Science and technology parks and cooperation for innovation: Empirical evidence from Spain

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Science and Technology Parks and Cooperation for Innovation: Empirical evidence from Spain

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ABSTRACT

Science and Technology Parks (STPs) are one of the most important regional innovation policy initiatives. Previous studies show that location in a Park promotes cooperation for innovation but have not investigated if they help to achieve better results from cooperation. We extend previous literature by analyzing how STPs influence the results of cooperation of Park firms and how this influence is channelled. We rely on a much larger sample of firms and STPs than previous studies and account for selection bias and endogeneity when these problems arise. Results show that location in a STP increases the likelihood of cooperation for innovation and the intangible results from cooperation with the main innovation partner, mainly due to the higher diversity of the relationship.

Keywords: Science and technology parks; cooperation; innovation; effect; agglomerations

1. INTRODUCTION

Agglomerations of firms, universities and other knowledge-intensive organizations are beneficial for the generation and utilization of knowledge (Ponds et al., 2010; Boschma and Frenken, 2011), which has been used as justification for the development of Science and Technology Parks (STPs) as part of public policy to stimulate innovation. The objectives of STPs include the promotion of cooperation, and technology transfer, especially between firms and knowledge providers such as universities and research institutes (Hogan, 1996).

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Previous academic research mostly analyses the effect of location in an STP on firm's results and behaviour (Löfsten and Lindelöf, 2005; Fukugawa, 2006; Squicciarini, 2008). While the effect on results is not clear, the empirical evidence shows that the likelihood of cooperation for innovation between firms and knowledge providers increases. However, most of these studies use very small samples of firms and STPs.

The present work extends this literature in a number of ways. First, it focuses on analysing the influence of STPs on the results of cooperation, how STP effects are channelled, and how much they increase the likelihood of cooperation.

Second, it uses a much larger sample of firms, and exploits the responses from a standard Community Innovation Survey (CIS) type questionnaire to evaluate the influence of STPs upon cooperation. This allows already tested covariates that capture the innovation behaviour of firms, to be used. This study relies on the 2007 Spanish Survey of Technological Innovation in Companies, undertaken by Spanish Institute of Statistics (INE), and cover 39,722 companies that are representative of the size, sector and regional location of the population of Spanish companies, 653 of which are located in 22 of the 25 Spanish STPs.

Third, it takes account of endogeneity and sample selection bias problems. The first problem arises because firms are not randomly located in a STP: their location is the result of the firm's decision and the STP's acceptance and these decisions could be explained by partially unobserved factors. The second problem can arise if the subsamples used are not representative of the population being analysed.

Fourth, it provides evidence for the Spanish case. Although STPs are a major Spanish innovation policy initiative, with the first Spanish STPs created in the 1980s and their number having grown considerably since then, evidence on their performance is scarce (Vásquez-Urriago et al., 2011).

Our results show that, even after accounting for endogeneity, STPs are important for fostering cooperation for innovation. We find also that the intangible outputs from cooperation are higher for Park firms for the main reason that their location facilitates the development of diverse cooperative relationships.

The paper is organized as follows. Section 2 reviews previous arguments on the effect of agglomeration on cooperation behaviour, and empirical evidence on the role of STPs. Section 3 explains methodological issues related to the empirical work. Section 4 presents the results of our analysis of the effect of STPs on the likelihood of cooperation and Section 5 focuses on the effect of STPs on the results of cooperation and the main drivers of this effect. Section 6 presents the conclusions.

2. PREVIOUS LITERATURE

2.1. AGGLOMERATION AND COOPERATION FOR INNOVATION

The agglomeration of knowledge intensive organizations traditionally was considered a source of innovation (Marshall, 1890; Jacobs, 1970), but it is only since the early 1990s that research has focused particularly on this effect (Feldman and Kogler, 2010). One important reason for the influence of agglomeration on innovation is that agglomeration favours the initiation and development of linkages between different organizations (Baptista, 1998; Hervas-Oliver and Albors-Garrigos, 2009). The likelihood of establishing relationships is higher for firms in agglomerations. On the one hand, proximity increases the chances of casual meetings and conversations that identify common interest, and may lead to joint projects (Guillain and Huriot, 2001). On the other, proximity reduces search costs (Feldman, 1999), and increases the likelihood of explicit searches for innovation partners (MacPherson, 1997). In addition, innovation partnerships in agglomerations are cheaper and work better, which provides another incentive for establishing a relationship.

There is a lack of agreement about why relationships between co-located partners work better (Breschi and Lissoni, 2001; Dahl and Pedersen, 2004; Giuliani, 2007; Ibrahim et al., 2009), but the debate is based on two main arguments. First, geographical proximity facilitates knowledge flows and, as a result, learning processes because closeness has a positive effect on the number of interactions (Torre and Gilly, 2000). Since tacit knowledge plays an important role in innovation processes (Polanyi, 1966) and frequent and repeated face-to-face contacts are key to its transmission (Baptista, 1998; Amin and Wilkinson, 1999), proximity is a facilitator. Maskell and Malmberg (1999) argue that the higher the tacit component of the knowledge, the more important is geographical proximity for knowledge to flow between partners. Accordingly, innovation partnerships among firms in agglomerations should achieve higher flows of knowledge due to the more diverse relationships they enable.

Second, geographical proximity reduces uncertainty and contributes to the building of trust which reduces the transactions costs involved in joint projects and results in more stable and longer lasting relationships (Bennet et al., 2000; Love and Roper, 2001). Longer relationships encourage the sharing of more valuable knowledge, resulting in a better adjustment between expectations and results, greater trust and increasing returns from collaboration (Izushi, 2003; Abramovsky and Simpson, 2011), especially in relation to intangible results (Barge-Gil and Modrego, 2011).

2.2. STPs and cooperation for innovation

Several empirical studies have analysed the role of STPs on cooperation for innovation, focusing mainly on firm-university links. Two main groups of studies are shown in Table 1. The first group is composed of case studies of STP in UK, Australia and Greece, that investigate whether location in a STP fosters university-industry links and, in the case of the last two studies listed, also inter-firm links. These studies analyse the behaviour of Park firms and find that they very often develop informal links and, to a lesser extent, formal links with other firms and local universities.

The studies in the second group are mostly quantitative. They use matching techniques to develop a control group of off-Park firms so that the effect of being located in a Park can be estimated. The evidence tends to show a positive effect of location in a STP, on collaboration with local universities and firms. However, these studies mostly do not control for endogeneity of Park location. The exception is Fukugawa (2006), who finds that an STP location has an effect on firms' links with universities, which is not restricted to local universities.

To sum up, these studies provide evidence that location in a Park promotes cooperation for innovation. However, none of this work investigates the influence of an STP location on the results of cooperative projects. This is the main focus of the present analysis.

Table 1: Studies analysing STPs and cooperation for innovation

Method	Study	Country	Sample[I]	Variables of cooperation	Results
Case study	Vedovello (1997)	United Kingdom	1 STP	**links between Park firms and host university**: - *informal links* (personal contacts, attendance at seminars, access to literature and equipment, etc.) - *human resources links* (sponsored student projects, recruitment of graduates, scientists and engineers, etc.) - *formal links* (research contracts, joint research, analysis and testing, etc.)	Significant presence of *informal* and *human resources* links in Park firms
	Phillimore (1999)	Australia	1 STP	**links between Park firms and host university** (cf Vedovello, 1997) **links between Park firms** (joint research, shared equipment, commercial transactions, social interaction)	Significant presence of both types of links in Park firms
	Bakouros et al. (2002)	Greece	3 STPs	**links between Park firms and local universities** (cf Vedovello, 1997) **links between Park firms** (cf Phillimore, 1999)	Significant presence of *informal and human resources links* (firm-university) in all cases and of *formal links* in STPs Links (between firms) in commercial transactions and social interaction
Matching	Monck et al. (1988)	United Kingdom	183 Park firms / 101 off Park firms	**links between firms and local universities** (informal contact, employment of academics, sponsor research, recruitment of graduates, training, access to equipment, test / analysis, etc.)	effect (+) of park location on informal contact and access to equipment (but not on more formal links)
	Westhead and Storey (1995)	United Kingdom	183 Park firms / 101 off Park firms and 47 Park firms / 48 off Park firms)	**links between firms and local universities**	effect (+) of Park location on links in general

	Löfsten and Lindelöf (2002, 2003, 2005); Lindelöf and Löfsten (2004)	Sweden	134 Park NTBFs* / 139 off Park firms	**links between firms and local universities** (R&D projects, basic and applied research, consultancy, discussions, equipment, R&D documents, recruitments, etc..)	Effect (+) of Park location on all links. Among Park NTBFs, more frequent links among academic NTBFs than corporate NTBFs
	Colombo and Delmastro (2002)	Italy	45 Park NTBFs / 45 off Park firms	**formal links between firms and universities** **formal links between firms and clients, suppliers and other firms** (commercial agreements, technological agreements)	Effect (+) of Park location on total links (in general) and on links with universities
	Malairaja and Zawdie (2008)	Malaysia	22 Park PYMES HT** / 30 off Park firms	**links between firms and local universities** (informal contact, projects, employment of academics and consultancy, equipment, collaborative research)	More links in Park firms, but no significant effects of park location
Matching and regression	Fukugawa (2006)	Japan	74 Park NTBFs / 138 off Park firms	**Joint research between firms and Higher Education Institutes (HEIs)** **Joint research between firms and local HEIs**	Effect (+) of park location on joint research with HEIs, although research partner of Park firms unlikely to be in the same region

[1] number of parks analyzed in case studies, and number of companies in other studies
*NTBF – New Technology Based Firms
**PYMES HT -

3. METHODOLOGY AND DATA

The empirical work is in two parts. We analyse the effect of location in a STP on the likelihood of formal cooperation for innovation and on the results from formal collaboration agreements. We also examine the channels of this effect. Investigation of the results of agreements is limited to relationships between firms and external sources of knowledge (ESK).

Methodologically, we rely on the treatment evaluation literature. Park firms are the treated group; non-Park firms are the untreated group. We estimate the Average Treatment Effect (ATE), understood as the expected effect of treatment on an individual drawn randomly from the population (Wooldridge, 2002). The ATE is the expected difference between outcomes, with and without treatment. This framework allows the underlying assumptions to be explicit. When the ATE is estimated as mean differences between Park and non-Park firms the underlying assumption is that location in a STP is completely random, which is an unrealistic assumption.[1] We can make two different assumptions about the ways in which Park and non-Park firms differ.

First, we can assume that it is possible to observe these differences. We use a regression with controls or a regression with propensity score.[2] Second, if we suspect that some of the (non random) differences between firms inside and outside Parks are not observable, we have an endogeneity problem, which is dealt with by applying a control function approach and instrumental variables with propensity score.

The data were extracted from the 2007 Spanish Survey of Technological Innovation in Companies undertaken by INE. This annual survey is modelled on the CIS. The sample population is 39,722 companies, representative of the size, sector and regional location of the population of Spanish companies.[3] The survey includes a question on location in a STP. We constructed a dichotomous variable (*SSTP*) that takes the value 1 if the company is located in one of the STPs belonging to the Association of Science and Technology Parks of Spain (APTE), and 0 otherwise: 653 companies (1.64% of the sample) are located in a Spanish STP.[4] The survey has an appendix of questions on the characteristics of cooperation with the firm's main innovation partner. The responses to these questions allow a deeper analysis of the influence of STP location on cooperation results.

[1] On the one hand, firms decide if they want to be located in a STP and, on the other, STPs usually have some conditions for belonging.
[2] The control variables are replaced by the estimated probability, according to these control variables, of the firm's being located in a STP.
[3] The specific characteristics of this sample are available on the INE webpage: http://www.ine.es/ioe/ioeFicha.jsp?cod=30061
[4] These firms are located in 22 out of the 25 STP in Spain that were included into APTE in 2007.

4. LOCATION IN AN STP AND LIKELIHOOD OF COOPERATION FOR INNOVATION

The dependent variable for the first part of the empirical analysis is a dummy variable that takes the value 1 if the firms engaged in formal collaboration for innovation during the period 2005-2007, and zero otherwise:[5] 4,695 firms (11.8% of total sample) had a formal collaboration. The definition of a formal cooperative agreement follows the definition in the Oslo Manual.[6] Potential partners include suppliers, customers, competitors, consultants or private knowledge intensive business firms, universities, public research centres and technology institutes[7].

Several firm specific factors have been found to influence the likelihood of cooperation for innovation. CIS data have been used to analyse what determines the likelihood of cooperation for innovation and there are several controls that have been found relevant for explaining cooperation. Barge-Gil (2010) provides a review of these studies and the indicators used. In this study, we include the general characteristics of firms (size, belonging to a group, export intensity, dummy for new firms, incidence and technological level of the sector) and the characteristics of the innovation process (innovation effort and cost and information obstacles encountered). Table 2 provides definitions of the variables.

Table 3 presents the results. The first row shows the percentage of Park and non-Park firms cooperating for innovation: 45% of Park firms and 11% of off-Park firms cooperate.

The second and third rows show the results of the regressions with controls and *propensity score.* Estimations were performed using Probit and Ordinary Least Squares (OLS). The results show that the effect of STP location is positive and significant, regardless of the estimation method used. The likelihood of cooperation increases by around 16-18 percentage points for the average firm (17-20 for the median firm).

The fourth and fifth rows show results of the control function and instrumental variables with propensity score approaches.[8] Both methods require an additional variable (instrument) related to the likelihood of being located in a STP but not the likelihood of cooperation. We use an indicator for the 'availability' of space in a STP: the percentage of firms located in an STP in the

[5] The survey asked firms whether they had engaged in innovation activities in the period. Only those firms responding positively (whether the efforts were successful or not) are considered potential candidates for cooperation, i.e. firms that do not engage in innovation activity do not cooperate for innovation.

[6] Innovation co-operation involves active participation in joint innovation projects with other organizations. These may be other enterprises or non- commercial institutions. The partners need not derive immediate commercial benefit from the venture. Contracting out of work that does not involve active collaboration is not considered to be co-operation. Co-operation is distinct from sourcing open information and acquisition of knowledge and technology in that all the parties involved must take an active part in the work (OECD and Eurostat, 2005, 79)

[7] One limitation of the survey is that it does not provide information regarding partner location. That is, we do not know if partners are located in the Park or elsewhere. Related evidence from an official survey of STP firms shows that 628 from 776 (81%) cooperating STP firms do cooperate with organizations from the same STP so that we can assume that most of partners are located in the same STP. However, this is an issue deserving further exploration. (For more information on this survey, see www.idi.mineco.gob.es).

[8] We performed two tests for exogeneity; the results did not allow us to reject the endogeneity assumption. We followed the procedure described in Wooldridge (2003: 483) and also performed a Hausman test to compare the coefficients of the OLS and the two stage OLS (2SLS) regressions. The results are presented in the Appendix.

firm's region.[9] This variable is calculated based on information from the APTE on the number of firms in each park, and data published in the Central Companies Directory (DIRCE) based on the regional business census.[10]

Table 2: Definition of covariates

General Company Characteristics	
Company size	Total turnover in 2005 (in logarithmic: natural logarithm of (1+indicator)). The square of this variable is also included.
Exporting behaviour	Share of export per total turnover in 2005
Group	Dummy variable - 1 if the company is part of a group
Newly established	Dummy variable - 1 if the company was established in 2005-2007
Merged	Dummy variable - 1 if turnover increased by 10% or more as a result of a merger with another company during 2005-2007
Downsized	Dummy variable - 1 if turnover decreased by 10% or more owing to the sale or closure of part of the company during 2005-2007
Technological level of sectors of activity	7 dummy variables: high-tech manufacturing, medium-high-tech manufacturing, medium-low-tech manufacturing, low-tech manufacturing, knowledge intensity service, no-knowledge intensity service, other sectors[a].
Companies` Innovation Activity	
Innovation effort	Expenditure on innovation activities in 2007 ('000 euros per employee)
Cost obstacles	Average measure of importance of the following factors as barriers to innovation during 2005-2007: lack of internal funds, lack of sources of finance, high costs of innovating, market dominated by established enterprises[b]
Information obstacles	Average importance of the following factors as barriers to innovation during 2005-2007: lack of qualified personnel, lack of information on technology, lack of information on the markets, problems finding cooperation partners[b]

[a] Classification of manufacturing and services (OECD, 2005). Other sectors: agriculture; extractive activities; production and distribution of electricity, gas and water; construction.
[b] Importance ranked on the scale from 1(crucial) to 4 (unimportant).The indicator is equal to [n / ∑ factors importance]

Both methods confirm the previous results. Location in a STP positively influences the probability of cooperation. The size of the effect also is similar: around 15-16 percentage points with the control function approach, and 16-21 percentage points with the instrumental variables method.[11]

The results for the control variables are presented in Table 4. They are mainly in line with the findings summarised in Barge-Gil (2010). Size, exporting, being part of a group, technological level of the industry, innovation effort and obstacles are all positively related to the probability of cooperation.

[9] Alternatively, we use the number and dimension (in m^2) of STPs in each region. The results do not change if these different instruments are used.
[10] This variable is positively related to location in a STP. The coefficient is 2.399 and std error 0.1715.
[11] Probit estimations with instrumental variables give consistent coefficient estimations but not consistent std errors (Adkins, 2011). This explains the non-signficance of the effect when using probit with instrumental variables, despite its similar size. OLS do not involve this problem and the coefficients are significant.

Table 3: ATE estimation of location in Spanish STPs, on cooperation for innovation

Dependent variable[I]	***Cooperation***					
Estimation Method	**Companies in an STP**		**Companies outside an STP**		**Difference**	
Mean differences	45.02		11.26		33.75 [a]	(0.012)
	OLS		**Probit**[II]			
			Mean		Median	
Regression with controls	0.22[a]	(0.012)	0.16[a]	(0.018)	0.20[a]	(0.021)
Regression with propensity score	0.21[a]	(0.012)	0.18[a]	(0.020)	0.17[a]	(0.019)
Control function	0.21[a]	(0.007)	0.15[a]	(0.000)	0.16[a]	(0.000)
IV with propensity score	0.80[a]	(0.087)	0.16	(0.103)	0.21[c]	(0.125)
# of observations	39722					

[I] *cooperation* = dummy: cooperation for innovation in 2005-2007.
[II] Marginal effects shown in probit models.
Standard errors in parentheses.
[a] p-value lower than 0.01, [c] p-value lower than 0.10.
All controls from table 2 are included in the regressions.

5. LOCATION ON STPs AND RESULTS FROM COOPERATION FOR INNOVATION

We have shown that location in a STP increases the likelihood of cooperation for innovation. In this section, we analyse whether cooperation yields better results for firms located in a STP and also examines the potential channels accounting for this.

5.1. Data and definition of variables

The data in this section are from an Appendix to the Spanish CIS Survey introduced in 2007. It contains questions that are addressed only to cooperating firms that declared that their main innovation partner in the period 2005-2007 was an ESK (university, public research centre, technology institute or private knowledge intensive services provider). The focus on ESK in this study is justified because one of the main purposes of STPs is increasing the flows of knowledge between ESK (specially, but not exclusively, universities) and on-Park firms. The questions in the Appendix relate exclusively to the main partner, which reduces the attribution problem faced by empirical studies that analyse cooperation more generally (Barge-Gil and Modrego, 2011) .

The Appendix questions were addressed by 1,820 firms (38.8% of firms cooperating in the 2005-2007 period), 150 of which are located in STPs (i.e., 51% of cooperating firms are in STPs). The questions ask about the characteristic of the relationship with the main innovation partner (e.g. length of the relationship and type of activities targeted) and about the intangible and economic results obtained (see Table 5). Firms were asked to evaluate the results on a Likert[12] scale.

[12] Where 0 = absence of impact, 1 = low impact, 2 = intermediate impact, 3 = high impact. Likert scales have been criticised because they introduce measurement error unduced by subjective responses (Levin et al., 1987). These indicators were tested by comparing with the results from quantitative answers in the

Table 4: Results for control variables for likelihood of cooperation

	Dependent variable	*Cooperation*					
	Estimation Method	*Regression with controls*		*Control function*		*IV with propensity score*	
General Company Characteristics	*Company size*	-0.08[a]	(0.00)	-0.08[a]	(0.00)	-0.08[a]	(0.00)
	Company size ^2[II]	0.005[a]	(0.00)	0.005[a]	(0.00)	0.005[a]	(0.00)
	Exporting behaviour	0.68[a]	(0.06)	0.68[a]	(0.06)	0.67[a]	(0.06)
	Group	0.33[a]	(0.02)	0.33[a]	(0.02)	0.32[a]	(0.02)
	Newly established	0.23[a]	(0.04)	0.22[a]	(0.04)	0.21[a]	(0.05)
	Merged	0.04	(0.06)	0.05	(0.06)	0.04	(0.06)
	Downsized	-0.31[a]	(0.07)	-0.30[a]	(0.07)	-0.31[a]	(0.07)
	low-tech manufacturing	-0.50[a]	(0.04)	-0.53[a]	(0.05)	-0.49[a]	(0.05)
	medium-low-tech manufacturing	-0.45[a]	(0.04)	-0.48[a]	(0.05)	-0.44[a]	(0.06)
	medium-high-tech manufacturing	-0.20[a]	(0.04)	-0.23[a]	(0.05)	-0.19[a]	(0.05)
	knowledge intensity service	0.09[b]	(0.04)	0.09[b]	(0.04)	0.09[c]	(0.04)
	no-knowledge intensity service	-0.64[a]	(0.04)	-0.67[a]	(0.04)	-0.63[a]	(0.05)
	other sectors	-0.59[a]	(0.05)	-0.61[a]	(0.05)	-0.57[a]	(0.06)
Inn. Act.	*Innovation effort*	0.004[a]	(0.00)	0.008[a]	(0.00)	0.008[a]	(0.00)
	Cost obstacles	0.94[a]	(0.04)	0.94[a]	(0.04)	0.93[a]	(0.05)
	Information obstacles	0.15[b]	(0.06)	0.16[a]	(0.06)	0.15[b]	(0.06)
	Constant	-1.54[a]	(0.05)	-1.55[a]	(0.06)	-1.54[a]	(0.06)
	Chi2	3684.89[a]		3459.66[a]		3809.75[a]	
	# of observations	39722					

[I] *cooperation* = dummy: cooperation for innovation in 2005-2007.
[II] Size effect is mainly positive as the minimum likelihood of cooperation is reached for values around 1,327€-1.524€ in firms' sales.
High technology manufacturing is used as baseline category.
Standard errors in parentheses.
[a] p-value lower than 0.01, [b] p-value lower than 0.05, [c] p-value lower than 0.10.
SSTP is included in every regression.

We constructed average values and first factor indicators based on this information:

- Average value of intangible results from cooperation with the main innovation partner (*Effects*);

- Average value of economic results from cooperation with the main innovation partner (*Impacts*);

- First factor[13] from intangible results from cooperation with the main innovation partner (*Fac_Effects*);

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case of the economic results (Barge-Gil and Modrego, 2011). The results were very similar suggesting that using the Likert scale is not affecting the results. Also, we use average values and factor analysis to check the robustness of results to different methods of aggregating the information obtained from the Likert scores.

[13] We conducted principal component analysis and extracted the first factor. All eight intangible results were included. A similar strategy was followed for the economic results.

- First factor from economic results from cooperation with the main innovation partner (*Fac_Impacts*).

Table 5: Indicators for results from cooperation for innovation

Intangible results from cooperation for innovation	
Strategies	Enhanced ability to define and plan innovation activities (*effect1*)
	Better market understanding (*effect2*)
Human Resources	Learning and staff training in new areas (*effect3*)
	Enhanced ability for teamworking and knowledge sharing (*effect4*)
Information management	Enhanced ability to retrieve and use information (*effect5*)
	Improved relationship between firm's R&D and other departments (*effect6*)
Relationships management	Improved utilization of other ESK (*effect7*)
	Improved access to public programs of public funding for innovation (*effect8*)
Economic results from cooperation for innovation	
Sales (*impact1*)	
Exports (*impact2*)	
Production costs (*impact3*)	
Profits (before taxes) (*impact4*)	
Employment (*impact5*)	
Internal R&D (*impact6*)	
Productivity (*impact7*)	

Table 6 presents the descriptive statistics for these indicators. On average, firms consider the impact on economic results of their main partner to be quite low, and the impact on intangible results between low and intermediate.

To understand why cooperation might produce different results for Park and off-Park firms we defined two additional variables to capture the arguments proposed in the literature.

First, diversity of the relationship (*Diversity*) is measured as the number of different activities engaged in during the period analysed. The activities considered are: training, laboratory testing services, technological consultancy, managerial consultancy, research and development and the indicator is in the range 1 to 6. Second, length of relationship (*Length*) is measured as the number of year since the cooperation started (in logs).[14] (see Table 6).

[14] This variable had 20 missing values. We checked whether the results were sensitive to the exclusion of these observations and we found them to be very similar.

Table 6: Summary statistics. Composite indicators for results and characteristics of cooperation for innovation

	Summary Statistics			
Variables	Mean	D.E.	Min.	Max.
Effects	1.49	0.64	0	3
Fac_Effects	2.48e-09	1	-2.29	2.30
Impacts	1.14	0.62	0	3
Fac_Impacts	-2.31e-09	1	-1.78	2.95
Diversity	2.80	1.32	1	6
Length	1.32	0.80	0	4.20
# of observations	1820			

5.2 Location on STP and results from collaboration for innovation with ESK

Our aim is to estimate the ATE of being located in a STP so we use the set of control variables in Table 2. Cooperation characteristics are not included; because they are likely to be affected by location in a STP so their inclusion would invalidate interpretation of the coefficient of STP as the ATE (Wooldridge, 2003; Angrist and Pischke, 2009). However, they may explain the effects of a Park location, which is something we explore later.

We need to take account of sample selection bias and endogeneity. Our sample here is a selected sample based on the firms that responded to the Appendix questions and whose main innovation partner is a ESK. We account for this by employing a Heckman estimation. The Mills ratio is insignificant and we found no evidence of sample selection[15]. We tested for endogeneity in the same way as before. This subsample is composed of a more homogeneous group of firms compared to the whole sample, which is probably why location in STP was not found to be endogenous. Accordingly, we use OLS estimations.

Table 7 presents the results**.** The first three rows show the mean values of the intangible and economic results for Park and non-Park firms. The values are higher for firms in STPs (1.68 vs 1.47 for *Effects* and 1.27 vs 1.13 for *Impacts*). The fourth and fifth rows respectively show the results of the regression with controls and propensity score. Both methods show a positive and significant effect of location in a STP on the intangible results of cooperation: location in a STP increases the effect by around 0.13-0.16 (almost a quarter of a standard deviation). This result is robust to average or first factor analysis. We found no effect of location in a Park on the economic results from cooperation.

[15] Heckman estimations are available upon request from the authors.

Table 7: ATE estimation of location in Spanish STPs, on results from cooperation for innovation

	Dependent variable	*Effects*	*Fac_Effects*	*Impacts*	*Fac_Impacts*
Means difference	**Companies in an STP**	1.689	0.297	1.278	0.209
	Companies outside an STP	1.479	-0.026	1.133	-0.018
	Difference	0.209[a] (0.055)	0.323[a] (0.084)	0.145[a] (0.053)	0.228[a] (0.085)
Regression with controls		0.137[b] (0.057)	0.212[b] (0.088)	0.084 (0.054)	0.132 (0.086)
Regression with propensity score		0.159[a] (0.055)	0.247[a] (0.086)	0.084 0.054)	0.133 (0.086)
	# of observations	1820			

OLS estimations.
Standard errors in parentheses.
[a] p-value lower than 0.01, [b] p-value lower than 0.05.
All controls from Table 2 are included in the regressions.

5.3 Why intangible results from cooperation are better for Park firms?

As discussed in Section 2, an important outcome of agglomeration is more diverse and longer relationships. Thus, location in a STP could influence the characteristics of firm-ESK cooperation, which might be the 'channel' that explains why firms on STPs achieve higher intangible results from such cooperation. We explore this in two steps. First we regress the characteristics of the relationships (diversity and length) on location in a STP, and the controls. Second, we include the characteristics of the relationship in the previous intangible results regression to check for changes in the coefficient of STP.

Table 8 shows the results of the first step. Location in a STP positively influences the diversity (by 0.4 or around one-third of a standard deviation) and length (by around 20%) of the cooperation.

Table 8: Influence of Spanish STPs on the characteristics of cooperation for innovation

Dependent Variable	Coefficient of *SSTP*	
Diversity	0.397[a]	(0.116)
Length	0.204[a]	(0.069)
# of observations	1820 / 1800[I]	

OLS estimations with all the covariates.
Standard Errors in parentheses.
[a] p-value lower than 0.01.
[I] When *Length* is the dependent variable, number of observations is 1,800.

Table 9 presents the effect of adding the characteristics of the relationship to the regression in Table 7. We include diversity first and then length, and then both characteristics together. In all cases, diversity and length are significant at 1%, showing that they influence the intangible results achieved from cooperation. The coefficient of STP is much lower when relationship diversity is included but is not affected by relationship length. This suggests that most of the effect of location in a STP on the intangible results from cooperation is due to the diversity of the relationships which is due to location in a STP.

Tabla 9: Effect of Spanish STPs on the intangible results from cooperation, taking account of diversity and length of the relationship

Dependent variable	*Effects*	*Fac_Effects*
Including *Diversity*		
Regression with controls	0.064 (0.051)	0.101 (0.080)
Regression with propensity score	0.073 (0.056)	0.114 (0.087)
Including *Length*		
Regression with controls	0.120[b] (0.057)	0.187[b] (0.088)
Regression with propensity score	0.131[b] (0.057)	0.204[b] (0.089)
Including *Diversity* and *Length*		
Regression with controls	0.063 (0.052)	0.099 (0.081)
Regression with propensity score	0.072 (0.057)	0.114 (0.088)
# of observations	1820 / 1800[l]	

OLS estimations.
Standard errors in parentheses.
[b] p-value lower than 0.05.
All controls from Table 2 are included in the regressions.
[l] 1800 observations when length is included.

CONCLUSIONS

This paper has analysed the effect of location in a STP on the likelihood and the results of cooperation for innovation. Many studies show that STPs foster and promote cooperation among firms and external knowledge sources. Previous work has analysed the influence of STPs on the likelihood of cooperation using small samples of firms and STPs and usually not accounting for endogeneity and sample selection issues. The present study contributes by analysing both the influence of STPs on the likelihood of cooperation and on the results of cooperation. We use a very large sample of firms located in several different STPs, and the characteristics of the database allow us to use a large set of already proven covariates and to account for endogeneity and sample selection issues when necessary.

Our results show that location in a STP has a positive effect on the likelihood of cooperation for innovation. The magnitude of the difference is around 15-21 percentage points. This result extends the previous empirical evidence showing that STPs foster the building of formal cooperation by on-Park firms.

We show also that location on an STP positively affects the intangible results of cooperation with the firm's main innovation partner. We explored why the intangible results from cooperation are better for Park firms and found that the higher diversity of their relationship with the main partner can account for it. However, we found no effect of location in a STP on the economic results from cooperation.

It should be noted that the results from cooperation are measured in the short term so caution is required when interpreting this result. It could be that many impacts – especially economic effects – emerge only in the medium term (Ham and Mowery, 1998). Another limitation is the assumption of a homogeneous effect of STPs on the likelihood of and results from cooperation, independent of the specific characteristics of the firms and the STP, and the impossibility of knowing whether collaboration partners are located in the same STP. These issues point to directions for future research.

To sum up, we can provide evidence that location in a STP increases the likelihood of cooperation for innovation, and increases the intangible results from cooperation with the main innovation partner. Our results suggest also that the effect of a STP location on the intangible results from cooperation is driven mainly by the more diverse relationships established by the on Park firms.

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Appendix

Tests of exogeneity of the treatment (*SSTP*)

Dependent variable [I]	***Cooperation***	
I. Wooldridge (2003) [II]		
$\hat{v}$ coefficient	-1.35[a]	(0.196)
II. Hausman Test [III]		
Chi2	47.11[a]	(0.000)
# of observations	39722	

[I] *cooperation* = dummy: cooperation for innovation in 2005-2007.
[II] Standard Errors in parentheses. (v are residuals from the reduced form of the *SSTP* equation, and are included in the structural equation; If $\hat{v}$ coefficient = 0, *SSTP* is exogenous).
[III] Prob>chi2 in parentheses. (The null hypothesis is that *SSTP* is exogenous).
[a] p-value lower than 0.01.