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Science Parks versus Technology Parks: does the university make the difference?

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Abstract

The importance of universities as external source of knowledge for firms innovation has been widely recognized since the 80s? (Bozeman, 2000) and further emphasised within the triple helix (Etzkowitz and Leydesdorff, 1997) and the open-innovation (Chesbrough, 2003) paradigms. Different policies to facilitate academia-industry relations have been adopted (Storey and Tether, 1998), including Science and Technology Parks (STPs), whose one of the aims is stimulating and managing the flow of knowledge and technology between universities and firms (IASP, 2002).
Even though the idea of linking tenant firms with universities is a key concept in the development of STPs, the variability of existing experiences, regarding the commitment of universities in STPs? initiatives is well known (Monck et al., 1988). Although, the relationships between universities and STPs may adopt different forms, two general types of parks have

been usually identified: parks with a more marked research vocation, in which the university takes an active managerial role, herein called Science Parks and parks composed of firms engaged in the commercial application of advanced technology, where the presence of university is not essential, herein called Technology Parks.
This difference can partly explain the contrasting evidence found on the effectiveness of STPs as innovation policy instruments (see for instance Phan et al., 2005) but, to our knowledge, it has been mainly disregarded in past studies on STPs.
This paper aims at filling this gap by studying how the innovative performances of tenant firms are affected by the relations between the park and the university. In particular we study the effect of the level of formal involvement of the university in the park on two firms? innovation outputs (turnover from new to the market products and number of patent applications) and on links between tenants and university.
To this end we have joined together data from firms and from Spanish STPs. On the one hand, we used the 2009 Community Innovation Survey for Spain (published in 2011), which provides very detailed information about the characteristics of innovation process of firms. On the other hand, we collected information on the relationships between STPs and universities, using secondary sources of information, such as an internal survey of the former Department of Science and Innovation of the Spanish government and the 2009 annual report of the APTE, the Spanish STPs? association.
Results show that:
a) A higher involvement of university in the management of the park negatively affects the turnover from new to the market products. Firms on TPs outperform firms on SPs where the turnover from new to the market products is concerned.
b) A higher involvement of university in the management of the park positively affects the propensity of firms to apply for patents.
c) The involvement of the university in the park does not seem to affect the propensity of tenants to cooperate with the university nor the amount of R&D bought from the university.

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commercial application of advanced technology, where the presence of university is not essential, herein called *Technology Parks*.

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1. Introduction

Science and Technology Parks (STPs) has the objective, according to the official definition given by the International Association of Science Parks, to increase the wealth of its community by promoting the culture of innovation and stimulating and managing the flow of knowledge and technology (IASP, 2002). STPs pursue this aim by locating innovative firms in the same area, normally close to a university, to facilitate access to external source of knowledge, whose importance has been widely recognised since the 1950s when the linear model of innovation was conceptualised (Godin, 2006), and recently further emphasised within the open-innovation paradigm (Chesbrough, 2003).

STPs have shown a huge diffusion worldwide in recent decades, but have generated a thriving debate on their effectiveness as an instrument of innovation and technology policy and on their added value for tenants (Albahari et al., 2010). One reason behind this debate could be that STPs are very heterogeneous, specially regarding the role played by universities. While some STPs do not show any formal relationship with a university, other STPs has been established and developed by universities, with the aim to reduce the problems arising when managing joint research with industry (Forey and Lissoni, 2010).

In this study we want to analyse whether the type of involvement of the university in the STPs affects the innovative behaviour and output of tenants. To this aim we employ two main datasets: the CIS survey for Spain and the Survey 2009 on the Characteristics and Results of Science and Technology Parks.

The rest of the paper is organized as follows. Section 2 provides a literature review, focusing especially on the rationale behind the existence of STPs and on the relations between parks and universities. Section 3 specifies the data sources used and provides the definition of variables used in our regressions. Section 4 presents the results of our study. Eventually section 5 concludes and provides some cues for future research.

2. Literature review

2.1. *The rationale behind Science and Technology Parks*

It is a shared opinion that, without external interventions, free market mechanisms would result in underinvestment in innovation (Martin and Scott, 2000) so that innovation policies are required. Thus a large number of instruments has being set up by central and local governments to promote R&D and innovation (Lundvall and Borrás, 2005). STPs have been one of the main

initiatives and have shown a huge diffusion through the world, although their added value for tenant firms is still debated.

The issue of spatial (or geographical) proximity is central in the STPs' model. Although spatial proximity *per se* is not a sufficient condition for knowledge spillovers, a large body of literature claims that agents that are spatially closed benefit from knowledge externalities (Boschma, 2005). Spatial proximity is believed to be important for innovation because small geographical distances facilitate the transfer of knowledge, especially tacit knowledge (Howells, 2002), which is often locally bounded (Sonn and Storper, 2008) as it needs face-to-face interactions between people to be transferred.

STPs could also encourage other types of proximity, such as organizational and technological proximity (Knoben and Oerlemans, 2006), which are important for the innovation process to take place.

Literature on agglomerations also provides theoretical basis for STPs existence and development. Marshall's theory on agglomeration externalities indicates supply- and demand-side benefits for specialized agglomerations, such as STPs. In particular they would allow firms to access specialized inputs, including labour, and to take advantages from knowledge spillovers. Moreover agglomerations would increase demand by reducing consumer search costs (McCann and Folta, 2008).

As said before, opinions regarding the effectiveness of STPs as promoters of innovation are contrasting. On the one hand, some authors questioned the park's model as they believe that STPs have generally failed to support the establishment and growth of innovative firms and to encourage technology transfer from academic institutions to firms. On the other hand other studies have found a positive impact of the on-park location on employment and sales growth, R&D productivity, innovative activity output and establishment of links with universities (for a review see for instance Albahari et al., 2010).

Recently the implicit assumption that firms equally benefit from the on-park location has been relaxed. Some authors (Hervas-Oliver and Albors-Garrigos, 2009; Barge-Gil et al., 2011a; Huang et al., 2012) have analyzed the influence of firms characteristics, such as size or R&D intensity, upon the benefits from location. We propose another possible explanation for previous contrasting evidence: STPs are not homogenous.

The great variety of shareholders and founders of STPs, often the result of public-private partnerships (Phan et al., 2005), has encouraged the formation of heterogeneous groups of parks (Westhead, 1997), to such an extent that the British association of Science Parks stated that no two parks are alike (Grayson, 1993). One important reason for heterogeneity is how the

university is connected with the park. The formal presence of a university in the governance of a STP, which is a must in some countries such as UK (Siegel et al., 2003) is not a shared characteristic in other countries. For example, Albahari et al. (forthcoming) have found, in particular, that more than the half of Spanish STPs and more than one out of three Italian parks do not have a university within their shareholders. Del Castillo Hermosa and Barroeta (1998) affirmed that two types of parks' model should be distinguished: *science parks*, where quality university research is available, and *technology parks*, where the university is not directly involved.

Although some authors have underlined the importance that different stakeholders have for STPs' mission and operational procedures (e.g. Phan et al., 2005; Bigliardi et al., 2006), few empirical studies on STPs' effectiveness have taken into account this source of heterogeneity[1]. The degree of involvement of the university seems to be particular important when assessing STPs' performance.

2.2. *STPs and universities*

STPs managed by universities, herein called *Science Parks* (SPs), would provide to their tenants, in addition to those illustrated before, also externalities due to proximity to a university.

The rationale behind SPs points at the creation of synergies between universities and on-park firms, promoted by geographical proximity as provided by SPs, to improve the flow of knowledge, information and technology between academy and industry and thus promoting innovation.

The effects of proximity to universities for firms' innovation have been widely studied (Lawton Smith, 2007). In particular, by locating close to the university, firms would be able to take advantages from knowledge spillovers, which are geographically localised (Feldman and Kogler, 2010). SPs aim at institutionalising this proximity between tenant firms and universities, as they would (Storey and Tether, 1998): a) enable academics at the local university to commercialise their research ideas; b) provide accommodation for existing businesses wishing to locate near, or on, a university campus so as to facilitate research links with individuals or departments within the university; c) enable existing small businesses to obtain benefits of close association with the university, other similar businesses on site and the managerial services provided by the Park staff.

[1] An exception is Link and Scott (2005) who in their model of spin-off company formation in STPs use a dummy variable to reflect whether the park is operated by the university of by a foundation or private contractor, although this variable is not statistically significant in their regressions.

However, the performance of SPs has not received much attention in the literature. Hansson et al. (2005), in their case study on two different STPs, claimed that the model of parks as intermediary between university and industry institutionalises certain distance and causes low interactions. For them the 'campus model' in which the university, without any intermediary, is in charge of the relations with business world is preferable.

A different stream of the literature has focused on the impact of the on-park location on the propensity of firms to establish links with local universities, usually without taken the difference *science* versus *technology* parks into account.

With few exceptions[2], the common view is that STPs facilitate the establishment of, at least, informal links with universities, while more evidence on the establishment of formal links is needed. Colombo and Delmastro (2002) and Fukugawa (2006) have found on-park firms are more likely to engage in formal agreements, such as joint research, with universities than firms in the off-park sample. Felsenstein (1994) found that low-level interactions (i.e. recruitment of local university graduates and use of university facilities) are more common than high-level interactions (i.e. joint research and industry funding of university research) and that on-park firms are more likely to report such interactions. These results are confirmed by Westhead and Storey (1995), Vedovello (1997) and Löfsten and Lindelöf (2002) who found that STPs facilitate the establishment of informal links, while have mostly no influence on the firms' capacity to establish formal links with HEIs.

Despite the fact that the lack of more formal links has often been seen as a weakness in STPs' model, the importance of informal links (as opposed to more formal mechanisms such as scientific publications, patents and the licensing of university-generated IP) should not be underestimated as they have proved to give an important contribution to industrial innovation (Perkmann and Walsh, 2007).

Thus most empirical papers found a positive effect of the on-park location on the establishment of links between firms and universities. Anyway we should take into account that many of these studies have been carried out in countries where STPs are managed by universities, like in the UK (Siegel et al., 2003) or in the US. As stated before, in other countries, this is not the case and universities have different level of formal and informal involvement with STPs, ranging from parks owned by universities (that we call *Science Parks*) to parks where the university does not have neither any formal nor informal involvement (herein called *Technology Parks*).

[2] Monck et al. (1988) in a pioneer study on STPs in UK found very similar figures regarding links between on- and off-park firms with local universities. These results are confirmed by Quintas et al. (1992) and Malairaja and Zawdie (2008), who did not find any statistically significant differences between on- and off-park firms regarding the existence of firms with local universities.

3. Data and variables definition

3.1. *Data*

Multiple data sources have been employed to perform this study. We have combined data on firm level from the 2009 Spanish Community Innovation Survey (CIS) with data from STPs' characteristics from the Survey 2009 on the Characteristics and Results of Science and Technology Parks, an internal survey that the former Department of Science and Innovation of the Spanish government yearly supply to Spanish STPs[3].

The 2009 CIS for Spain (published in 2011) is managed by the Spanish National Statistics Institute (INE). The survey collects very detailed information on the characteristics of the innovation process of firms and, since 2007, it includes a question on the possible on-park location of the firm. In its 2009 version 37.201 firms, representative of the Spanish business structures, were surveyed; of them 849 firms were located on 25 STPs[4] in 12 different Spanish regions.

The survey allows us to use a wide set of covariates and to have a much higher heterogeneity across STPs than previous studies. Furthermore, being modelled upon the European Community Innovation Survey (CIS), it facilitates comparisons with other studies using CIS.

3.2. *Variables definition*

Our main interest is in analysing how the type of presence of universities in STPs may affect tenants' innovation behaviour and performance.

We have distinguished four types of STPs, according to the level of university involvement. More precisely we use information on parks' shareholders, the share percentage of each shareholder and on university location. The four types of parks are shown and explained in Table 1.

[3] Although the central government in not directly involved in any STPs' initiative, this survey has acquired a mandatory nature in order to have access to governmental funding for STPs. In very few cases, the lack of data on a particular park called for direct contact with park managers.

[4] We have considered within the STP's sample only those STPs that were *full members* of the Association of Science and Technology Parks of Spain (APTE) at least two years in advance.

Table 1. Park types' definition.

Park type	**Characteristics**
Science Park (SP)	STP with more than the 50% of shares owned by the university
Mixed Park (MP)	STP where the university is a minority shareholder
Technology Park with University (TUP)	STP where the university is not a shareholder, but it locates some of their research facilities inside the STP
Technology Park (TP)	STP that does not belong to any of the previous three categories[5]

An additional strength of our study is given by the parks' type heterogeneity in the sample: out of the 25 STPs in the sample, we have five SPs, five MPs, eight TPUs and seven TPs.

3.2.1 Dependent variables

lnewmerl

We measure the innovation performance of on-park firms using the sales from new to the market products, whose data is available for each firm as it is one of the questions of the CIS survey. This indicator has been often used in recent studies on innovation (for a review see for instance Vásquez-Urriago et al., 2011) as it is argued to overcome the typical problems of others indicators such as patents, R&D expense or number of innovations (Griliches, 1990).

Operationally the dependent variable *lnewmerl* is the logarithm of the sales obtained from new to the market product/service per employee.

lpatnuml

Another indicator of innovation performance widely used in past studies on innovation is the number of patents granted (Griliches, 1990). The variable *lpatnuml* is the logarithm of the number of patent applications per employee.

coopuni

The variable *coopuni* is a dummy variable, which takes value 1 if the firm cooperates with a university or with other higher education institutions.

lRDboughtl

This variable indicates the amount of external R&D that firms have bought from universities; it has been defined as the logarithm of the total expenses for R&D services bought from universities per employee.

[5] We have confirmed this was the case with parks' managers.

3.2.2. *Independent variables* (*Science and Technology Parks' characteristics*)

Characteristics included in our model are summarized in Table 2 and briefly explained in this section.

Table 2. STPs' characteristics.

Characteristic	**Label**	**Description**
Age	age	Age of the STP (years)
	ageq	Age of the STP (quadratic)
Dimension	lnfirms	Number of tenant organizations in 2008 (log)
Location	provGDPpp	Provincial GDP per capita
Management	lstaffr	Number of full-time equivalent employees in the park's management company per 100 tenants
	international	1 if the park provides services to foster internationalization of firm, 0 otherwise
	consult	1 if the park provides advice on legal, commercial and fiscal issues, 0 otherwise
Park type	SP	1 if the park is a Science Park, 0 otherwise
	MP	1 if the park is a Mixed Park, 0 otherwise
	TUP	1 if the park is a Technology Park with University, 0 otherwise
	TP	1 if the park is a Technology Park, 0 otherwise

The age of the STP (*age*, number of years since the establishment of the park) has been used in its quadratic form (*ageq*).

lnfirms is the log of the number of tenants of the park at the end of the previous year (2008) and proxies the dimension of the park.

The level of technological development of the area in which the park is located is proxied by the Gross Domestic Product per capita of the province where the park is located in, *provGDPpp*. This variable can be considered as a structural characteristic of the STP.

STPs' characteristics have been obtained using the Survey 2009 on the Characteristics and Results of Science and Technology Parks. From this survey we have gathered information on parks' age, parks' dimension (in terms of number of tenants and physical area) and characteristics of park's management (in terms of number of full-time equivalent employees and provision of internationalization and consulting services) have been obtained using the Survey 2009 on the Characteristics and Results of Science and Technology Parks. Provincial GDP per capita has been drawn from the National Statistics Institute's database on national accounting.

The independent variables related with the characteristics of the management of the park are: a) *lstaffr*, the number of full-time equivalent employees in the park's management company per 100 tenants; b) *international*, a dummy variable which takes the value 1 if the park management provides services to foster internationalization of its tenants, 0 otherwise; c) *consult*, a dummy variable which takes the value 1 if the park management provides legal, commercial and/or fiscal issues consulting services to its tenants, 0 otherwise.

Eventually, four dummies variables, one for each park type, have been defined according to the level of involvement of the university in the STP. *SP* takes value 1 if the park is controlled by the university, that is if the university is the major shareholder, 0 otherwise. *MP* takes value 1 if the university is a minority shareholder, 0 otherwise. *TPU* takes value 1 if the university is not a shareholder, but it has some premises or research facilities on-park. The last dummy variable, *TP* takes value 1 if the university is not involved formally in the park (not as shareholder, nor with any on-park facility).

3.2.3. *Definition of firm-level covariates*

The good choice of covariates is essential to perform an effective multiple regression analyses under the *ceteris paribus* assumption, as it allows us to explicitly control for those factors that affect the dependent variable, purging their effect.

According to previous studies that have used the CIS (for a review see Vásquez-Urriago et al., 2011), we can use two groups of covariates as determinants of innovation: general firms' characteristics (i.e. total turnover, exports, industrial sector and firm's age) and more innovation-specific firms' characteristics (i.e. innovation effort and perceived obstacles to innovate).

The list of covariates used is shown in Table 3.

Table 3. Firms' Covariates

Characteristic	Label	Description
Turnover	lsales07 lsales07_2	Turnover in 2007 (log) Turnover in 2007 (log, quadratic)
Exports	x_s07	Exports over turnover in 2007
Industrial sector	high mediumhigh mediumlow low kis nkis restact	Technological level of industrial sector (0,1) (following OECD Science, Technology and Industry Scoreboard) 7 dummies: high-tech manufacturing, medium-high-tech manufacturing, medium-low-tech manufacturing, low-tech manufacturing, knowledge intensity service, no-knowledge intensity service, other sectors
Age	lfirmage	Firm age (years) (log)
Innovation effort	lrdexpl	Expenditure on innovation activities in 2007 per employee (thousand euros)
Cost obstacles to innovation	costobst	Perceived average importance of the following factors as a barrier to innovation during 2007-2009: - lack of internal funds - lack external funds - high costs of innovating - risk costs due to uncertain demand of innovative products and services (scale: 1 – 4; 1 very important; 4 unimportant)
Information obstacles to innovation	infobst	Perceived average importance of the following factors as barriers to innovation during 2007-2009: - lack of qualified personnel - lack of information on technology - lack of information on the markets - difficulty to find cooperation partners (scale: 1 – 4; 1 very important; 4 unimportant)

4. Results

4.1. *Influence of park type on innovation results*

The effect of park type upon innovation results is shown in Table 4. A first view of the effect of different type of parks on sales from new products per employee can be drawn from column I. In this specification, we include the wide set of firm covariates, but do not control by other park characteristics so that no significant difference is found across park types. In column 2, we include measures for the 'structural' characteristics of parks (age and size). These characteristics have been found to be very relevant to explain the performance of tenants (Albahari et al., 2013) and they are correlated with park types so that they should be included in the regression to avoid omitted variable bias. When the effect of these variables is controlled for, we observe that firms

located in science and mixed parks perform worse than parks without a university. These results are corroborated when variables capturing park management, such as size of the management team and provision of internalization and consultancy services, are included (column III). The effects are quite large in magnitude, 120 log points for SPs and 93 for MPs (roughly 70% and 60% less of sales from new products per employee, respectively).

Regarding covariates, our results agree with previous literature on the large importance of innovation effort and age as well as on the insignificant influence of industry when other factors are accounted for. In addition, no significant effect is found for size, nor for exports and obstacles.

(Insert Table 4)

Columns IV-VI provide the same group of specifications for the dependent variable patents per employee. Characteristics of parks are not able to explain this output and, accordingly, the three specifications yield very similar results. Firms in SPs perform much better than the rest of park types when patents are the output to be analyzed. Again, differences are very large in magnitude, between 129 and 135 log points (almost four times more patents per employee).

Regarding covariates, again innovation effort is the most significant one. We also find a positive effect of exports and no significant effect from size, industry technological level or obstacles to innovation.

Accordingly, this table shows a clear output specialization in different park types. Firms in SPs show the highest performance in patents but the lowest in sales from new products while firms in parks without a university (TPs) show exactly the opposite pattern. Firms in MPs and TPUs can be found between both extremes. It could be argued that it is not the influence of the park the main factor accounting for this result but that the firms located in each of them differ in the orientation of their innovation processes. We have included a wide set of covariates representing firms' characteristics to try to minimize such differences (for example, exporting behaviour, industry technological level, innovation effort, age or type of obstacles in the innovation process). All of these may capture some degree of the heterogeneity of the innovation process. In Tables 5 and 6, we include an additional covariate, the percentage of R&D employees with a PhD degree. This variable aims at directly proxying for the type of innovation process (more scientific oriented or more product oriented) carried out by the firm. The main drawback of using this indicator is that we only observe it for those firms holding a formal R&D department. They are 667 (78.6% of firms in parks).[6] We explore two different ways of dealing with this

[6] Around 50% of Spanish innovators innovate without a R&D department. They obtain new products and process from the development of other innovation activities, e.g. design (Barge-Gil et al., 2011).

sample reduction. First, in Table 5, we assume that firms without a R&D department are not scientific, but product oriented and accordingly, we assign them a zero percentage of PhDs in the R&D team. Second, in Table 6, we simply do not use these firms and estimate the model with the smaller sample.

Main results are not significantly changed under any of these analyses, despite the percentage of PhDs shows a positive effect on patents and a negative (non significant) effect on products. In addition, when our preferred specifications controlling for the whole set of the park characteristics (columns III and VI) are examined, effects are also very similar in magnitude to those shown in Table 4. Accordingly, it seems that the different performance of firms located in different type of parks are, at least to some point, a consequence of the park activity and the environment it creates rather than to differences in the firms located in each of them. This result is no surprising. Spanish universities have traditionally shown the drawback of being unable to transform knowledge into new products (Testar Ymbert, 2012) and, accordingly it is not surprising that parks with a high influence of universities (science and mixed parks) show exactly the same problem. In this sense, the conclusion would be that SPs have not contributed to overcome this problem. On the other hand, it should be highlighted that they are able to promote patents. This result in itself is not easy to interpret. On the one hand, it could be a first step towards more marketable results. On the other, most of patents never become a new product and lot of effort is necessary to transform patents into an economic success (Chesbrough, 2003).

(Insert Tables 5 and 6)

4.2. *Influence of park type on links with universities*

A different, interesting question to analyze is whether relationships between tenants and universities are higher in SPs. We analyze two different dependent variables. The existence of cooperation and the external R&D bought to universities. Table 7 shows a first set of results. Again, columns I and IV do not include park characteristics, columns II and V include park' age and size and columns III and VI include also park' management characteristics. We do not find any evidence of SPs fostering cooperation with universities. Results in columns I-III are very similar and no differences across park types can be reported. When external R&D is analyzed, we observe that the coefficient of SPs is always positive and quite large in magnitude although it is only significant in column IV, where park characteristics are not accounted for.

Regarding covariates, we find a significant effect of innovation effort, the technological level of the industry and the provincial level of development. This last effect is negative, indicating that firms in more developed provinces are less likely to cooperate with universities and contract

them a lower amount of external R&D[7]. No significant effect is found for size, exports or innovation obstacles while age show a positive effect that is significant in the cooperation equation but it is not in the external R&D equation.

(Insert Table 7)

As with innovation outputs, these results could be biased if the specific orientation of firms' innovation processes has not been adequately captured by the covariates used. The composition of the R&D team and, more specifically, the percentage of PhDs over total R&D employees have been shown to influence the relative weight of universities on the partner portfolio (Barge-Gil and Conti, 2013). In Table 8 we include this indicator assuming that firms without a R&D department are not scientific, but product oriented and accordingly, we assign them a zero percentage of PhDs, while in Table 9 we perform the regression without these firms. Results are very similar to those from Table 7. No difference is found across park types regarding the likelihood of cooperation with universities and a positive, non significant, effect of SPs is found when analyzing external R&D. Finally, as expected the percentage of PhDs in the R&D team shows positive coefficients, although they are only significant for external R&D and in Table 8.

All in all, results suggest that the decisions of firms regarding the existence and amount of relationship with universities are not affected by the type of park in which they are located. If one of the purposes of SPs is to foster cooperation between tenants and the university, it seems that it has not been fulfilled by Spanish science parks so far.

(Insert Tables 8 and 9)

5. Conclusions and future research

In this paper we have studied how the different level of formal involvement of the university in Science and Technology Parks (STPs) affect the innovative output and behaviour of tenants. We have distinguished four types of park: *science park* (SP), where the park is managed by a university; *mixed park* (MPs), in which the university is a minority shareholder; *technology park with university* (TPU), in which the university is not a shareholder, but it has some research facilities on-park; and *technology park* (TP), in which the university does not have any formal involvement.

[7] This is probably due to the fact that more developed provinces show a more varied supply of R&D partners, composed not only by the public universities but also for private companies. In addition, the role of technology institutes is very important as providers of external R&D to firms and their weight is high in some rich provinces, such as those in the Basque Country or Navarra (Barge-Gil et al, 2011b).

Using two main data sources, the CIS Survey for Spain and the Survey 2009 on the Characteristics and Results of Science and Technology Parks, after controlling for a wide set of covariates, we have found that:

- Firms in SPs show the highest performance where the number of patents is concerned, but the lowest when considering innovation sales. Firms in TPs show the opposite pattern; while firms in MPs and TPUs are between these two extremes.
- We do not find robust evidence that the level of involvement of the university in the park affect the propensity of tenants to cooperate with the university nor the amount of R&D bought from the university.

We believe that parks' heterogeneity could be partly responsible for the contrasting evidence found so far in the literature on STPs as an instrument of innovation policy and that the relations between universities and STPs should be further analysed. A natural prosecution of this work would be to assess whether the quality of the university involved in the STP affects the innovative results and behaviour of firms.

This study is a part of a PhD. dissertation aimed at better understanding the supply-side of STPs. Future studies could try to further investigate parks' heterogeneity also from a demand-side (that is to say from firms') perspective. Particularly interesting are, for example, issues related with firms' ecosystem within the parks.

References

ALBAHARI, A., BARGE-GIL, A., PÉREZ-CANTO, S. and MODREGO, A. (2013) *forthcoming*: "The influence of Science and Technology Parks' characteristics on firms' innovation results". MPRA, University Library of Munich, Germany.

ALBAHARI, A., CATALANO, G. and LANDONI, P. (forthcoming): "Evaluation of national Science Park Systems: a theoretical framework and its application to the Italian and Spanish systems". *Technology analysis and strategic management*.

ALBAHARI, A., PÉREZ-CANTO, S. and LANDONI, P. (2010): "Science and Technology Parks impacts on tenant organisations: a review of literature". MPRA Paper No. 41914, University Library of Munich, Germany.

BARGE-GIL, A. and CONTI, A. (2013) *forthcoming*: "An analysis of the determinants of outsourcing by Spanish R&D firms". MPRA, University Library of Munich, Germany.

BARGE-GIL, A., NIETO, M.J. and SANTAMARÍA, L. (2011): "Hidden innovators: the role of non-R&D activities". *Technology Analysis and Strategic Management* , **23**, 415-432.

BARGE-GIL, A., SANTAMARÍA, L. and MODREGO, A. (2011b). "Complementarities between universities and technology institutes. New empirical lessons and perspectives". *European Planning Studies* **19**, 195-215.

BARGE-GIL, A., VASQUEZ-URRIAGO, A. and MODREGO, A. (2011a). "El impacto de los parques científicos y tecnológicos españoles sobre la innovación empresarial según distintos tipos de empresas". *ICE, Información Comercial Española, Revista de Economía*, **860**, 73-88.

BIGLIARDI, B., DORMIO, A. I., NOSELLA, A. and PETRONI, G. (2006): "Assessing science parks' performances: directions from selected Italian case studies". *Technovation*, **26**, 489-505.

BOSCHMA, R. A. (2005): "Proximity and Innovation: A Critical Assessment". *Regional Studies* **39***,* 61–74.

BOZEMAN, B. (2000). "Technology transfer and public policy: a review of research and theory". *Research Policy*, **29**, 627–655.

CHESBROUGH, H. W. (2003): *Open Innovation. The New Imperative for Creating and Profiting from Technology.* Boston: Harvard Business School Press.

COLOMBO, M. G. and DELMASTRO, M. (2002): "How effective are technology incubators? Evidence from Italy". *Research Policy*, **31**, 1103-1122.

DEL CASTILLO HERMOSA, J. y BARROETA, B. (1998): "The technology park at Boecillo: an instrument for regional development in Castilla-Leon". *Progress in Planning*, **49**, 241-254.

ETZKOWITZ, H., and L. LEYDESDORFF (1997): *Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations*. London: Pinter.

FELDMAN, M. and KOGLER, D. (2010): *Stylized facts in the geography of innovation* in Hall, B. H. and N. Rosenberg (eds.), The Handbook of the Economics of Innovation, Volume 1. Amsterdam: Elsevier, 381-410

FELSENSTEIN, D. (1994): "University-related Science Parks - Seedbeds or enclaves of innovation". *Technovation*, **14**, 93-110.

FORAY, D. AND LISSONI, F. (2010): *University research and public-private interaction*. In Hall BH, Rosenberg N (eds.), Handbook of the Economics of Innovation, Volume I. Amsterdam: Elsevier, 276-314.

FUKUGAWA, N. (2006): "Science parks in Japan and their value-added contributions to new technology-based firms". *International Journal of Industrial Organization*, **24**, 381-400.

GRAYSON, L. (1993): *Science Parks: An Experiment in High Technology Transfer*. The British Library Board, London.

GODIN, B. (2006): "The linear model of innovation: the historical construction of an analytic framework". *Science, Technology & Human Values*, **31**, 631–667.

GRILICHES Z. (1990): "Patent statistics as economic indicators: a survey". *Journal of Economic Literature*, **28**, 1661–1707.

HANSSON, F., HUSTED, K. and VESTERGAARD, J. (2005): "Second generation science parks: from structural holes jockeys to social capital catalysts of the knowledge society". *Technovation*, **25**, 1039-1049.

HERVAS-OLIVER, J. L. and ALBORS-GARRIGOS, J. (2009): "The Role of the Firm's Internal and Relational Capabilities in Clusters: When Distance and Embeddedness are not Enough to Explain Innovation", *Journal of Economic Geography*, **9**,263-283.

HOWELLS, J.R.L. (2002): "Tacit knowledge, innovation and economic geography". *Urban Studies*, **39**, 871– 884.

HUANG, K-F, YU, C-M J and SEETOO, D-H (2012). "Firm innovation in policy-driven parks and spontaneous clusters: the smaller firm the better?". *The Journal of Technology Transfer*, **37**, 715-731.

IASP 2002. IASP International Board, 6 February 2002

J. KNOBEN and L.A.G. OERLEMANS (2006): "Proximity and inter-organizational collaboration: a literature review". *International Journal of Management Reviews*, **6**, 71–89.

LAWTON SMITH, H. (2007): "Universities, innovation, and territorial development: a review of the evidence". *Environment and Planning C: Government and Policy*, **25**, 98-114.

LINK, A. N. and SCOTT, J. T. (2005): "Opening the ivory tower's door: An analysis of the determinants of the formation of US university spin-off companies". *Research Policy*, **34**, 1106-1112.

LÖFSTEN, H. and LINDELÖF, P. (2002): "Science Parks and the growth of new technology-based firms - academic-industry links, innovation and markets". *Research Policy*, **31**, 859-876.

LUNDVALL, B.-Å and BORRÁS, S. (2005): *Science, technology, innovation and knowledge policy*, in: J. Fagerberg, D. Mowery & R. R. Nelson (Eds), The Oxford Handbook of Innovation. Norfolk: Oxford University Press.

MALAIRAJA, C. and ZAWDIE, G. (2008): "Science parks and university-industry collaboration in Malaysia". *Technology Analysis & Strategic Management*, **20**, 727-739.

MARTIN, S. and SCOTT, J.T. (2000): "The nature of innovation market failure and the design of public support for private innovation". *Research Policy* **29**, 437–447.

MCCANN, B.T. and FOLTA, T.B. (2008): "Location matters: where we have been and where we might go in agglomeration research". *Journal of management*, **34**, 532-565.

MONCK, C.S.P., PORTER, R.B., QUINTAS, P., STOREY, D. and WYNARCZYK, P. (1988): *Science Parks and The Growth of High-Technology Firms*. Croom Helm, London.

PERKMANN, M. and WALSH, K. (2007): "University-industry relationships and open innovation: towards a research agenda". *International Journal of Management Reviews*, **9**, 259–280.

PHAN P.H., SIEGEL D.S. and WRIGHT M., (2005): "Science parks and incubators: observations, synthesis and future research". *Journal of Business Venturing*, **20**,165-182.

QUINTAS, P., WIELD D. and MASSEY, D. (1992): "Academic-industry links and innovation - Questioning the science park model". *Technovation*, **12**, 161-175.

SALTER, A. and MARTIN, B.J. (2001): "The economic benefits of publicly funded basic research: a critical review". *Research Policy*, **30**, 509–532.

SIEGEL, D. S., WESTHEAD, P. and WRIGHT, M. (2003): "Assessing the impact of university science parks on research productivity: exploratory firm-level evidence from the United Kingdom". *International Journal of Industrial Organization*, **21**, 1357-1369.

SONN, J. W. and STORPER, M. (2008): "The increasing importance of geographical proximity in knowledge production: an analysis of US patent citations, 1975-1997". *Environment and Planning A*, **40**, 1020–1039.

STOREY, D. J. and TETHER, B. S. (1998): "Public policy measures to support new technology-based firms in the European Union". *Research Policy*, **26**, 1037-1057.

TESTAR YMBERT, X. (2012): *Informe CYD 2011. Monografía. La transferencia de tecnología y conocimiento universidad-empresa en España: estado actual, retos y oportunidades*. Eds Fundación Conocimiento y Desarrollo.

VÁSQUEZ-URRIAGO, A.R., BARGE-GIL, A. and MODREGO, A. (2012): "Science and technology parks and cooperation for innovation: Empirical evidence from Spain". MPRA Paper 39572, University Library of Munich, Germany.

VEDOVELLO, C. (1997): "Science parks and university-industry interaction: geographical proximity between the agents as a driving force". *Technovation*, **17**, 491-502.

WESTHEAD, P. (1997): "R&D 'inputs' and 'outputs' of technology-based firms located on and off science parks". *R & D Management*, **27**, 45-62.

WESTHEAD, P. and STOREY, D. J. (1995): "Links between higher-education institutions and high-technology firms". *Omega-International Journal of Management Science*, **23**, 345-360.

Tables

Table 4. Influence of park type on innovation outputs. Main specification

	(1) lnewmerl	(2) lnewmerl	(3) lnewmerl	(4) lpatnuml	(5) lpatnuml	(6) lpatnuml
SP	-0.512	-0.763*	-1.204**	1.355***	1.437***	1.392**
	(0.424)	(0.359)	(0.390)	(0.328)	(0.383)	(0.410)
MP	-0.510	-0.992**	-0.933**	0.064	-0.068	0.107
	(0.498)	(0.342)	(0.286)	(0.275)	(0.295)	(0.328)
TPU	-0.561	-0.531	-0.300	0.012	-0.001	-0.031
	(0.375)	(0.313)	(0.253)	(0.336)	(0.316)	(0.317)
lsales07	0.109	0.123	0.119	0.009	0.011	0.009
	(0.101)	(0.099)	(0.100)	(0.060)	(0.060)	(0.058)
lsales07_2	-0.005	-0.006	-0.006	-0.004	-0.004	-0.004
	(0.007)	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)
x_s07	1.244	1.182	1.280	2.466*	2.448*	2.486*
	(1.106)	(1.145)	(1.172)	(1.090)	(1.091)	(1.076)
restact	-1.621	-1.597	-1.728	0.331	0.325	0.282
	(1.331)	(1.325)	(1.300)	(0.505)	(0.507)	(0.481)
low	-0.641	-0.846	-0.647	0.168	0.151	0.119
	(1.022)	(1.021)	(1.045)	(0.613)	(0.628)	(0.637)
mediumlow	-0.533	-0.548	-0.602	0.611	0.642	0.627
	(1.413)	(1.406)	(1.402)	(0.515)	(0.505)	(0.514)
mediumhigh	-0.622	-0.689	-0.626	0.077	0.089	0.052
	(0.907)	(0.898)	(0.901)	(0.427)	(0.425)	(0.420)
kis	-1.022	-1.054	-1.125	0.163	0.159	0.147
	(0.767)	(0.756)	(0.761)	(0.233)	(0.231)	(0.226)
nkis	-0.528	-0.596	-0.596	-0.147	-0.166	-0.208
	(0.849)	(0.867)	(0.870)	(0.307)	(0.305)	(0.300)
lrdexpl	0.388***	0.392***	0.390***	0.169***	0.170***	0.167***
	(0.043)	(0.042)	(0.042)	(0.015)	(0.015)	(0.014)
costobst	1.056	1.032	1.021	-0.121	-0.140	-0.174
	(0.860)	(0.841)	(0.857)	(0.396)	(0.388)	(0.400)
infobst	0.825	0.584	0.554	-0.135	-0.150	-0.152
	(1.277)	(1.245)	(1.256)	(0.693)	(0.690)	(0.719)
lfirmage	0.788***	0.770**	0.768**	0.084	0.081	0.068
	(0.209)	(0.206)	(0.208)	(0.126)	(0.124)	(0.130)
provGDPpp	-0.023	-0.043	-0.049*	0.010	0.006	0.013
	(0.032)	(0.021)	(0.017)	(0.020)	(0.028)	(0.024)
age		-0.489**	-0.700***		-0.040	-0.076
		(0.134)	(0.116)		(0.152)	(0.149)
ageq		0.016**	0.022***		0.002	0.002
		(0.005)	(0.004)		(0.005)	(0.005)
lnfirms08		0.336**	0.460**		0.060	0.117
		(0.116)	(0.132)		(0.101)	(0.106)
lstaffr			0.445***			0.044
			(0.106)			(0.132)
international			0.393			-0.305
			(0.210)			(0.253)
consult			-0.691			-0.077
			(0.382)			(0.302)
N	849	849	849	849	849	849
r2	0.117	0.126	0.131	0.131	0.133	0.135

OLS with standard errors clustered by parks.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 5. Influence of park type on innovation outputs (Includes Phd. Full Sample)

	(1) lnewmerl	(2) lnewmerl	(3) lnewmerl	(4) lpatnuml	(5) lpatnuml	(6) lpatnuml
SP	-0.283	-0.527	-1.028**	1.104**	1.168**	1.187**
	(0.443)	(0.339)	(0.356)	(0.322)	(0.369)	(0.380)
MP	-0.444	-0.923*	-0.833**	-0.001	-0.134	-0.003
	(0.494)	(0.343)	(0.273)	(0.263)	(0.301)	(0.340)
TPU	-0.571	-0.543	-0.283	0.071	0.063	0.014
	(0.397)	(0.306)	(0.242)	(0.319)	(0.299)	(0.303)
lsales07	0.111	0.125	0.123	-0.005	-0.002	-0.005
	(0.098)	(0.096)	(0.097)	(0.059)	(0.058)	(0.057)
lsales07_2	-0.006	-0.007	-0.007	-0.002	-0.002	-0.002
	(0.007)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)
x_s07	1.446	1.384	1.502	2.193	2.175	2.203
	(1.107)	(1.143)	(1.181)	(1.100)	(1.103)	(1.092)
restact	-1.642	-1.619	-1.758	0.389	0.386	0.353
	(1.312)	(1.306)	(1.279)	(0.505)	(0.505)	(0.484)
low	-0.611	-0.813	-0.596	0.135	0.112	0.072
	(1.019)	(1.021)	(1.054)	(0.645)	(0.659)	(0.671)
mediumlow	-0.551	-0.558	-0.591	0.729	0.752	0.722
	(1.458)	(1.451)	(1.451)	(0.520)	(0.516)	(0.526)
mediumhigh	-0.594	-0.657	-0.583	0.058	0.064	0.025
	(0.918)	(0.911)	(0.920)	(0.449)	(0.447)	(0.444)
kis	-0.977	-1.009	-1.084	0.129	0.126	0.121
	(0.753)	(0.741)	(0.743)	(0.243)	(0.237)	(0.235)
nkis	-0.494	-0.564	-0.572	-0.222	-0.240	-0.269
	(0.829)	(0.844)	(0.845)	(0.312)	(0.308)	(0.304)
lrdexpl	0.396**	0.404*	0.412**	0.282***	0.283***	0.275***
	(0.142)	(0.145)	(0.145)	(0.064)	(0.064)	(0.064)
doctores	-1.768	-1.775	-1.890	2.156**	2.150**	2.161**
	(1.095)	(1.092)	(1.105)	(0.684)	(0.682)	(0.689)
idin	0.117	0.077	-0.020	-1.436*	-1.435*	-1.372*
	(1.446)	(1.481)	(1.461)	(0.582)	(0.572)	(0.576)
costobst	1.006	0.983	0.957	-0.050	-0.068	-0.088
	(0.915)	(0.891)	(0.908)	(0.386)	(0.383)	(0.393)
infobst	0.793	0.556	0.544	-0.055	-0.078	-0.096
	(1.284)	(1.255)	(1.255)	(0.770)	(0.775)	(0.805)
lfirmage	0.781***	0.764***	0.762***	0.134	0.130	0.120
	(0.202)	(0.199)	(0.201)	(0.130)	(0.128)	(0.134)
provGDPpp	-0.022	-0.043	-0.047**	0.005	-0.000	0.006
	(0.035)	(0.022)	(0.016)	(0.018)	(0.025)	(0.022)
age		-0.483**	-0.704***		-0.055	-0.079
		(0.137)	(0.104)		(0.143)	(0.142)
ageq		0.016**	0.022***		0.002	0.003
		(0.005)	(0.003)		(0.005)	(0.005)
lnfirms08		0.341**	0.496***		0.058	0.084
		(0.112)	(0.126)		(0.099)	(0.105)
lstaffr			0.476***			0.018
			(0.094)			(0.122)
international			0.354			-0.232
			(0.205)			(0.250)
consult			-0.603			-0.153
			(0.336)			(0.289)
N	849	849	849	849	849	849
r2	0.122	0.130	0.136	0.157	0.158	0.160

OLS with standard errors clustered by parks.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 6. Influence of park type on innovation outputs (Includes Phd. Restricted Sample)

	(1) lnewmerl	(2) lnewmerl	(3) lnewmerl	(4) lpatnuml	(5) lpatnuml	(6) lpatnuml
SP	-0.630	-0.931	-1.360**	1.026**	1.001*	1.083*
	(0.518)	(0.461)	(0.405)	(0.336)	(0.422)	(0.412)
MP	-0.702	-1.436***	-1.254***	-0.077	-0.225	-0.156
	(0.663)	(0.367)	(0.270)	(0.309)	(0.381)	(0.427)
TPU	-0.821	-0.704	-0.476	0.080	0.092	-0.006
	(0.539)	(0.398)	(0.294)	(0.366)	(0.339)	(0.363)
lsales07	0.153	0.169	0.171	-0.050	-0.046	-0.050
	(0.108)	(0.105)	(0.103)	(0.065)	(0.064)	(0.063)
lsales07_2	-0.007	-0.008	-0.008	0.001	0.001	0.001
	(0.007)	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)
x_s07	0.194	0.005	0.217	2.049	2.012	2.051
	(1.532)	(1.587)	(1.636)	(1.368)	(1.379)	(1.358)
restact	-1.491	-1.322	-1.438	0.954	0.977	0.967
	(1.838)	(1.820)	(1.767)	(0.768)	(0.770)	(0.755)
low	0.981	0.831	0.986	0.359	0.318	0.311
	(1.466)	(1.472)	(1.487)	(0.940)	(0.955)	(0.969)
mediumlow	-0.718	-0.649	-0.714	1.309	1.336*	1.293
	(1.673)	(1.666)	(1.669)	(0.639)	(0.639)	(0.662)
mediumhigh	-0.694	-0.766	-0.747	0.526	0.513	0.450
	(1.097)	(1.052)	(1.054)	(0.537)	(0.540)	(0.537)
kis	-0.804	-0.760	-0.825	0.354	0.354	0.355
	(0.938)	(0.919)	(0.923)	(0.294)	(0.286)	(0.286)
nkis	-0.437	-0.425	-0.432	-0.161	-0.178	-0.190
	(1.248)	(1.272)	(1.283)	(0.515)	(0.505)	(0.505)
lrdexpl	0.554**	0.596**	0.583**	0.568***	0.574***	0.563***
	(0.178)	(0.173)	(0.173)	(0.086)	(0.084)	(0.085)
doctores	-1.729	-1.758	-1.868	1.840*	1.831*	1.881*
	(1.047)	(1.042)	(1.051)	(0.700)	(0.693)	(0.718)
costobst	0.410	0.364	0.376	-0.034	-0.043	-0.058
	(1.122)	(1.130)	(1.141)	(0.549)	(0.551)	(0.555)
infobst	1.177	0.768	0.725	-0.054	-0.128	-0.168
	(1.308)	(1.318)	(1.337)	(0.944)	(0.955)	(0.981)
lfirmage	0.908*	0.919**	0.922**	0.161	0.161	0.152
	(0.327)	(0.319)	(0.317)	(0.163)	(0.161)	(0.162)
provGDPpp	-0.045	-0.083**	-0.080***	-0.009	-0.015	-0.011
	(0.045)	(0.025)	(0.018)	(0.021)	(0.030)	(0.026)
age		-0.716***	-0.929***		-0.118	-0.142
		(0.138)	(0.100)		(0.159)	(0.154)
ageq		0.024***	0.029***		0.004	0.004
		(0.005)	(0.004)		(0.005)	(0.005)
lnfirms08		0.392*	0.574**		0.098	0.082
		(0.182)	(0.159)		(0.130)	(0.141)
lstaffr			0.512***			-0.019
			(0.128)			(0.171)
international			0.243			-0.191
			(0.266)			(0.291)
consult			-0.793*			-0.264
			(0.378)			(0.349)
N	667	667	667	667	667	667
r2	0.057	0.073	0.078	0.133	0.135	0.137

OLS with standard errors clustered by parks.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 7. Influence of park type on links with universities. Main Specification

	(1) coopuni	(2) coopuni	(3) coopuni	(4) lcompraidunil	(5) lcompraidunil	(6) lcompraidunil
SP	0.026	-0.008	-0.028	0.948*	0.884	1.119
	(0.055)	(0.055)	(0.067)	(0.433)	(0.441)	(0.592)
MP	0.059	0.055	0.031	0.102	0.173	-0.163
	(0.040)	(0.037)	(0.036)	(0.262)	(0.451)	(0.444)
TPU	-0.005	0.011	0.031	0.011	0.053	0.061
	(0.043)	(0.032)	(0.032)	(0.250)	(0.235)	(0.217)
lsales07	-0.002	-0.003	-0.003	0.007	0.001	-0.004
	(0.011)	(0.011)	(0.011)	(0.069)	(0.069)	(0.069)
lsales07_2	0.001	0.001	0.001	0.001	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)
x_s07	0.054	0.054	0.056	1.771	1.783	1.715
	(0.153)	(0.154)	(0.152)	(1.062)	(1.089)	(1.090)
restact	-0.196*	-0.185*	-0.188*	-0.825	-0.797	-0.728
	(0.075)	(0.075)	(0.075)	(0.443)	(0.446)	(0.443)
low	-0.166	-0.177	-0.158	-0.451	-0.451	-0.414
	(0.089)	(0.092)	(0.090)	(0.477)	(0.482)	(0.490)
mediumlow	-0.239*	-0.263*	-0.267*	-1.186*	-1.257*	-1.292*
	(0.108)	(0.103)	(0.102)	(0.491)	(0.453)	(0.470)
mediumhigh	-0.290***	-0.306***	-0.296***	-1.257**	-1.294**	-1.252**
	(0.055)	(0.056)	(0.054)	(0.358)	(0.368)	(0.380)
kis	-0.058	-0.053	-0.056	-0.596	-0.577	-0.546
	(0.059)	(0.058)	(0.058)	(0.394)	(0.399)	(0.402)
nkis	-0.220**	-0.210**	-0.203**	-1.110**	-1.071*	-0.985*
	(0.059)	(0.058)	(0.059)	(0.393)	(0.398)	(0.393)
lrdexpl	0.041***	0.041***	0.041***	0.216***	0.214***	0.221***
	(0.004)	(0.004)	(0.004)	(0.029)	(0.029)	(0.029)
costobst	0.097	0.098	0.103	-0.128	-0.120	-0.035
	(0.079)	(0.080)	(0.081)	(0.655)	(0.655)	(0.644)
infobst	-0.097	-0.110	-0.114	-0.364	-0.365	-0.425
	(0.132)	(0.129)	(0.126)	(0.664)	(0.649)	(0.641)
lfirmage	0.046**	0.047**	0.049**	0.009	0.016	0.046
	(0.016)	(0.015)	(0.015)	(0.111)	(0.109)	(0.113)
provGDPpp	-0.008**	-0.011**	-0.012***	-0.073**	-0.076**	-0.092**
	(0.003)	(0.003)	(0.003)	(0.020)	(0.027)	(0.025)
age		-0.031	-0.041*		-0.014	0.035
		(0.018)	(0.016)		(0.148)	(0.128)
ageq		0.001	0.001*		0.000	-0.001
		(0.001)	(0.000)		(0.005)	(0.005)
lnfirms08		-0.029	-0.030		-0.141	-0.301
		(0.016)	(0.022)		(0.145)	(0.193)
lstaffr			0.025			-0.079
			(0.018)			(0.129)
international			0.080**			0.662*
			(0.025)			(0.245)
consult			-0.050			-0.306
			(0.055)			(0.523)
N	849	849	849	849	849	849
r2	0.167	0.175	0.179	0.122	0.125	0.132

OLS with standard errors clustered by parks.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 8. Influence of park type on links with universities. (Includes Phd. Full Sample)

	(1) coopuni	(2) coopuni	(3) coopuni	(4) lcompraidunil	(5) lcompraidunil	(6) lcompraidunil
SP	0.002	-0.032	-0.045	0.725	0.645	0.931
	(0.059)	(0.058)	(0.070)	(0.497)	(0.526)	(0.654)
MP	0.052	0.048	0.022	0.043	0.112	-0.264
	(0.038)	(0.038)	(0.036)	(0.289)	(0.489)	(0.478)
TPU	-0.006	0.009	0.027	0.054	0.100	0.094
	(0.042)	(0.030)	(0.032)	(0.265)	(0.255)	(0.231)
lsales07	-0.001	-0.003	-0.003	-0.003	-0.009	-0.016
	(0.011)	(0.011)	(0.011)	(0.069)	(0.070)	(0.069)
lsales07_2	0.001	0.001	0.001	0.003	0.003	0.003
	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)
x_s07	0.036	0.036	0.036	1.540	1.549	1.459
	(0.148)	(0.149)	(0.147)	(1.045)	(1.076)	(1.075)
restact	-0.196*	-0.185*	-0.187*	-0.781	-0.750	-0.668
	(0.075)	(0.075)	(0.074)	(0.416)	(0.421)	(0.417)
low	-0.169	-0.181	-0.163	-0.480	-0.485	-0.458
	(0.089)	(0.092)	(0.089)	(0.492)	(0.500)	(0.513)
mediumlow	-0.242*	-0.267*	-0.271*	-1.101*	-1.179*	-1.219*
	(0.109)	(0.105)	(0.105)	(0.496)	(0.459)	(0.488)
mediumhigh	-0.293***	-0.310***	-0.301***	-1.276**	-1.319**	-1.281**
	(0.055)	(0.056)	(0.054)	(0.373)	(0.382)	(0.401)
kis	-0.064	-0.059	-0.061	-0.629	-0.610	-0.573
	(0.058)	(0.057)	(0.058)	(0.377)	(0.383)	(0.385)
nkis	-0.221***	-0.212**	-0.205**	-1.169**	-1.129**	-1.036*
	(0.058)	(0.057)	(0.058)	(0.388)	(0.394)	(0.387)
lrdexpl	0.033***	0.033***	0.035***	0.291**	0.290**	0.302**
	(0.006)	(0.006)	(0.006)	(0.082)	(0.083)	(0.083)
doctores	0.172	0.177	0.176	1.868*	1.884*	1.982*
	(0.097)	(0.097)	(0.096)	(0.893)	(0.889)	(0.886)
idin	0.058	0.055	0.042	-1.003	-1.009	-1.067
	(0.054)	(0.059)	(0.061)	(0.551)	(0.564)	(0.565)
costobst	0.101	0.103	0.109	-0.068	-0.059	0.042
	(0.080)	(0.081)	(0.081)	(0.655)	(0.651)	(0.638)
infobst	-0.096	-0.109	-0.114	-0.302	-0.308	-0.381
	(0.134)	(0.132)	(0.129)	(0.657)	(0.646)	(0.635)
lfirmage	0.044**	0.046**	0.049**	0.044	0.052	0.088
	(0.015)	(0.014)	(0.015)	(0.115)	(0.112)	(0.117)
provGDPpp	-0.008**	-0.010**	-0.012***	-0.077**	-0.080*	-0.098**
	(0.003)	(0.003)	(0.003)	(0.023)	(0.031)	(0.027)
age		-0.032	-0.041*		-0.025	0.033
		(0.018)	(0.015)		(0.166)	(0.135)
ageq		0.001	0.001*		0.000	-0.001
		(0.001)	(0.000)		(0.006)	(0.005)
lnfirms08		-0.029	-0.034		-0.143	-0.333
		(0.016)	(0.023)		(0.156)	(0.209)
lstaffr			0.022			-0.105
			(0.018)			(0.140)
international			0.083**			0.726**
			(0.023)			(0.253)
consult			-0.059			-0.379
			(0.054)			(0.547)
N	849	849	849	849	849	849
r2	0.172	0.179	0.184	0.139	0.142	0.151

OLS with standard errors clustered by parks.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 9. Influence of park type on links with universities. (Includes Phd. Restricted Sample)

	(1) coopuni	(2) coopuni	(3) coopuni	(4) lcompraidunil	(5) lcompraidunil	(6) lcompraidunil
SP	-0.007	-0.041	-0.028	0.682	0.505	1.000
	(0.070)	(0.067)	(0.083)	(0.556)	(0.573)	(0.680)
MP	0.056	0.038	-0.005	-0.010	0.056	-0.460
	(0.054)	(0.052)	(0.046)	(0.413)	(0.670)	(0.617)
TPU	-0.014	0.003	0.023	-0.012	0.046	0.023
	(0.059)	(0.045)	(0.039)	(0.373)	(0.342)	(0.273)
lsales07	-0.006	-0.008	-0.009	-0.042	-0.050	-0.061
	(0.013)	(0.012)	(0.013)	(0.088)	(0.089)	(0.089)
lsales07_2	0.001	0.001	0.001	0.007	0.008	0.008
	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)	(0.006)
x_s07	-0.095	-0.098	-0.108	1.844	1.858	1.647
	(0.212)	(0.212)	(0.211)	(1.133)	(1.186)	(1.227)
restact	-0.260*	-0.239*	-0.237*	-0.826	-0.774	-0.678
	(0.103)	(0.105)	(0.104)	(0.635)	(0.659)	(0.668)
low	-0.097	-0.081	-0.076	0.292	0.376	0.319
	(0.165)	(0.165)	(0.161)	(0.919)	(0.905)	(0.928)
mediumlow	-0.235	-0.254	-0.265	-1.008	-1.097	-1.204
	(0.142)	(0.139)	(0.138)	(0.595)	(0.570)	(0.603)
mediumhigh	-0.295***	-0.297***	-0.286***	-1.215*	-1.217*	-1.157*
	(0.077)	(0.075)	(0.075)	(0.489)	(0.485)	(0.520)
kis	-0.058	-0.044	-0.048	-0.610	-0.564	-0.558
	(0.079)	(0.078)	(0.078)	(0.440)	(0.460)	(0.466)
nkis	-0.292**	-0.261*	-0.255*	-1.598**	-1.480*	-1.420*
	(0.094)	(0.095)	(0.094)	(0.511)	(0.531)	(0.531)
lrdexpl	0.069***	0.071***	0.074***	0.556**	0.564**	0.592**
	(0.011)	(0.011)	(0.011)	(0.155)	(0.158)	(0.161)
doctores	0.147	0.152	0.155	1.594	1.614	1.757
	(0.093)	(0.093)	(0.092)	(0.896)	(0.889)	(0.894)
costobst	0.136	0.131	0.139	-0.044	-0.040	0.025
	(0.092)	(0.096)	(0.096)	(0.867)	(0.866)	(0.850)
infobst	-0.129	-0.140	-0.147	-0.255	-0.269	-0.349
	(0.184)	(0.183)	(0.178)	(0.877)	(0.837)	(0.822)
lfirmage	0.056**	0.060**	0.064**	-0.007	0.009	0.040
	(0.018)	(0.017)	(0.018)	(0.152)	(0.151)	(0.155)
provGDPpp	-0.012***	-0.015***	-0.018***	-0.103**	-0.109*	-0.136***
	(0.003)	(0.003)	(0.004)	(0.031)	(0.040)	(0.033)
age		-0.042*	-0.042*		-0.089	0.027
		(0.019)	(0.019)		(0.206)	(0.162)
ageq		0.001*	0.001*		0.002	-0.000
		(0.001)	(0.001)		(0.008)	(0.006)
lnfirms08		-0.037	-0.054		-0.158	-0.472
		(0.025)	(0.033)		(0.204)	(0.262)
lstaffr			0.014			-0.207
			(0.025)			(0.191)
international			0.121***			0.976**
			(0.027)			(0.318)
consult			-0.077			-0.519
			(0.062)			(0.621)
N	667	667	667	667	667	667
r2	0.102	0.112	0.119	0.111	0.116	0.131

OLS with standard errors clustered by parks.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1