Journal of Regional Research
Investigaciones Regionales

ISSN: 1695-7253 e-ISSN: 2340-2717
investig.regionales@aecr.org
AECR - Asociación Española de Ciencia Regional
www.aecr.org
España – Spain

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Investigaciones Regionales - Journal of Regional Research, 58, 2024/1
Asociación Española de Ciencia Regional, España

Available on the website: https://investigacionesregionales.org/numeros-y-articulos/consulta-de-articulos

Additional information:

To cite this article: Sande Veiga, D. (2024). Do the Structural Funds in innovation influence the growth of companies? Analysis through the ERDF-Innterconecta programme in Andalusia differentiating by business size and role in the projects. Investigaciones Regionales – Journal of Regional Research, 2024/1(58), 5-29. https://doi.org/10.38191/iirr-jorr.24.001

Investigaciones Regionales – Journal of Regional Research (2024/1) 58: 5-29
https://doi.org/10.38191/iirr-jorr.24.001

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European Regional Policy

Do the Structural Funds in innovation influence the growth of companies? Analysis through the ERDF-Innterconecta programme in Andalusia differentiating by business size and role in the projects

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Recieved: 16 March 2023
Accepted: 29 September 2023

Abstract:

As a Convergence Objective Autonomous Community of the European Union, Andalusia was a beneficiary of the significant volume of European resources for regional innovation mobilised by the 2007-2013 Technological Fund and the 2014-2020 Smart Growth programme. The Andalusian productive fabric is mostly made up of Small and Medium-sized Enterprises (SMEs). For this reason, we evaluate the impact of the ERDF-Innterconecta programme financed through the previous operational programmes on the main indicators of business growth. The proposed analysis seeks to identify whether there has been an impact for Andalusian companies that have participated in the subsidised projects on three indicators (revenue, GVA, number of employees), further differentiating these companies by size, participation in innovation and role taken in the funded projects. This impact varies according to the characteristics of the companies, being more positive for Large Enterprises (LE), leaders of the projects and for those that had not previously registered research investments in the accountancy.

Keywords: Structural Funds; Regional Innovation Systems; business growth; Policy impact analysis; Large enterprises and SMEs.

JEL Classification: L53; R58; O38.

¿Influyen los Fondos Estructurales en innovación en el crecimiento de las empresas? Análisis a través del programa FEDER-Innterconecta en Andalucía diferenciando por tamaño y rol empresarial en los proyectos

Resumen:

Como Comunidad Autónoma Objetivo Convergencia de la Unión Europea, Andalucía fue beneficiaria del importante volumen de recursos europeos para innovación regional movilizados por el Fondo Tecnológico 2007-2013 y por el programa de Crecimiento Inteligente 2014-2020. El tejido productivo andaluz está conformado en su mayoría por Pequeñas y Medianas Empresas (Pymes). Por este motivo evaluamos el impacto del programa FEDER-Innterconecta financiado a través de los anteriores programas operativos en los principales indicadores de crecimiento de las empresas. El análisis propuesto trata de identificar si ha habido repercusión para las empresas andaluzas que han participado en los proyectos subvencionados en tres indicadores (ingresos, VAB, número de empleados), diferenciando además a estas

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empresas por tamaño, participación en la innovación y rol tomado en los proyectos financiados. Ese impacto se muestra desigual en función de las características de las empresas, siendo más positivo para las grandes empresas, líderes de proyectos y para aquéllas que no registraban inversiones en innovación en su contabilidad.

Palabras clave: Fondos Estructurales; Sistemas Regionales de Innovación; crecimiento empresarial; análisis impacto políticas; grandes empresas y pymes.
Clasificación JEL: L53; R58; O38.

1. Introduction

In addition to the deep financial crisis suffered from 2008 onwards, known by many authors as the Great Recession, Andalusia and the rest of the Autonomous Communities with Convergence Objective were affected by the reduction of the European Structural and Investment Funds (ESIF) from the 2007-2013 programming period. The ESIF are the main financial instrument of the European Union (EU) to try to combat disparities between territories with higher and lower levels of development within the Union itself. Despite the progressive cuts in this type of European resources, in Spain new business innovation policies were implemented. These policies had been financed firstly by the so-called Technology Fund 2007-2013 (TF) -a policy aimed mainly at the Convergence Objective territories- and subsequently by the so-called Operational Programme for Smart Growth (SGP) 2014-2020.

Precisely taking into account the characteristics of an industrial fabric in a peripheral territory such as Andalusia, made up mainly of SMEs in need of growth to generate economies of scale and improve the use and attraction of public resources, this paper aims to analyse the extent to which the planning, design and implementation of business R&D&I programmes financed by the TF and the SGP had a positive impact on the growth of Andalusian companies, depending on their characteristics. Specifically, as a fundamental part of the innovation policies implemented in the territory, the ERDF-Innterconecta programme has been selected for this study. This programme was in force during the period 2011-2020 proposed for study. The Innterconecta programme constituted the most important line of aid from the TF and from the SGP specifically aimed at business projects in which support for innovative SMEs was included as a key objective.

While the body of literature on the impact of European Funds on Spanish firms has started to grow in recent years (Sande & Vence, 2019; Sande, 2022a; Moral & Paniagua, 2016; Romero, Ortiz & Ribeiro, 2010), the need to promote further research on the impact of these resources in the Andalusian Autonomous Community has given rise to this original and novel study that addresses the microeconomic impact of a European business innovation programme. Furthermore, a regional perspective has been used in this work, differentiating both the results obtained according to the characteristics and role of the companies participating in the projects financed by the policy analyzed, which conforms a new and original approach for this kind of *ex-post* business impact evaluation in Andalusia. The results obtained will make it possible to discern the differences between some companies and others and to model policies that are better adapted to the needs of the business fabric (*target policies*).

From here, the article is structured as follows: the second section reviews the literature on the importance of the ESIF and innovation policies and their influence on firm growth, also analysing the role of the TF and the SGP; the third section characterises and justifies the methodology used for the analysis; the fourth section assesses the impact of the ERDF-Innterconecta programme of the TF and the SGP on the main indicators of companies` growth in Andalusia, differentiating companies according to the characteristics described; finally, the last section draws conclusions and recommendations for policies derived from the results observed.

2. The importance of financing SMEs business growth through the structural funds and the description of the ERDF-INNTERCONECTA calls for proposals

The recent proliferation of R&D&I support programmes has been a response to the increased interest shown by the different levels of the administration, the business sector, universities and research organisations and social agents. For this reason, both the European Union and the state and regional administrations have programmed and implemented different policies and strategies aimed at promoting business R&D&I in Spain over the last few years, for example the Technology Fund, the RIS3 strategy or the Smart Growth Programme.

Recent literature has shown, from a systemic conception, that to achieve growth and it is necessary to have a system that favours interactions between agents (Rodríguez-Pose & Crescenzi, 2008; Freeman, 2008; Gu & Lundvall, 2006; Cassia, Colombelli & Paleari, 2009; Fagerberg, Lundvall & Schrolec, 2018) with the aim to conform networks to foster innovation activity. Since companies are a crucial element in innovation systems, this article has focused on demonstrating the existence or non-existence of growth in the companies participating in the selected policy, paying special attention to SMEs, since they make up the vast majority of the private entities that make up its business network. In every sense, it is worth noting the difficulty of measuring the effects of structural policies in times of economic crisis or recession or similar circumstances (Sande, 2020; Camagni & Capello, 2017; Di Caro & Fratesi, 2022).

2.1. Literature review

Economic approaches such as the cluster approach value positively the processes of business rivalry, collective learning, collaboration and interaction between firms (Freeman, 1991; Singh, Chhetri & Padhye, 2022; Akhmetshin, Barmuta, Yakovenko, Zadorozhnaya, Mironov, & Klochko, 2017). For them, the accumulation of experience and collaboration between different agents is a key factor in improving the technological capabilities of the business fabric (Lall, 1992; Bell & Pavitt, 1995; Ahn, Minshall & Mortara, 2015). In this sense, the role of large firms in the formation of cooperative networks could be analysed. However, some authors emphasise the need for decentralisation not only of business R&D (Leiponen & Helfat, 2011), but also innovation policies (Taylor, 2007; Cooke, 2009; Rangus & Slavec, 2017), only in case of multiple policy variables in the region for others (Strumpf, 2002), to avoid excessive concentration of activity and resources in large companies, *which* could be an interesting approach for other research taking into account how innovation competences are shared between the state and the regional governments in Spain. Under this last idea, this paper reviews several key aspects for a peripheral region such as Andalusia: a) The impact of European policies on business growth; b) The impact of the ESIF according to the size of companies; and c) The importance of support for SMEs.

Support through the ESIF for the financing of technological innovation has shown mixed results over time. Thus, it is possible to find literature defending positive results of technological innovation policies for the business fabric (Musyck & Reid, 2007; Segarra-Blasco, 2018; Le & Jaffe, 2017; Bronzini & Piselli, 2016), while other studies show moderately positive results in peripheral contexts (Sande & Vence, 2021), or even non-existent results for some contexts (Blasio, Fantino & Pellegrini, 2015).

More specifically, in relation to the indicators selected for the present work, there also has been scientific studies showing that business growth and revenue growth has been achieved thanks to ESIF, for companies belonging to manufactures sector (Carboni, 2017), for small companies (Maroshegyi & Nagy, 2010) or analyzing results for other European Territories (Hartsenko & Sauga, 2012). On the other hand, different literature (Fattorini, Ghodsi & Rungi, 2019) do not find relation between ESIF and business growth. Regarding other indicators which take part in this paper such as employment and gross value added (GVA), some authors defend a positive relationship between ESIF implementation and the positive evolution of these business indicators, in the local level (Bachtrögler, Fratesi, & Perucca; 2019) o through the implementation of multiple instruments (Bondonio & Greenbaum, 2014). But there are also studies showing zero effects of these policies on employment (Bernini & Pellegrini, 2011; Bachtrögler & Hammer, 2018). However, other authors add a few nuances. For example, Vivarelli (2014) introduce a nuance in

their analysis of the impact of innovation on employment by indicating that the short-term reduction in employment in economies resulting from technological development would be counteracted and compensated under certain conditions (such as the support to process innovation, or the domestic capabilities), in the medium and long term with increases in labour demand. For Sande (2022a), using the same methodology, and for Alzugaray, Mederos & Sutz (2012) there would be positive results for this indicator derived from ESIF allocation. Nevertheless, the previous positive relationship would not be demonstrated for other indicators such as revenue or GVA.

With specific reference to the effects of ESIF depending on the size of enterprises and the role they play in the innovation projects financed, there is not abundant literature. Despite this, there are some studies conducted in recent years which are focused on the differences produced between firms according to their size, but aimed at not-Andalusian regions (Santamaría & Nieto, 2009; Silva & Carrizo, 2018; Blaschke, Demel & Kotorov, 2021). Thus, while some studies using the same methodology (Segarra-Blasco, 2018) or different (Benkovskis, Tkacevs & Yashiro, 2019) have found that companies´size is a key factor other authors (Sande & Vence, 2021) found that large enterprises (LEs) have absorbed part of the expected impact in SMEs. Finally, for others (Sande, 2022b) large and medium-sized enterprises have benefited from the impact of ESIF in some indicators, mainly because these companies have been the ones which have lead the projects, and it let them have received more funds and capitalise the project results.

In a context of financial support to projects of a relevant dimension, it is worth looking in more detail at some relevant issues affecting peripheral regional systems. Firstly, peripheral regions are very often conformed by SMEs. Secondly, despite the difficulties of SMEs to absorb the ESIF -for reasons such as dependence on specialized intermediaries or lack of productivity (Stolz & Schrammel, 2014), deviation funds (Horvat, 2005), lack of specialized human resources, knowledge, infrastructures, and others (Sande, 2020; Lucian, 2021)-, this companies continue to be one of the most important endogenous factors in creating the conditions for structural change (Cooke, 1992; Macdonald, Assimakopoulos & Anderson, 2007; Vuorinen & Mereuta, 2020). And thirdly, the impact of R&D&I support for SMEs has also been controversial. Thus, some studies show positive effects of policies on SMEs innovation using different methodologies (Devins, Johnson & Sutherland, 2004; Čadil, Mirošník & Rehák, 2017; Belas, Gavurova & Toth, 2018; Piątkowski, 2020). On the other hand, other studies show a more moderate impact (Lewandowska, Bilan & Mentel, 2021; Sergej, 2016), or positive for medium-sized companies and null for Micro SMEs (Sande, 2022b) using a similar methodology, or null depending on the efficiency of the programmes implemented (Gouveia, Henriques & Costa, 2021).

Finally, the authors agree that the conditions of regional innovation systems are relevant to foster business innovation and growth, for example the existence of direct financial support programmes (Rodriguez-Pose & Wilkie, 2016), a purposive management of knowledge flows at the level of the innovation ecosystem (Radziwon, Bogers & Bilberg, 2017), or the existence of a complete dotation of innovation infrastructures (Sande, 2020). And even the centralization or decentralization of innovation policies could be a key factor to implement more efficient policies in peripheral regions.

2.2. Description of the analyzed funds

Andalusia, as a peripheral and moderately innovative Autonomous Community, received between 2007-2020 ESIF to improve its business innovation. This funding was planned mainly through two operational programmes: the TF and the SGP. In the current study we analyze the impact of an instrument such as the Innterconecta programme implemented in Andalusia and belonging to both operational programmes.

The objective of reaching 3% of Gross Domestic Product (GDP) investment in R&D&I set in the Lisbon Strategy led to the establishment of two new objectives prior to the start of the 2007-2013 programming period: a) The development of research, education and innovation, and b) The promotion of innovation policy. In line with these latter objectives, the European Council approved an additional allocation of ERDF resources for Spain for the promotion of business R&D&I in the Autonomous Regions with Convergence Objective. This item took the form of a programme known as TF, created along lines that were continued for the 2014-2020 period when the SGP was approved.

The TF has been a programme dedicated to the promotion of business R&D&I (Ministerio de Economía y Hacienda, 2007) whose birth was approved by the European Council and which had a continuity framework for business innovation after the approval of the SGP (Ministerio de Hacienda y AAPP, 2014). The main key data of this policy of subsidies to business projects, including its funding, territorial allocation, objectives and eligible actions can be reviewed in the appendix (table A).

The ERDF-Innterconecta is a line of funding that seeks public-private collaboration through direct subsidies on a competitive basis to support strategic and large-scale business projects for experimental development and industrial research, with the aim of developing innovative technologies in areas with international economic projection. The key data of the programme are shown below (table 1).

Table 1.
ERDF-Innterconecta Programme key data

	Technology Fund	Smart Growth
Assignment to Spain	262 M€	210 M€
Publication of the Call for Proposals	2011; 2013	2015; 2016; 2018
Territorial distribution of the Funds	-Andalusia 150 M€	
	-Galicia: 105 M€	-Plurirregional
	-Extremadura: 7 M€	
	-Castilla La Mancha: This region does not participate	
Subsidised areas	-All, as long as they stimulate employment and increase added value (Ministerio de Economía y Competitividad, 2013)	Health, demographic change and well-being, food safety and quality; safe, efficient and clean energy, smart, sustainable and integrated transport; action on climate change; social change and innovations, digital economy and society; security, safety and defence
Dimension and Amounts subsidised in the projects (Andalusia)	Up to 5 M€	Between 1-4 M€
Project requirements	Formation of an Economic Interest Grouping (EIG) or Consortium	
Projects duration	Two- and three-year projects (Ministerio de Ciencia e Innovación, 2012)	
Objectives	Support for large R&D projects Increasing business R&D expenditure Use of existing infrastructures Mobilisation of SMEs Greater involvement of stakeholders and promotion of innovative culture Internationalisation of innovation Experimental development and cooperation between companies	

Source: Own elaboration, taken from Author (n.d.).

In view of the program data, it is worth asking whether, in effect, there is a different impact on the indicators of the companies of the European regional innovation funds depending on their size and the role they have played in the projects. For this reason, it is why the Innterconecta program can serve as a guiding thread to carry out the proposed analysis.

3. The analyzed funds and the methodology used

This section has a twofold objective. The first part introduces the methodology employed in the current research, while the second part highlights key information regarding the data processed.

3.1. Methodology

In the present work a large amount of quantitative data taken from multiple sources is crossed, which gives a strong empirical component to the study. Among these sources it is possible to distinguish R&D information referring to the context of the territory obtained from official organizations such as the National Institute of Statistics (INE), the Ministry of Finance of the Junta de Andalucía, the Spanish Ministry of Finance, Eurostat and the European Administration. Data from the participating companies provided by the Centre for Technological and Industrial Development (CDTI) and built with the information obtained from the planning organizations during the research process have also been used (CDTI has provided a data base including the name of the companies, the name and the field of the project and the amount subsidised per project and company); and, finally, data on economic and financial performance indicators of the companies participating in Innterconecta obtained through the ARDÁN business information service of the Vigo Free Trade Zone Consortium (ARDAN has provided a data base including economic classification of the companies and business performance for the variables analyzed in the current research –revenue, GVA, employment-, as well as information for research indicators which has been object of study in a different research focused in innovation results). The variables object of the study have been chosen taking into account the previous research of the literature review. The intertwining of data and information throughout the study period, together with qualitative information and the work of obtaining and interpreting quantitative data from LEs and SMEs, with subsequent statistical analysis using the Propensity Score Matching (PSM) technique, like the previous literature review analyzed suggests. It is also worth noting the effort to synthesize the information generated, will serve to achieve the goals formulated in this paper.

The start of this study focuses on the analysis of the main economic indicators of growth of a sample of 337 Andalusian companies participating in the calls of the ERDF-Innterconecta program for this Autonomous Community. With this start, the aim is to analyze the evolution of the following indicators during the period 2011-2020, compared to a sample from the ARDÁN database of 355 Andalusian companies not affiliated to the program: revenue, GVA and employment. The reason for selecting the period 2011-2020 is justified by the fact that this is the period from the launch of the first call of the program under analysis to the end of the implementation period of the last call. The reason for choosing these variables, which do not appear as specific objectives of the programme, is to check whether the funding mobilised has enabled the companies to improve their situation in terms of business growth. This question is particularly relevant if we take into account that the majority of Andalusian companies are SMEs, mainly MicroSMEs. This being the case, it would be a desirable objective to ensure that the companies that are attracted to innovation can see their improvements in terms of results in these areas. For these indicators directly related to the possible growth of companies, the PSM technique will be applied. Regarding the unobservable characteristics of the control sample, an attempt has been made to select non-participating companies that had a probability of being selected as participants in the policy greater than the minimum, fundamentally taking into account their size, since the program allowed the participation of all economical sectors.

This technique makes it possible to estimate the effect of a policy on a set of agents conducting an analysis of the covariance of the observed values. For this purpose, this methodology requires the analysis of the results of two samples: on the one hand, a sample of companies that have participated in the policy analysed and, on the other hand, a control sample of companies that have not participated in the policy. The results of the test carried out will make it possible to check whether the null hypothesis is satisfied and thus verify whether the policy has had an influence on the results observed in the first sample. If the value of the standardised mean difference (SMD) of each of the study groups is greater than 0.1, an imbalance is observed and the PSM is applied. In this case the observed value is index-dRevenue > 0.1, so we estimate the propensity score by applying a *logit* model in which the outcome variable is a binary variable indicating

whether a certain policy has been applied or not, for which we use the R software, *MatchIt package*. There are different methods to perform the matching (*radius*, *kernel*, *xact matching, nearest neighbour, optimal matching, full matching and caliper matching*,...), among them we select the *nearest neighbour*. The nearest neighbour method matches each individual in the treatment group with the individual in the control group that has the closest propensity score. We use the most common implementation of PS matching, in practice is one-by-one matching, in which pairs of treated and control units are formed (this info has been included in the methodology). Using one-by-one nearest neighbour PS matching =N(1)iC, one treated unit i ∈ T is matched to one control unit j ∈ C. That is, that individual is selected from the candidates pairing whose propensity score is the most similar to the propensity score of the individual to be paired in the case group. There is a one-to-one matching, in the former an element of the control group is used more than once. If instead of an element of the comparison group, all those with a close PS are used, the estimates use the information available is better and they are more stable. The counterpart is that if the same element of the comparison group is used too many times could increase sampling error. Among the matching algorithms most used in practice, and one of those that produces the best results, is the so-called *nearest neighbour* matching. This matching technique consists on choosing from the comparison group the element with the closest PS (ANII, 2023). Other forms of matching such as *caliper* or *radius* are used with poor samples (this is not the case), or they carry out matnhings between more disparate units (e.g. kernel) (Rodríguez, 2012). The values of the variables have been taken at the end of the period, as a result for these indicators. Once the test is completed, we include the *p-value* which if <0.05 implies the existence of significant differences between the two groups.

3.2. Key data of the study

This research initially analyses the evolution of the main economic indicators related to the growth of companies during the period 2011-2020: revenue, GVA and employment. The data used are based on company accounting information collected from the database held by ARDÁN.

The total number of directly participating companies was 1,392, of which 827 could be identified (some of them repeat participation in the projects approved). Information in ARDAN was available for 337 of them, so we have extracted the general data for this part of the study from these enterprises. Those companies that had more than 250 employees in 2007 -at the beginning of the European programming period- were taken as LE. These companies received the Innterconecta aid between 2011-2020, so if there is an impact the indicators should show changes in these and subsequent years.

The comparative evolution of the selected indicators has been carried out thanks to a control sample of 355 companies in the Autonomous Community that have not participated in the policy. As for the control sample, this has been selected by the Ardán business service, taking a random sample -with similar characteristics (size, innovation role)- of Andalusian companies that have not participated in the policy. This will make it possible to determine if there is better behaviour in these indicators for the companies participating in the policy or if, on the contrary, it is similar to the behaviour of other groups of companies that have not received financing through this policy.

The total number of projects applied for in the five Innterconecta calls analysed exceeded 600, although around half (334 projects) were finally approved. However, the number of companies applying was more than double the final number of participants (table 2). The average projected budget per company was €639,679.85, taking into account the five calls for proposals analyzed, but CDTI grants covered on average only half of this amount: €302,406.91.

Analysing the sample used for the impact study, the technological areas to which the 337 companies participating in Innterconecta directed their projects were mainly industrial manufacturing activities (34.12%) and professional, scientific and technical activities (27.60%), which tend to correspond to consultancy and specialised services. The remaining Innterconecta resources went, in order, to ICT (9.20%), retail and wholesale trade (8.90%) and construction (8.31%).

The average number of participating companies per project was 4.17. It should be noted that universities, technology centres and research organisations also participated in the consortia. With regard to the classification of the companies according to their size, it was observed that almost three quarters

(247) were SMEs (73.29%) and the remaining quarter (90) were LE (26.71%). At the end of the period, the number of LE was minor (-47%) because of the financial and the pandemic crisis effects, and because possible lack of data of the source. The LEs have played a relevant role in leading the projects, which has translated into a greater amount of resources managed and greater responsibility. In order to further analyse the data according to the characteristics of the companies, the differences between the 63 leading companies (18.69%) and the 274 partners (81.31%) of the projects have also been considered, as well as between the 327 companies that did not innovate in 2011 (93.03%) and the 10 that did innovate (2.97%).

TABLE 2.
ERDF-Innterconecta key data

	1st Call (2011)	2nd Call (2013)	3rd Call (2015)	4th Call (2016)	5th Call (2018)
Requested projects	74	59	269	231	NA*
Approved projects	31	41	131	64	67
Companies requesting	410	255	946	822	NA*
Approved companies	195	211	511	246	229

***Note:** Plurirregional, data for requested projects not available for 2018.
Source: Own elaboration basen on ARDÁN and CDTI data.

The business networks formed through this policy are characterised by a profuse participation of ICT and technical consultancy companies, present in almost all the projects. The networks also included on a timely basis companies from sectors that coincide with Andalusia's productive specialisation: commerce, hotels and catering, fishing and wood. Below is also a table of descriptive statistics in relation to the composition of projects and participating companies (table 3).

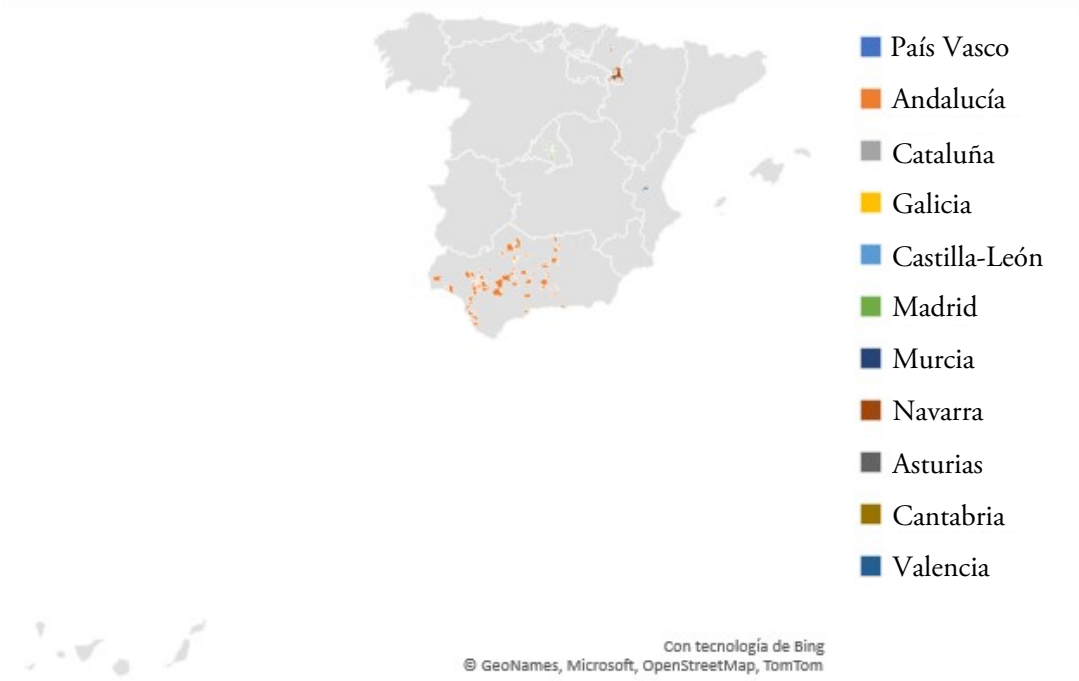
TABLE 3.
Descriptive statistics of the projects analyzed at the beginning of the period

Number of participating companies analyzed // Control sample	337	355	
	Small and Medium Enterprises	247 (73.29%)	345 (97.18%)
	Large Enterprises	90 (26.71%)	10 (2.82%)
Number of companies per project	4.17		
Role in the projects	Leaders	63 (18.69%)	
	Partners	274 (81.31%)	
Role in innovation of participants // Control sample	Previously innovative (accountancy data)	10 (2.97%)	3 (0.85%)
	Non-innovative (accountancy data)	327 (93.03%)	352 (99.15%)
Sector of activity of the projects subsidized	Industrial manufacturing activities	34.12%	
	Scientific and technical activities	27.60%	
	ICT	9.20%	
	Retail and wholesale trade	8.90%	
	Construction	8.31%	
	Other activities	11.87%	

Source: Own elaboration based on ARDÁN and CDTI data.

The comparison carried out between the two samples has shown very small differences in behaviour between the entities participating in the policy and those that have not, depending on the size of the companies. The breakdown of the data at territorial level and by calls for proposals did not provide relevant additional information, so all calls for proposals are analysed together. Notwithstanding that, information about the registered offices of the companies participating in the policy analysed is provided below. These companies are concentrated primarily in Seville, but also mainly in Malaga and Cordoba, and to a lesser extent in Jaen. Other Andalusian territories have hardly any participation at all. The map also includes Spanish companies participating in the policy from outside Andalucia (map 1).

Map 1.
Spatial location of the companies participating in the Innterconecta programme in Andalusia, by registered office



Source: Own elaboration based on ARDÁN data.

4. Evaluation of the impact of the ERDF-Innterconecta programme of the Technology Fund for Andalusia on the growth of firms

As literature review shows, there are other studies focusing on analyzing innovation indicators (Segarra-Blasco, 2018; Sande & Vence, 2021), but not in the business growth indicators analyzed in this paper -with the exception of the employment for the leader companies of the projects (Sande, 2022b). This section breaks down the information into two parts: the first is a general study of the Innterconecta programme data, analysing aspects such as the size and characteristics of the projects approved and the networks formed; the second part analyses, in comparative terms, the main innovation indicators of the companies participating in the policy evaluated according to their size, participation in innovation and role in the projects.

4.1. Comparative evolution of the growth indicators of the companies participating in Innterconecta in Andalusia

Given that the volume of funds mobilised by the Innterconecta initiative in Andalusia has been significant, there was a high expectation regarding the impact of this policy on participating companies. In order to approximate this impact, the behaviour of the main business growth indicators of the innovative companies participating in Innterconecta has been analysed. To this end, their size and role in innovation were taken into account. In this respect, it should be noted that factors such as the financial crisis suffered from 2007-2008 (Great Recession), the application of other public policies, regulatory changes in company accounting, or the different management of each company may have had an impact on the evolution of the values observed, without these circumstantial issues undermining the results obtained.

For this section, the control sample of 355 Andalusian companies not participating in the policy has been considered as a reference. Table 4 shows the descriptive statistics with the variation produced in each of the variables by size and function of the participating enterprises while table 5 shows the same results for the control sample. The main differences when comparing the sample information in the study tables comes from the disaggregation by groups of the sample of companies participating in the policy. The size of the two samples is similar in both cases, and differences in the number of observations for some indicators between samples in some cases could come from different factors: on the one hand the availability of data for this companies when comparing (it depends on the data provided by the sources), the possible activation of this indicator in the accountancy of the companies (i.e. innovation investment), or other factors (other situation of the firms).

SMEs participating in the Innterconecta calls show better results in the three previously selected variables (revenue, GVA, number of employees). Partner and leader firms would show positive values in the comparison with the control sample for two indicators (while leader firms would not show such a positive result for the number of employees, and partners regarding revenues). In a similar way, companies that did not innovate in 2011 (RI=0) and those that already innovated (RI>0) also show a positive evolution for two of the indicators (with the exception of revenue and GVA respectively).

In an approximation to the first group of variables, and if we focus on what has happened since the launch of the Innterconecta programme in 2011-2012, it can be seen that most groups of companies show a favourable evolution for several of the proposed indicators, with the exception of companies that had already innovated previously. In view of the evolution data, it would be the companies that did not innovate and project partners that would show the greatest relative improvements in these indicators.

It has also been included the mean variation in the main growth indicators of the companies participating and not participating in Innterconecta by size and role (table 6). The data shows some differences between LE performance of both groups, with a positive evolution for the Innterconecta sample and a negative behaviour for the control sample.

In general, the overall results are quite moderate. In order to appreciate more precisely what has happened with the application of the Innterconecta programme, the behaviour of the following specific innovation performance variables for the identified groups will be shown graphically below: revenue, GVA and number of employees. The form chosen for the presentation of the data is base 100, as this allows differences in behaviour to be identified more clearly. It has been considered convenient to represent these figures using a logarithmic scale in base 10, in order to give more accurate information in perspective on their evolution over time. To calculate the values initially in base 100, in the specific cases in which the initial data for 2011 is zero, the first positive value of the series has been taken. At this point it should be remembered that, by definition, the logarithmic base does not allow negative values or values that are zero to be represented, which may be reflected in some cases in discontinuities in sections of these lines or in the graphic absence of some value. These values have also been compared with those obtained for Andalusian companies in the control sample for which information is available.

TABLE 4.
Aggregate change and relative impact of participation in the main growth indicators of the companies participating in Innterconecta by size and role, 2011-2020

		Agregate change			Relative impact		
Size and role	**Numberº Companies**	**Revenue (€)**	**GVA (€)**	**Employees**	**Revenue (%)**	**GVA (%)**	**Employees (%)**
LE>250 employees	90	-4,713,833,684	3,134,705,659	36,662	-7.77	+28.21	+29.90
SME<250>50 employees	89	570,888,270	260,994,250	5,548	+34.00	+58.17	+123.48
SME>50 employees	158	607,582,794	103,837,876	1,391	+187.92	+137.64	+87.05
RI=0 (2011)	327	-3,534,198,981	3,471,841,233	40,935	-5.67	+30.26	+32.43
RI>0 (2011)	10	96,091,661	-33,474,612	137	+12.02	-13.02	+2.88
Leaders	63	2,319,043,576	1,660,111,000	-8,117	+12.32	+31.10	-12.04
Partners	274	-5,802,551,486	1,765,408,516	49,377	-13.10	+27.62	+77.66
Companies Andalucía	337	-3,535,362,620	3,499,537,785	43,601	-5.61	+30.08	+33.88

Source: Own elaboration based on ARDÁN and CDTI data.

TABLE 5.
Aggregate change and relative impact of participation in the main growth indicators of the companies belonging to the control sample by size and role, 2011-2020

		Agregate change			Relative impact		
Size and role	**Numberº Companies**	**Revenue (€)**	**GVA (€)**	**Employees**	**Revenue (%)**	**GVA (%)**	**Employees (%)**
LE>250 employees	10	87,075,933	-16,245,475	2.029	+7.84	-4.76	+44.60
SME<250>50 employees	314	8,555,753,984	1,819,554,260	33,240	+345.29	+479.27	+416.23
SME>50 employees	31	120,164,286	68,301,575	597	+33.80	+132.97	+66.19
RI=0 (2011)	351	8,759,948,465	1,870,730,960	35,908	+229.05	+246.35	+272.71
RI>0 (2011)	4	3,045,738	879,400	-42	+2.55	+6.89	-15.55
Leaders	-	-	-	-	-	-	-
Partners	-	-	-	-	-	-	-
Control Sample	355	8,746,998,134	1,856,558,012	35,537	+221.77	+240.44	+264.47

Source: Own elaboration based on ARDÁN and CDTI data.

TABLE 6.
Mean variation in the main growth indicators of the companies participating and not participating in Innterconecta by size and role, 2011-2020

	Companies participating in the policy				Companies not participating in the policy			
Size and role	**Numberº Companies**	**Revenue (€)**	**GVA (€)**	**Employees**	**Numberº Companies**	**Revenue (€)**	**GVA (€)**	**Employees**
LE>250 employees	90	-52,375,929.8	34,830,062.88	407.36	10	8,707,593.3	-1,624,547.50	202.9
SME<250>50 employees	89	6,414,474.94	2,932,519.66	62.33	314	27,247,624.15	5,794,758.79	105.86
SME>50 employees	158	3,845,460.72	657,201,75	8.80	31	3,876,267.29	2,203,276.61	19.26
RI=0 (2011)	327	10,807,948	10,617,251.48	125.18	351	26,788,833.23	5,720,889.78	109.81
RI>0 (2011)	10	9,609,166.1	-3,347,461.20	13.70	4	304,573.8	87.94	-4.2
Leaders	63	-10,807,948	10,617,251.48	-128.84	-	-	-	-
Partners	274	9,609,166.10	-3,347,461.20	180.21	-	-	-	-
Companies Innterconecta	337	-10,490,690.3	10,384,385.1	129.38	355	-29,456,275.63	29,192,743.44	354.74

Source: Own elaboration based on ARDÁN and CDTI data.

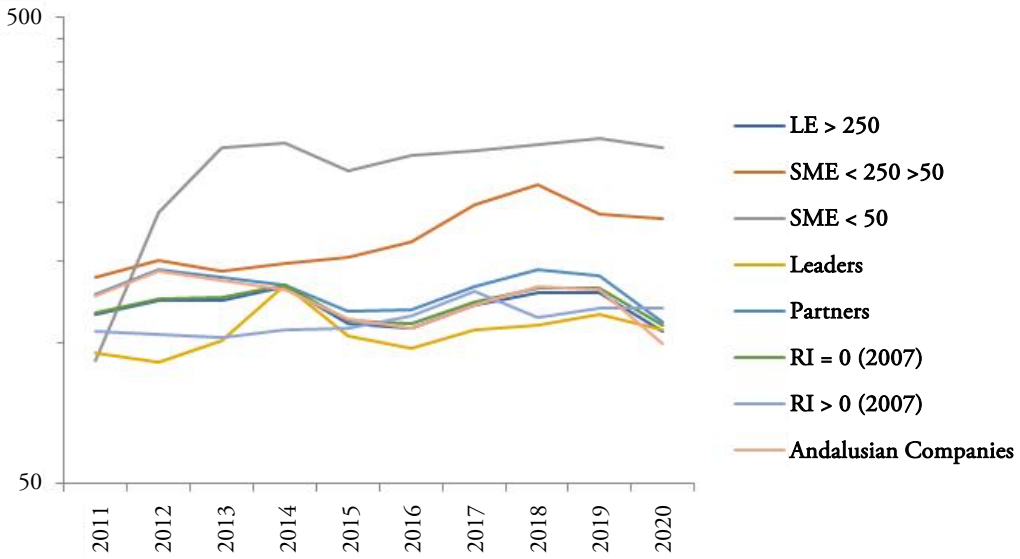
In general terms, the data for the three selected variables show a favourable behaviour over the whole period for the companies participating in the policy. In a first approximation, it can be observed that the behaviour is different per indicator. Thus, the size of the companies participating in Innterconecta does not appear to be a key factor in the greater absorption of resources. Nor are the results very significant if we look at what happened with the leading and associated companies. In general, an improvement is observed in these companies with respect to the control sample, with the exception of the leading companies in terms of employment. Focusing on the results obtained for companies that were already innovators (RI>0 in 2011) and new innovators (RI=0 in 2011), we again see that the results are not very positive. While the companies that were not innovating and the companies that were already innovating in 2011 seem to take slight advantage of the funding. The differences between the total control sample and the individual cases where the values of n are different from those of the control sample relate to companies for which no information was available for the year 2020. Similarly, this may be the case for the sample of companies participating in Innterconecta. This issue has to do with the availability of information from the source.

Impact on revenue by type of company

In general terms, the different groups of companies analysed have shown a positive evolution of the revenue indicator in absolute terms for the period analysed, although it should be noted that for these companies a break in their evolution has been observed in several years (2015) as a result of the deep financial crisis suffered.

The LEs, medium sized companies and small sized companies show differentiated results for this indicator, taking apparently the SMEs greater advantage of the funds. The results are similar for leading companies and partners, as is the case for companies that did not innovate previously and those that did innovate previously. These results would indicate a low incidence depending on the latter characteristics, in contrast to the case of business size. All companies -except for LE, leaders and partners- obtained better results in the period than the control sample showed (Figure 1).

Figure 1.
Comparative evolution of revenue of companies participating in Innterconecta-Andalucía 2011-2020, by size and company role (index 2007=100, log10(x))



Source: Own elaboration based on data from ARDÁN and CDTI.

In order to test the existence of significant differences between the behaviour of companies participating and not participating in the policy, we performed a statistical test for this indicator using the PSM methodology on the total set of companies for which data were available. For this test, the number of companies in the control sample with activated accounting data for this indicator was n_1 = 338, while for the total number of companies participating in Innterconecta those that recorded accounting values were taking the different n_2 values collected for each study group given that the sample of companies did not always have values for all companies and variables (table 7). The mean of the values for the first sample after the application of the funds is $\bar{x}_1$ = €37,594,951.57 and its standard deviation σ_1 = €94,740,323.08, while for the companies that received resources from the innovation policy the mean $\bar{x}_2$ and the standard deviation σ_2 take higher values, except for partner companies and SMEs. If the value of the standardised mean difference (SMD) of each of the study groups is greater than 0.1, an imbalance is observed and the PSM is applied. In this case the observed value is *index-d*$_{Revenue}$ > 0.1, so we estimate the propensity score by applying a *logit* model in which the outcome variable is a binary variable indicating whether a certain policy has been applied or not, for which we use the R software, *MatchIt* package. There are different methods to perform the matching (*xact matching, nearest neighbour, optimal matching, full matching and caliper matching*,...), among them we select the *nearest neighbour*. The *nearest neighbour* method matches each individual in the treatment group with the individual in the control group that has the closest propensity score. Once the test is completed, we include the *p-value* which if <0.05 implies the existence of significant differences between the two groups. The results show that the fact of having participated in the policy would have a significant impact on this indicator for LE, leader companies and companies that were not innovating previously.

TABLE 7.
Results of the statistical analysis of revenue using PSM

	n1	n2	$\bar{x}_1$	$\bar{x}_2$	σ_1	σ_2	Index-d (DME)	p-value
LE>250 employees	338	76	37,594,951.57	699,336,850.78	94,740,323.08	1,789,161,344.43	0.522	0.0074
SME<250>50 employees	338	73	37,594,951.57	28,504,249.75	94,740,323.08	45,824,227.23	0.122	0.9964
SME<50 employees	338	83	37,594,951.57	8,121,438.95	94,740,323.08	17,709,843.39	0.432	0.9930
RI=0 (2011)	338	224	37,594,951.57	245,851,920.50	94,740,323.08	1,087,469,424.18	0.270	0.0082
RI>0 (2011)	338	8	37,594,951.57	104,207,516.50	94,740,323.08	146,329,293.73	0.540	0.9869
Leaders	338	51	37,594,951.57	408,581,945.06	94,740,323.08	684367209.67	0.759	0.0086
Partners	338	182	37,594,951.57	192,724,805.36	94,740,323.08	1148628303.85	0.190	0.1075

Source: Own elaboration using *R software.*

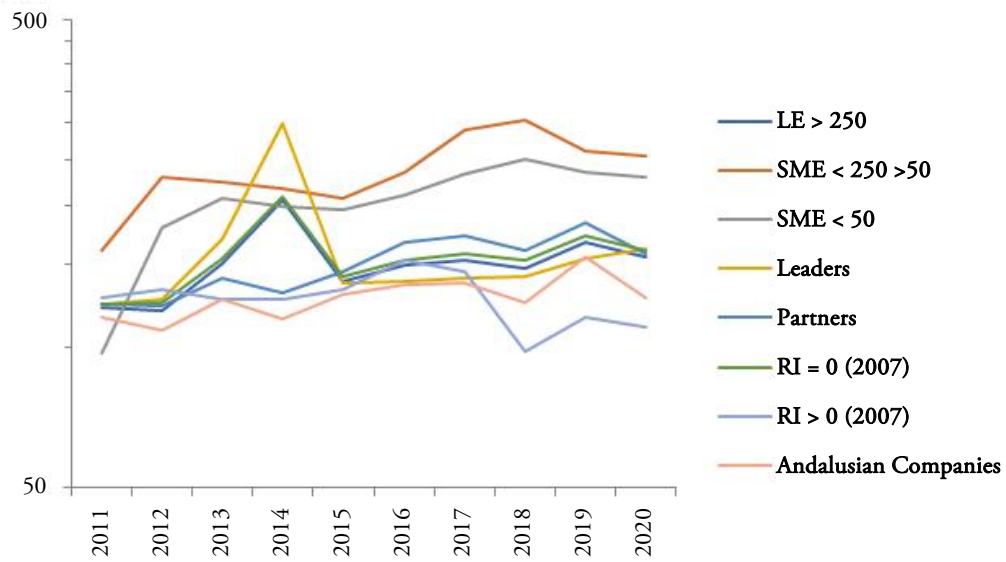
IMPACT ON GVA BY TYPE OF COMPANY

Small-sized companies would show the greatest relative growth in this indicator, followed by medium sized companies and large companies. Leader companies also increased their investments to a greater extent than the partners. With regard to the evolution of the companies according to their participation in innovation, it is those that were not already innovating in 2007 (RI=0) that experienced the greatest increase in the period analysed, with the evolution being negative for companies that were innovating in that initial year (RI>0). Only partner companies obtained worse results in the period than the control sample (Figure 2).

We performed the statistical test for investment in development using the same methodology as above. The number of companies of the control sample with activated data in their accounting for investment in development is n_3 = 338, while for the total number of Innterconecta participants the different values shown for n_4 were taken given that the sample of companies did not always have values for all companies and variables (table 8). The mean of the values for the first sample after the application of the funds is $\bar{x}_3$ = €7,821,750.08 and its standard deviation σ_3 = €15,071,607.98, while for the companies

that received resources from the innovation policy the mean $\bar{x}_4$ and standard deviation σ_4 take higher values in almost all cases, except for SMEs<50 employees. The value of the standardised mean difference (SMD) is *index-*d_{GVA} is greater than 0.1 in almost all cases, which would indicate a situation of imbalance and would require the reapplication of PSM. The results show that the fact of having participated in the policy would have a significant impact on this indicator for LE and leader companies, while companies that were not innovating previously are next to the limit of validation.

FIGURE 2.
Comparative evolution of GVA of companies participating in Innterconecta-Andalucía 2011-2020, by size and business role (index 2007=100, log10(x))



Source: Own elaboration based on data from ARDÁN and CDTI.

TABLE 8.
Results of the statistical analysis of GVA using PSM

	n3	n4	$\bar{x}_3$	$\bar{x}_4$	σ_3	σ_4	Index-d (DME)	p-value
LE>250 employees	338	76	7,821,750.08	169,271,977.89	15,071,607.98	419,475,012.46	0.544	0.0039
SME<250>50 employees	338	73	7,821,750.08	8,995,978.95	15,071,607.98	18,370,790.90	0.070	0.8557
SME<50 employees	338	83	7,821,750.08	1,680,641.33	150,71,607.98	1,595,323.75	0.573	0.8514
RI=0 (2011)	338	224	7,821,750.08	60,056,335.10	15,071,607.98	255,777,338.02	0.288	0.0042
RI>0 (2011)	338	8	7,821,750.08	26,031,368.88	15,071,607.98	19,899,848.55	1.032	0.9536
Leaders	338	51	7,821,750.08	135,967,972.94	15,071,607.98	399,862,686.11	0.453	0.0593
Partners	338	182	7,821,750.08	36,966,586.86	15,071,607.98	185,364,477.96	0.222	0.0616

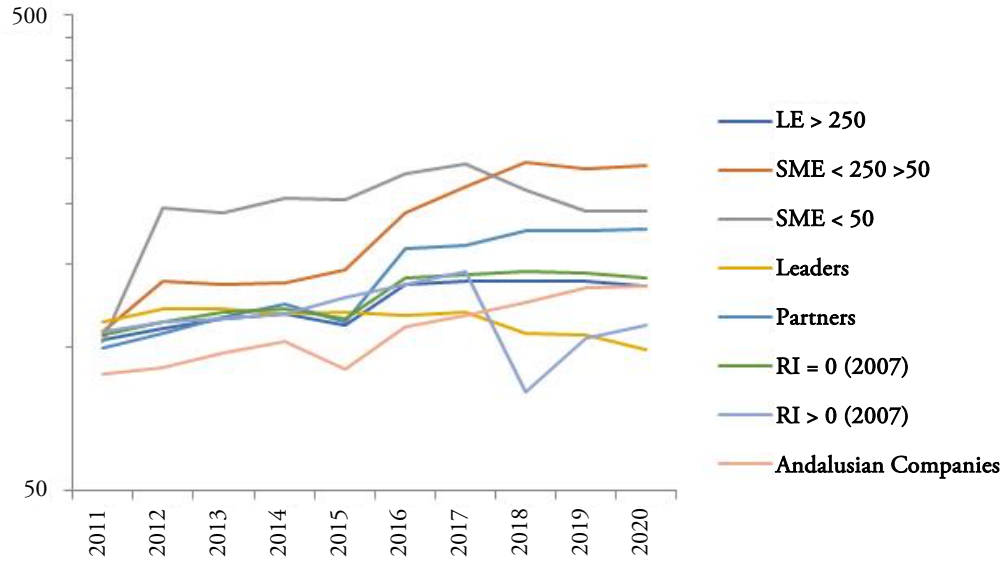
Source: Own elaboration using *software R.*

IMPACT ON EMPLOYMENT BY TYPE OF COMPANY

In 2011, the companies participating in the policy analysed had 390,659 employees, reaching 516,592 in 2020. Medium sized companies show the greatest relative growth in this indicator, followed by small-sized companies and large companies. Partner companies also increased their number of

employees to a greater extent than the leaders. With regard to the evolution of the companies according to their participation in innovation, it is those that were not already innovating in 2011 (RI=0) that experienced the greatest increase in the period analysed, with the evolution also being positive for companies that were not innovating in that initial year (RI>0). Only leader companies and those that were previously innovative at the beginning of the period obtained worse results in the period than the control sample (Figure 3).

FIGURE 3.
Comparative evolution of employment of companies participating in Innterconecta-Andalucía 2011-2020, by size and business role (index 2007=100, log10(x))



Source: Own elaboration based on data from ARDÁN and CDTI.

We performed the statistical test for investment in development using the same methodology as above. The number of companies in the control sample with activated data in their accounting for investment in development is n_5 = 355, while for the total number of Innterconecta participants the different values shown for n_6 were taken given that the sample of companies did not always have values for all companies and variables (table 9). The mean of the values for the first sample after the application of the funds is $\bar{x}_5$ = 150.62 and its standard deviation σ_5 = 327.03, while for the companies that received resources from the innovation policy the mean $\bar{x}_6$ and standard deviation σ_6 take higher values in almost all cases, except for SMEs<50 employees. The value of the standardised mean difference (SMD) is $index\text{-}d_{InvDevelopment}$ is greater than 0.1 in almost all cases, which would indicate a situation of imbalance and would require the reapplication of PSM. The PSM analysis again shows the existence of positive results for three types of companies: LE, leader companies and companies that were not innovating previously.

TABLE 9.
Results of the statistical analysis of employment using PSM

	n5	n6	$\bar{x}5$	$\bar{x}6$	$\sigma 5$	$\sigma 6$	Index-d (DME)	p-value
LE>250 employees	355	76	150.62	1,748.93	327.03	2,755.44	0.815	0.0003
SME<250>50 employees	355	72	150.62	124.74	327.03	52.01	0.111	0.8968
SME<50 employees	355	83	150.62	28.71	327.03	13.18	0.527	0.8800
RI=0 (2011)	355	223	150.62	625.98	327.03	1,789.65	0.370	0.0009
RI>0 (2011)	355	8	150.62	586.25	327.03	552.03	0.960	0.8743
Leaders	355	51	150.62	1,146.43	327.03	1,788.71	0.774	0.0403
Partners	355	181	150.62	474.25	327.03	1,724.95	0.261	0.0644

Source: Own elaboration using *software R.*

Below is a summary table listing the results observed for each of the three main indicators of business growth analyzed, differentiating companies by size and by role within the projects (table 10).

TABLE 10.
Summary of the results of positive impact (+), or not demonstrated (=) of the analyzed policy, by indicator

	LE>250 employees	SME<250>50 employees	SME<50 employees	RI=0 (2011)	RI>0 (2011)	Leaders	Partners
Revenue	+	=	=	+	=	+	=
GVA	+	=	=	+	=	+*	=
Employment	+	=	=	+	=	+	=

***Note:** values close to the confirmation limit.
Source: Own elaboration.

5. POLICY IMPLICATIONS AND RECOMMENDATIONS

Evaluating business growth and European policies is a complex task that presents additional difficulties to the context in which they occur. These difficulties include not only the choice of an appropriate methodology for measuring the impact of policy on business actors, but also the causal attribution of observed outcomes. These difficulties could lead one to think that there is a certain degree of indeterminacy in the results. In this sense, a rigorous analysis of the impact of these policies should not be exempt from a certain degree of caution when interpreting the data and extrapolating them to other territories. In view of the above, it has been considered appropriate to differentiate in the conclusions between practical and policy considerations.

5.1. PRACTICAL CONSIDERATIONS

In view of the results obtained, the average size of the projects approved in Innterconecta (approximately €4-5 M) has not had a clear impact on the growth of the Andalusian companies that have participated in this programme.

Specifically, regarding the impact on the main growth indicators for the companies participating in Innterconecta, the graphical analysis shows some differences between what happened with larger and smaller companies. Indeed, SMEs would show the greatest impact on the three indicators analysed, while

for larger companies this improvement would be less significant. For the leading and partner companies of the projects, and for the companies that did not innovate previously and those that did, the graphical results are generally positive, not allowing a great difference to be observed between them, with the impact being slightly lower in the case of the partner companies. However, the results of the statistical test confirm that there has not been a significant impact on the indicators analysed for the companies participating in this policy, except for the positive impact for LE, project leaders and companies that did not innovate previously, which gives us a very specific profile of results in which SMEs do not participate.

The centralised management of the FT from the CDTI possibly explains some of the problems detected in its execution, such as the delay in launching calls for proposals, the direction of priorities and the vocation to facilitate the participation of large companies, not always with registered offices in the autonomous community, in leading the projects.

5.2. Policy considerations

Expectations for the improvement of business innovation in Andalusia were high following the implementation of the Innterconecta programme, which was endowed with almost 500 million euros. However, the management and application of these resources has led to modest results with respect to the objectives formulated. In view of the indicators analysed, it is not possible to affirm, for example, that a greater growth in SMEs mobilised has been achieved, despite the fact that these companies are one of the specific objectives of the programme. On the contrary, LEs and project leaders (conformed mainly by LEs) have been the companies that have benefited most from this policy.

On the other hand, a positive aspect of the implementation of this policy, which was not a previous specific objective, is that those companies that were not previously involved in innovation have been able to take advantage of the resources to achieve higher revenue and increase their number of employees.

In view of the above results, it can be argued that the objectives of the policy have not been fully met. In this respect, the size of the projects supported and the role played by the partner companies in the partnership projects could be improved and policies could be reformulated to ensure that smaller companies have a greater capacity to absorb the impact of the funds.

The existence of centralised management at CDTI and the existence of leading project companies with registered offices outside the autonomous community suggests, for the authors, that the level of centralization-decentralization of these policies could be negatively influencing the results observed for Andalusian companies, for being part of the impact absorbed by non-Andalusian companies, but further research is necessary in this field.

Finally, for the future, it would be advisable to continue working on more precise indicators in innovation programmes and calls for proposals (such as those indicated in this study or through growth in corporate sales and profits, increased investment, or the financial and market value of the companies), so that the impact of these policies on the business fabric can be analysed by differentiating the results by agents´ characteristics, in order to be able to assess the effects of the application of funds in different dimensions.

Funding

This research has been supported by the ICEDE research group, to which the authors belong, Galician Competitive Research Group ED431C 2022/15 financed by Xunta de Galicia.

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Appendix

Table A.
Key data on the Technology Fund and the Smart Growth Programme

	Technológy Fund	Smart Growth
Assignment to Spain	2.248,45 M€	3.939,18 M€
Assignment to Andalusia	976,80 M€	1.612 M€*
Territorial distribution Funds	-70% for Obj. Convergence regions (Andalusia, Galicia, Extremadura and Castilla La Mancha) -15% for Phasing-in regions (growth effect) -10% for Competitiveness Objective regions -5% for Phasing-out regions (statistical effect)	-Plurirregional
Objectives	-Articulate and integrate the Spanish R&D&I system with the regional innovation systems -Promote business innovation, especially in SMEs in Convergence Objective regions -Support the transfer of research results to companies	-Promoting R&D&I -Improving the use, quality and access to Information and Communication Technologies (ICT) -Improve the communication and competitiveness of SMEs
	-Widen the base of the S-C-T-E by attracting SMEs to R&D&I	
	-Promote gender equality in R&D&I	
Subsided actions	-Vertebrate the innovation system, incorporating SMEs into innovative activity -Create and consolidate Technology and Research Centres oriented towards relations with companies -Promote the transfer of research from PRIs to companies -Attract SMEs and other agents to innovation and research activity	-Capacity building for the development of R&D&I activities supported by competitive scientific infrastructures at European and international level -Stimulating and fostering capacities for the implementation of business R&D&I projects -Promoting the incorporation of researchers and R&D&I personnel and fostering mobility between public sector personnel and the business fabric, as well as the creation of high added value employment

Source: Own elaboration, taken from Author(2023)

*Note: Total forecast expenditure (Boscá, Escribá, Feri & Murgui, 2016)

Abreviations

ANNI- Agencia Nacional de Investigación e Innovación (UY)

CDTI- Centre for Industrial and Technological Development (Spain)

ERDF- European and Regional Development Funds

ESIF- European and Structural Investment Funds

EU- European Union

GDP- Gross Domestic Product

GVA- Gross Value Added

INE- Spanish Statistical Institute

LE- Large Enterprises

PSM- Propensity Score Matching

RI- Research Investment

R&D- Research and Development

R&D&I- Research and Development and Innovation

SGP- Smart Growth Programme

SME- Small and Medium Enterprises

TF- Technology Fund