71	intipp	Intensive company IPP types used	5.12	467	2.62	1,281	***	164.58	0.000	0.0533	3.01	1,748

Indicator I12 number of other IPP used			CDTI			NO CDTI						Total		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.	St. Dev.	t	Mean	St. Dev.	N
72	ippnum	No. (types) of IPP used	0.29	0.57	9,116	0.15	0.44	48,882	-0.13	0.01	*** -25.6	0.17	0.46	57,998
73	ippnum_re	Index types of IPP used	100.83	38.85	2,082	99.71	37.42	5,972	-1.12	0.96	-1.2	100.00	37.79	8,054
74	esfipp	Effort in types of IPP used	0.00	0.04	9,105	0.00	0.02	48,808	-0.00	0	-1.4	0.00	0.03	57,913
75	esfipp_rel	Relative effort in types of IPP used	13,190.50	562,899.29	9,105	6,903.45	465,851.92	48,808	-6,287.05	5506.97	-1.1	7,891.89	482404	57,913

Note: * p<0.1, **p<0.05, *** p<0.01

Source: Own compilation

Table A 10: Variables considered for indicator 13 on turnover generated by new products for the market by beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

			CDTI			NO CDTI						t	Total		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.	St. Dev.			Mean	St. Dev.	N
77	newmer	New products for the market (% figure)	11.71	24.45	9,116	5.61	17.94	48,882	-6.11	0.22	***	-28.0	6.56	19.24	57,998
57	newmercifra	Novelty index for the market	101.07	107.20	3,566	99.59	107.95	9,305	-1.48	2.12		-0.7	100.00	107.74	12,871
78	newemp	New products for the company (% figure)	13.76	26.72	9,116	8.67	23.19	48,882	-5.09	0.27	***	-18.8	9.47	23.85	57,998
59	newempcifra	Novelty index for the company	93.36	104.76	4,298	102.14	113.49	13,314	8.78	1.95	***	4.5	100.00	111.49	17,612
79	old	Unaltered products (% figure)	36.98	41.46	9,116	21.24	36.83	48,882	-15.74	0.43	***	-36.7	23.71	38.03	57,998
80	oldcifra	Innovation resistance index	98.27	33.40	4,504	100.58	32.52	13,480	2.30	0.56	***	4.1	100.00	32.76	17,984

Note: * p<0.1, **p<0.05, *** p<0.01

Source: Own compilation

Table A 11: Variables considered for the indicators on economic results (I14-I18) by beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

			CDTI		NO CDTI			Chi2	p	Cramér's V	Total	
			%	N	%	N					%	N
Indicator I14 annual growth in turnover												
81	intcreccifra	Intensive growth or annual sales figure	49.67	3,663	48.92	18,219		1.42	0.233	0.0056	49.04	21,882
Indicator I15 annual growth of labour productivity												
84	intcrecprodlab	Intensive in annual production growth, work apparent	47.11	3,474	47.1	17,542		0.00	0.983	0.0001	47.1	21,016
Indicator I16 Rate of growth for exports												
87	intcrecexport	Intensive in growth of annual exports	42.44	2,264	40.59	7,369	**	5.88	0.015	0.0158	41.01	9,633
Indicator I17 annual growth of gross investment in material goods												
90	intcrecinver	Intensive in annual growth of material goods	44.80	2,557	43.76	10,314		2.01	0.156	0.0083	43,96	12,871
Indicator I18 companies entering international markets												
93	mdoext	Turns to international markets	82.65	7,534	59.21	28,945	***	1800.00	0.000	0.1765	62.9	36,479

			CDTI			NO CDTI						Total		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.	St. Dev.		*t*	Mean	St. Dev.	N
Indicator I14 annual growth in turnover															
82	creccifra	Annual growth rate sales figure	1.31	72.06	7,374	0.36	16.44	37,246	-0.96	0.42	**	-2.3	0.52	32.92	44,620
Indicator I15 annual growth of labour productivity															
85	crecprodlab	Annual production growth rate, work apparent	1.23	60.67	7,374	0.51	18.81	37,246	-0.72	0.38	*	-1.9	0.63	30.06	44,620
Indicator I16 Rate of growth for exports															
88	crecexport	Export growth rate	34.66	352.35	5,334	1,152.94	142,257.36	18,156	1,118.28	1,947.85		0.6	899.00	125,067.38	23,490
Indicator I17 annual growth of gross investment in material goods															
91	crecinver	Rate of gross growth of investment in material goods	8,182.68	526,747.24	5,708	767.92	18,724.72	23,570	-7,414.76	3,439.77	**	-2.2	2,213.49	233,188.78	29,278
Indicator I18 companies entering international markets															
95	crecintracom	Growth rate of intra-community sales	36.77	502.40	4,962	1,168.1	144,918	16,715	1131.33	2,057.310		0.6	909.13	127,255	21,677

Note: * p<0.1, **p<0.05, *** p<0.01

Methodological note: Indicators 81, 84, 87 and 90 have been refined in this final evaluation. Missing values were considered as maximum values leading to overcalculation of values. Indicators 88 and 91 have been multiplied by 100 in this final evaluation in order to have values in a high scale

Source: Own compilation

Table A 12: Variables and indicators on the organisation of innovation (I19-I26) by beneficiary companies (CDTI), non-beneficiary companies (No CDTI) and total for the 2010-2016 period

			CDTI		NO CDTI						Total	
			%	N	%	N		Chi2	p	Cramér's V	%	N
Indicator I19 companies that cooperate with research centres												
97	cooperacentro	Cooperates with research centres	38.81	3,201	21.22	6,121	***	1100.00	0.000	0.1686	25,13	9,322
98	cooperacentroNAC	Cooperates with national research centres	38.18	3,149	20.77	5,991	***	1000.00	0.000	0.168	24,64	9,140
Indicator I20 companies that cooperate with international partners (outside the group)												
101	cooperaINTnogr	Cooperates with international partners (not group)	27.45	2,502	47.53	23,233	***	1300.00	0.000	-0.1471	44,37	25,735
Indicator I21 companies that introduce innovations working procedures												
102	inorgntrab	Inno org: work procedures (new business practices)	41.24	3,759	27.87	13,623	***	654.00	0.000	0.1062	29.97	17,382
Indicator I22 companies that introduce innovations, management responsibility and decision making												
103	inorgnresp	Inno org: work places, distribution of responsibilities, decision making	39.69	3,618	27.58	13,480	***	542.15	0.000	0.0967	29.48	17,098
Indicator I22 companies that introduce innovations, management of external and institutional relations												
104	inorgnrel	Inno org: external relations (new methods for managing external relations)	19.27	1,757	11.84	5,790	***	374.61	0.000	0.0804	13.01	7,547
Indicator I24 companies that disseminate technological innovations to other companies or sectors												

Note: Variable PITEC not available

Indicator I26 companies that find alternative sources of funding [to the company: f1 (own funds); the group: F2 (other group companies); and subsidy: f5 (ACE subsidies) and f6 (ACE contracts)]

117	otrafina	Has obtained alternative financing	20.85	1,832	7.9	3,863	1400.00	0.000	0.156		9.88	5,695		

			CDTI			**NO CDTI**						**Total**		
			Mean	St. Dev.	N	Mean	St. Dev.	N	Diff.	St. Dev.	*t*	Mean	St. Dev.	N
Indicator I19 companies that cooperate with research centres														
99	coopcentro	Number of partnerships with research centres	0.76	1.25	8,248	0.42	1.03	28,843	-0.34	0.01 ***	-25.2	0.49	1.09	37,091
100	coopcentroNAC	Number of partnerships with research centres	0.6	0.88	8,248	0.32	0.70	28,843	-0.28	0.01 ***	-30.3	0.39	0.75	37,091
Indicator I25 diversity in the network of cooperation														
105	divcoopNAC	No. of national partnerships (excluding group)	1.28	1.79	8,248	0.77	1.50	28,843	-0.51	0.02 ***	-26.0	0.89	1.58	37,091
107	divcoopINT	No. of international partnerships Outside of the group	0.57	1.62	8,248	0.31	1.22	28,843	-0.26	0.02 ***	-15.5	0.37	1.32	37,091
109	divcoopTOT	Total no. of partnerships (excluding group)	1.85	3.02	8,248	1.08	2.43	28,843	-0.76	0.03 ***	-23.8	1.25	2.59	37,091
111	esfdivcoopNAC	Diversity effort in national cooperation (turnover)	0.00	0.04	8,240	0.00	0.03	28,812	0.00	0	0.0	0.00	0.03	37,052
113	esfdivcoopINT	Diversity effort in international cooperation (turnover)	0.00	0.01	8,240	0.00	0.01	28,812	0.00	0	-0.4	0.00	0.01	37,052
115	esfdivcoopTOT	Diversity effort in cooperation (turnover)	0.00	0.04	8,240	0.00	0.03	28,812	-0.00	0	-0.1	0.00	0.04	37,052

Indicator I26 companies that find alternative sources of funding [to the company: f1 (own funds); the group: F2 (other group companies); and subsidy: f5 (ACE subsidies) and f6 (ACE contracts)]

118	otrafina_pc	Percentage of alternative financing	5.92	16.72	9,116	3.25	14.22	48,882	-2.67	0.17	***	-16.0	3.67	14.68	57,998
119	divotrafina	Diversity index alternative financing	170.99	598.47	9,116	86.76	460.68	48,882	-84.23	5.53	***	-15.2	100.00	485.90	57,998

Note: * p<0.1, **p<0.05, *** p<0.01

Source: Own compilation

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