Science and Technology Parks in Italy: main features and analysis of their effects on hosted firms*

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Abstract

In this paper we analyze the results of a survey conducted by the Bank of Italy during the spring of 2012 on Italian science and technology parks. We begin by describing the main features of such parks in Italy and we then investigate whether they have been effective in improving both the economic performance and the innovative capacity of the firms located within them. We find a pronounced heterogeneity among science and technology parks, whose cooperation with public research institutions is characterized by physical proximity. Although the business situation of firms located in science and technology parks tends on average to be better than that of similar non-park firms, a difference-in-differences estimation shows that entering in a science and technology park did not generally improve the firms business/innovating activity with respect to outside counterparts.

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1 Introduction

In recent decades the issue of improving and fostering innovation activity of both public and private institutions has attracted increasing attention from academics and policy-makers. There has been a particularly high level of interest in the question in Italy, where the diminishing competitiveness of the national economy has raised strong concerns.

Among the policies that can be adopted to counter economic decline is the creation and strengthening of science and technology parks (SPs). In general terms, a science park is a geographical area in which firms, R&D laboratories, universities and research centres locate together in order to exploit proximity advantages, knowledge spillovers and agglomeration economies (Capello and Morrison, [6]). The rationale behind the promotion of SPs is twofold. First, SPs offer firms a number of services (project management advice, legal support, provision of logistics infrastructures, staff training, R&D and patenting advice) that may affect their net income, profitability and financial condition. Second, SPs are intended to foster links between hosted firms and universities, to encourage the creation of knowledge based businesses and to transfer technologies and skills.

As we show in Section 2, many papers, focusing on various countries and using different empirical strategies, have investigated whether SPs have actually succeeded in promoting innovation, high-skill activities and economic performances among resident firms. Their findings are mixed and the impact of SPs on firms remained doubtful. This paper contributes to this literature by investigating the activity of Italian science parks and their effects on the firms they host (hereafter SP firms). We base our analysis on a survey of Italian SPs that the Bank of Italy carried out in the spring of 2012, which provided detailed information on 25 Italian SPs (out of 39) and an updated list of the firms hosted (if any) in these parks. Starting out from this survey we perform several analyses that allow us to address three main issues. The first matter of interest arises from the limited knowledge that we have of these institutions: previous studies on Italian SPs focused on specific cases (Bigliardi et al. [4]) or dealt mainly with the effectiveness of business incubators (Capello and Morrison, [6]) or else treated both incubators and science parks (Colombo and Delmastro [8]).[1] However, no paper tried to get a general picture of Italian science parks: their nature, cooperative strategies and services provided to firms, univerisities and other hosted institutions. Thanks to the above mentioned survey, we try to fill this gap by providing a detailed overview of Italian science parks according to their year of creation,

[1] For example, Colombo and Delmastro study the impact of 17 SPs and 25 BICs (Business Innovation Centers) on the incubated firms propensity to innovate. However, the fact that their inquiry also encompasses BICs, which may actually have different goals than SPs, renders their analysis of science parks activity incomplete. Also, their study dates back to than 10 years ago, when many of the Italian SPs were just born.

their ownership, their financial conditions, the types of services provided to firms, and the degree of cooperation with universities and research centres. We find that Italian SPs differ widely in terms of size, performance, strategy and specialization. SPs show a quite limited reliance on direct public direct funds, increasing turnover and an expanding staff, evidence of their increasing activity in recent years. Interestingly, all SPs have their main partnering university in their home region, often in their home province, suggesting they engage in a significant level of cooperation with other local knowledge institutions. After a description of the nature and the services provided by italian SPs we moved to investigate the characteristics of the firms that are hosted inside the parks. We address this second issue by checking whether SP firms display distinctive features in term of balance sheet indicators and innovative performance compared with similar businesses located outside the parks. The data show that SP firms outperform their non-SP counterparts (in terms of business size, investments and profitability indicators), a result that partially confirms the findings of Colombo and Delmastro [8].

The third issue that we address is linked with this finding. Concretely, SP firms may outperform non-SP firms either because they actually get a significant benefit from being in located inside science parks or because they were already better before deciding to locate inside a park. In the former case, SPs are undoubtedly an effective tool to boost firms competitiveness. In the latter case the answer is less clear: although SP firms were better ex ante, they may or may not derive a benefit from being in a science park. To answer this question we study only the firms that decided to enter a science park, not those born in one, looking for a difference in their performance related to their staying in the park.

After a matching process that allows us to compare the hosted (i.e. treated firms) with non-hosted firms, we run a difference-in-difference estimation to test whether being located in a park actually enhances SP firms performances compared with their counterparts. This check uses 2011 data for firm indicators such as sales, value added, return on assets, investment and patents. The analysis finds no significant effects of science parks for firms that moved inside a park except for value added, for which we find a positive (though weak) effect.

Since the SP firms perform better than similar firms located outside but their competitive advantages do not seem to increase after moving into a park, these results could appear to support the findings of other papers such as Felsenstein [9], namely that SPs are actually used by firms for reputational reasons. However, some aspects suggest a less conclusive statement. First, a distinction according to the age of the parks shows that their positive effect on hosted firms value added only occur for the older parks. This suggests that science parks may need time, i.e. experience, to be really effective in improving hosted firms performance. Moreover, our analysis does not

consider either the firms born in science parks or those that left the parks before the Bank of Italy survey was made; for these firms, the science park experience may have a bearing on their survival rates.
While we acknowledge that our analysis has limitations, to the best of our knowledge it is the first to examine the effectiveness of Italian science parks through a quantitative approach by considering firms located in a large number of parks at the same time. Further investigations are needed to understand which factors (services provided, SP organization, etc.) could help to enhance SP firms performance and to make SPs more effective in supporting firms activity.
The paper is organized as follows. The next section reviews the empirical literature on science parks and Section 3 describes the data used. Section 4 provides a detailed description of the main features and differences among Italian science parks. Section 5 gives a first overview of the main balance-sheet data of SP firms compared with non-SP firms. Section 6 study the performance of SP firms compared with non-SP firms and Section 7 concludes.

2 Literature review

Looking at the literature on SPs it is straightforward to see all the articles are empirical and based on two main approaches. The first approach is basically made of case studies on one (or few) science parks where the authors get some information on the SP's activity or about the success of the firms that used the SP services. The aim is therefore limited to the actual contribution of the single park to the creation and the growth of their in-SP firms and to explore what instruments they adopt, the internal organization of the SP, the rules that firms must follow to get access to the benefit etc. Examples of these kind of papers are Chan and Lau [7] and Zhang [33]. In the former, the authors try to see which factors (like free rents, access to laboratories, networking, information sharing etc.) have a positive effect on the performance of the firms incubated in a Hong Kong's science park. The authors find that networking and information sharing with other in-SP firms do not provide benefits to firms while SPs services, like free access to laboratories and buildings, are beneficial. In the second paper, Zhang surveys 21 managers of firms operating in 4 Chinese SPs finding that the effectiveness of a SP is determined by several factors like the existence of areas where in-SP firms can settle after their incubation period as well as the local proximity to ITC firms and/or operating in the same sector of the in-SP firms.
The second approach is more quantitative and it aims to empirically test the effect of SPs on either the in-SP firms or the territory nearby the SP

(i.e. higher economic growth, employment R&D spillover etc.).[2] Examples of papers focused on last issue are Felsenstein [9], who question whether SPs are seedbeds or enclaves of innovation, Wallsten [29] and Hu [15][3] while the question about SP effect on hosted firms is usually pursued throughout a counterfactual analysis on the performance of the in-SP *versus* out-SP firms. Up to now the results provided on this issue are mixed: it is still doubtful whether SPs have been successful in promoting innovation and high skill activities among firms. In fact, some analysis do not find relevant differences in term of innovative activities between firms located within SP and NSP firms (Westhead and Storey [31]). At the same time, other works support the positive and important role of SPs for the development of those firms joining them (e.g., Ferguson and Olofsson [10]; Squicciarini [26] [27] and [28]).

A good survey on the empirical works about this topic is proposed by Barge-Gil et al. [2]. Moreover, in this work they employ different methods in order to evaluate the impact of the location of more than 39,000 spanish firms in 22 spanish SPs by using data from the 2007 Spanish Technological Innovation Survey. Their main results are that the location in a SP positively affects the level of product innovation and sales. On the other hand Monck et al. [24] and Westhead [30] find no significant effects of SPs in United Kingdom in terms of several firms' outcomes (patents, new products, R&D expenditure, etc...). In particular, Monck et al. [24] uses 183 and 101 firms resident respectively inside and outside the British SPs in the 1986 whereas Westhead [30] works with 47 firms inside and 48 firms outside during the period 1986-1992. The matches between the firms located in and out the Parks' samples are done by considering firms that share similar economic sectors, age, ownership as well as comparable geographical areas. Similar criteria are used by Lindelöf and Löfsten [18] for Swedish SPs in the period 1996-1998. They consider 9 SPs and 134 firms inside the techno-pole (i.e. SP) and 139 outside finding mixed results: only for some variables, as the links between the firms and high education institutes, the location in a SP is an advantage for the hosted firms whereas, for others variables, as the number of patents/products launched in the last three years, no statistical significant differences are recorded. Ferguson and Olofsson [10] considers two Swedish SPs with 30 firms located inside and 36 outside of them. They find positive effects of the survival rate of firms and no significant effects on growth in terms of sales and employment.

The contribution of our paper to the economic literature is threefold. First,

[2]Actually some recent contributions by Link and Scott [19] and [20] are also trying to see which factors, like university proximity, may influence the performance of SPs.

[3]In particular Wallsten [29] study whether the clustering effect of SPs in UK have a positive effect on the employment and the venture capital in the areas close to the science parks (with a negative answer). Hu [15] instead analyzes whether the chinese SPs provide some benefit in terms of higher productvity, finding that this is actually the case.

thanks to our survey we are able to provide a broad and updated snapshot of a relevant number of science parks, a study that is met neither in case-studies (focused on very few SPs) nor in counterfactual analysis (focused on in-SP firms). The second contribution of our paper is linked on the existing literature related to the effects of science and technology parks on their hosted firms (see above). Last but not least, we pay our attention on Italian science parks. As already said in the previous section, there are only few papers that study the Italian science parks. Colombo and Delmastro [8] study a sample of 90 firms equally split between firms within a SP or a business incubator (BIC) and firms outside the SP/BIC. The objective is to make a counterfactual analysis in order to check whether the two subsamples are different in terms of propensity to innovate and to cooperate with other research institutions. In spite of the fact that they do not find a significant difference between the two groups, the authors find that firms inside SPs or business incubators are endowed with a stronger human capital (hence they should have a larger absorptive capacity), they tend to be more connected with other research institutions and, consequently, they participate to international research projects more than firms outside the parks.
More recently, Capello and Morrison [6] study two Italian SPs to check whether SPs actually is able to enhance the networking and the technology transfer (hence the innovative capacity) among their in-SP firms. Taking into account the different purposes of a science park, the authors find that the SPs effectiveness depends on in-SP firms' feature. In particular, it is found that only the firms with a high absorptive and relational capacity are able to exploit the SPs' services. On the other hand, Bigliardi et al. [4] study four Italian SPs in order to define some methodological issues related to the SP performance evaluations. In particular, they conclude that SPs are so different in terms of stakeholders, organization and objectives that a deep analysis on the activity made by the science parks is necessary to make a fair evaluation, and it should take into account of these differences (rather than look at one only dimension as done in the counterfactual analysis).
With respect to these papers, our survey provide a broad and updated picture of the current situation of the Italian science parks while our new and updated firm database shed light on the effectiveness of Italian SPs on their hosted firms.

3 Data description

This study uses a survey of the italian SPs that we made on behalf of the Bank of Italy from February to May 2012. We contacted 39 SPs located in Italy: thirty-one of them belongs to the "Associazione Parchi Scientifici e Tecnologici Italiani" (APSTI).[4] The other parks has been suggested by the

[4]See the website http://www.apsti.it/ for further details

local research offices of the Bank of Italy because of their regional relevance.

A first phone contact lead us to exclude three science parks because of their closure or their merge with other non-SP institutions. The remaining 36 parks received a PDF questionnaire via e-mail.[5] Globally, from thirty-six potential SPs, twenty-five parks answered to our survey with a response ratio of almost the 70%; eight of the collaborating parks are located in the North West of Italy, five in the North East, seven in the Center and five in the South. The remaining eleven parks decided not to participate.[6]
The information collected through the questionnaire can be distinguished as follows:

1. **general information:** name, year of foundation, ownership;
2. **financial:** turnover, budget share of public direct funds;
3. **cooperation:** type of cooperation with universities and other public research institutions;
4. **size:** area, total employees of the SP managing institution;
5. **services supplied:** incubation staff, technology transfer staff, type of services provided by the SP;
6. **firms:** year of the first firm established in the park, number of firms settled/born/exit, firms' name.

Since some variables (like area and total SP staff) were missing for a couple of SPs, we integrated them by consulting the science parks' website. The dataset has the obvious limit of being a cross-section, which hampers to make an evaluation of the evolution of SPs during the last years. However, we tried to fill this gap by integrating some information (e.g. turnover, employees) with further questions about the changes occured during the previous five years.
All the collected information refers to 2010 as a year-base. The only information updated to spring 2012 is related to the name of the firms established in the SP, an information collected for only 20 SPs because five parks do not host firms. Thanks to such list of names we took for each firm some general information and balance sheets data from Infocamere, CeBi and Cerved databases allowing us to collect data for 425 firms located within parks. As a second step, we merged these balance sheet data with PatStat dataset

[5] See Appendix C for a translated version of the questionnaire. For whom interested, the original (Italian) version is available upon request to the authors.

[6] Looking at only science parks belonging to the APSTI then 20 over 27 SPs participated to our survey.

Table 1: Original lists of park contacted for the survey

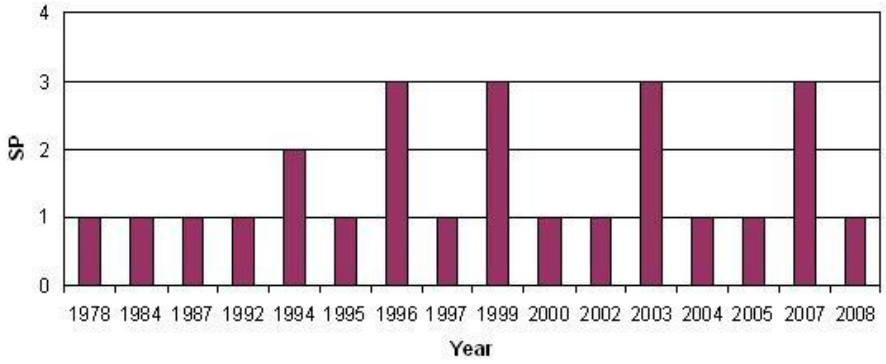
		City	*Province*	*Region*	*Area*
1	***Bioindustry Park del Canavese***	Colleretto Giacosa	TO	Piemonte	North-West
2	***Environment Park***	Torino	TO	Piemonte	North-West
3	***Virtual Reality & Multimedia Park***	Torino	TO	Piemonte	North-West
4	***Tecnogranda***	Dronero	CN	Piemonte	North-West
5	***PST della valle scrivia***	Tortona	AL	Piemonte	North-West
6	***Tecnoparco Del Lago Maggiore***	Verbania	VB	Piemonte	North-West
7	***ComoNExT***	Como	CO	Lombardia	North-West
8	***Kilometro Rosso***	Stezzano	BG	Lombardia	North-West
9	***Parco Tecnologico Padano***	Lodi	LO	Lombardia	North-West
10	***Polo Tecnologico Milano Bicocca***	Milano	MI	Lombardia	North-West
11	***Science Park RAF***	Milano	MI	Lombardia	North-West
12	***Servitec***	Dalmine	BG	Lombardia	North-West
13	***Area Science Park***	Trieste	TS	Friuli-Venezia Giulia	North-East
14	***Friuli Innovazione***	Udine	UD	Friuli-Venezia Giulia	North-East
15	***PST Galileo***	Padova	PD	Veneto	North-East
16	***STAR - Parco Scientifico di Verona***	Verona	VR	Veneto	North-East
17	***VEGA - PST di Venezia***	Marghera	VE	Veneto	North-East
18	***Centuria***	Cesena	FC	Emilia Romagna	North-East
19	***Parma Tecninnova***	Parma	PR	Emilia Romagna	North-East
20	***Trentino Sviluppo***	Rovereto	TN	Trentino Alto Adige	North-East
21	***TIS innovation park***	Bolzano	BZ	Trentino Alto Adige	North-East
22	***Polo Tecnologico di Navacchio***	Navacchio di Cascina	PI	Toscana	Center
23	***Pont-Tech***	Pontedera	PI	Toscana	Center
24	***Toscana Life Sciences Park***	Siena	SI	Toscana	Center
25	***Polo Tecnologico Lucchese***	Lucca	LU	Toscana	Center
26	***PST delle Marche (Tecnomarche)***	Marino del Tronto	AP	Marche	Center
27	***Umbria Innovazione***	Terni	TR	Umbria	Center
28	***Pa.L.Mer.***	Ferentino	FR	Lazio	Center
29	***Parco Scientifico Romano***	Roma	RM	Lazio	Center
30	***Tecnopolo S.p.A.***	Roma	RM	Lazio	Center
31	***Campania Innovazione***	Napoli	NA	Campania	South
32	***Technapoli***	Pozzuoli	NA	Campania	South
33	***Consorzio PST Multisettoriale Magna Grecia***	Crotone	KR	Calabria	South
34	***CalPark S.C.p.a.***	Rende	CS	Calabria	South
35	***Molise Innovazione s.c. a r.l.***	Campobasso	CB	Molise	South
36	***Tecnopolis s.c. a r.l.***	Valenzano	BA	Puglia	South
37	***Cittadella della ricerca***	Brindisi	BR	Puglia	South
38	***PST della Sicilia S.c.p.A.***	Palermo	PA	Sicilia	South
39	***Sardegna Ricerche***	Pula	CA	Sardegna	South

with the aim of capturing the innovative capacity of the SP firms.[7]
Even though this firm dataset sheds light on SP specialization (see below), it is mainly used to investigate whether in-SP firms are performing better than their out-of park counterparts. Before answering to such question it is however worth to study which are the main features and what are the main differences (if any) among Italian Science Parks. To this purpose, in the next section we give a further look on the main results that come out from our survey.

4 Main features and differences among Italian Science Parks: an overview

The first SP created in Italy was "AREA science park" in 1978 followed by two other parks during the '80s (see Figure 1). The creation of science parks actually blossomed in '90s, when eleven parks have been created from 1990 to 1999, and continued during the last decade, with a SP created each year on average. Since all the parks have either a public or a mixed ownership, with the exception of "Kilometro rosso", it seems that policy makers put a significant effort in pursuing the creation of SPs in Italy. However, as found in our survey, the recent closure of SPs or they merge with other public institutions suggests a possible policy change which deserves a further attention in the following years.

Figure 1: Frequency of Italian Science Parks according to the year of foundation



[7]As a matter of fact, PatStat is a dataset that collects all the patents applied to the European Patent Office. For our purposes, we use the dataset created by Giovanni Marin which merges the firm level data by AIDA Bureau Van Dijk with patents data by the European Patent Office. For further details about PatStat and its merging with AIDA see Marin [22] [23] and Lotti and Marin [21].

The turnover of the interviewed SPs is extremely volatile, passing from over 23 million of euros to less than 100.000 (Table 2, with a mean and a median of $4,28$ and of $2,37$ million of euros respectively). This evidence is quite reasonable if we think that parks may have different operating levels because of their different year of foundation and different objectives.

Table 2: Descriptive statistics of all SPs

	Obs.	Mean	Median	St. Dev.
Turnover (million of euros)	25	4,28	2,37	5,63
Share of direct public funds	24	31,44	22	36,62
Area (thousand metres)	24	36,81	10	89,63
Total SP Staff	25	38,60	12	56,19
Incubation SP Staff	24	2,96	2	3,28
Technology transfer SP staff	24	10,58	3	30,04
Firms within SP	25	28,12	19	26,93
Firms served	24	105,0	40	170,36

An interesting point is that 17 over 25 SPs increased their turnover in the last 5 years (5 decreased), denoting a growing activity of the SPs (Table 3). Such growing activity is also confirmed by the total staff, increased for fifteen SPs. In spite of their recent creation and the public nature of the

Table 3: Financial and staff variation during the last 5 years

	Increased	***Unchanged***	***Decreased***	***Unknown***
Turnover	17	3	5	-
Budget share	5	10	7	3
Total staff	15	2	8	-

Italian SPs, the share of direct public funds has an average and a median of 31% and 22% respectively, showing a good financial independence. Moreover, seven SPs were able to reduce this share in the last 5 years, while ten SPs registered a substantial stationarity. Nevertheless, it is not clear whether this result is due to a higher ability of science parks to be independent (in spite of the economic crisis) or to a higher difficulty of national and local governments to provide such funds (because of the crisis).
High dispersion is also found in both surface and total staff employed by the SP management authority. For example, the surface of a science park passes from less than 1.000 to over $700.000m^2$ while the total staff goes from 3 to 250 employees. However, these two indicators do not provide the same information about the size: some parks should be classified as small if we look at the total staff whereas they become medium, or even big, if we look

at their surface.[8] Classifying a SP by its size is therefore quite difficult because it is sensitive to the variable used.
We then tried to use these variables to perform a (hierarchical) cluster analysis in order to group the parks according to their size. However, also in this case the groups formed were very sensitive to the clustering criterion adopted such that the results were not reliable.[9] Therefore, we do not make any descriptive analysis according to the size in order to avoid specious comments.
Also the number of firms established in SPs is quite dispersed. If we consider five science parks without firms in their structures, the average number of firms in the SPs is in fact 28, with a median of 19. Similarly, the number of firms served by SPs, no matter whether they are inside or outside the park, has an average and a median of 105 and 40 respectively. This variability holds even accounting for the area of the SPs. Furthermore, the time needed for a SP to be able to attract the first firm within its area is around three years.[10]
Looking at the cooperation with universities and other Public Research Institution (PRI), SPs tend to cooperate by participating to joint research projects, especially national ones, as well as by allowing the reciprocal use of the structures (e.g. laboratories, machineries etc.). In general, SPs tend to be more connected with Universities rather than to PRIs (Tables 4 and 5). All SPs have the main university partner always within the same region

Table 4: Cooperation with universities

	Yes	***No***	***Unknown***
Financial (towards Universities)	10	15	-
Financial (from Universities)	8	17	-
National research project links	18	7	-
Foreign research project links	14	11	-
Training/Hiring	14	11	-
Use of SP structures	17	8	-
Use of University structures	18	6	1

where they operate, with almost all of them settled in the same province (20 over 25). On the other hand, the "Consiglio Nazionale delle Ricerche" (CNR) is the main principal PRI partner for half of the SPs; but also in

[8] Even though to a lesser extent, the same occurs even if we consider the turnover of the SP.

[9] In particular, the Ward and Centroid methods, which are the most common clustering algorithms provide different distances, hence different orderings, of the SPs. We also tried to overcome this problem by considering the turnover of the SP in the cluster analysis. Unfortunately, also in this case results were too sensitive to the clustering method adopted.

[10] This average does not take into account the five SPs without firms in their area.

this case the main partnering PRIs are localized in the same area of the SP. Such strong physical proximity of the main partners shows a clustering and

Table 5: Cooperation with PRI

	Yes	***No***	***Unknown***
Financial (towards Public research institution)	5	18	2
Financial (from Public research institution)	7	16	2
National research project links	15	9	1
Foreign research project links	14	10	1
Training/Hiring	6	18	1
Use of SP structures	12	12	1
Use of Public research institution structures	13	10	2

a complementarity between the SP and local research institutions.[11]
As shown in Table 6, the services provided by SPs to firms settled inside and outside parks are quite numerous, with the exception of legal assistance and the patent support, served by 8 and 15 SPs respectively. The pivotal

Table 6: Services provided to firms inside and outside the Science Parks

	Yes	***No***	***Unknown***
R&S	19	6	-
Partnership	25	0	-
Incubation	19	6	-
Business planning	20	4	1
Training	22	3	-
Project management	23	2	-
Research of financial support	23	2	-
Patenting support	15	10	-
Legal support	8	17	-
SP structures	20	4	1
Do you have a technology transfer office?	17	8	-

services of Italian parks are Incubation, R&D, Project management, and Partnership.[12] In an open question, three parks pointed out their activity on promoting the technology transfer. After this first general analysis, we

[11] Obviously, such close localization of the main partner does not mean that SPs do not cooperate with others settled elsewhere.

[12] By "Project management" we mean a long term support to the strategy of the project, in according to costs, timing and objectives. We defined "Partnership" service as assistance in joint ventures and other cooperative agreements, support in the relationships with other public institutions etc.

now study the main characteristics of SPs according to the year of incorporation, ownership, and sectorial specialization.

Year of foundation We sort the SPs under three periods, namely 1978-1989 ("Old" SPs), 1990-1999 ("Recent" SPs) and 2000-2008 ("New" SPs). Using this classification, data suggests that recent SPs are quite different from both Old and New. The main quantitative results are shown in Table 7.[13] First, recent SPs are on average much smaller than others in terms of

Table 7: Descriptive statistics of SPs **by year of foundation** (standard deviation in brackets)

	Old	Recent	New
Turnover (million of euros)	10,02	3,50	3,49
	(11,68)	*(3,59)*	*(4,98)*
Share of direct public funds	15,00	35,61	26,50
	(15,00)	*(40,38)*	*(36,27)*
Area (thousand metres)	55,00	15,83	49,47
	(32,79)	*(24,49)*	*(133,09)*
Total Staff	64,67	40,36	29,73
	(69,83)	*(72,96)*	*(31,37)*
Incubation Staff	4,33	2,45	3,09
	(2,08)	*(4,44)*	*(2,12)*
Technology transfer staff	15,67	16,09	3,68
	(21,22)	*(44,46)*	*(2,31)*
Firms within SP	55,33	21,55	27,27
	(25,70)	*(31,24)*	*(19,04)*
Firms served (inside and outside the SP)	357,67	57,09	84,00
	(317,45)	*(84,72)*	*(141,98)*

total area, an outcome that should be more suited for younger SPs. Their share of direct public funds is higher than new SPs, even though they have a similar turnover level and a higher number of employees. It is worth mentioning that five of the seven science parks that declared a reduction in the share of direct public funds are Recent. During the last 5 years Recent are the only to register a reduction of turnover; also the decrease of SP employees mostly involved recent SPs.
Looking at the services provided to firms, Recent shows a lower propensity with respect to their counterparts. Incubation, patent and legal support, and the use of infrastructures are the least services provided. Recent host/serve a lower number of firms, even accounting for the smaller dimension. This

[13]Results on the other qualitative answers (like turnover variation in the last 5 years, number of services provided to firms etc.) are available upon request by the author.

lower attitude of recent SPs to serve firms' R&D activity is in line with the lower number of service provided, but it looks in contrast with the fact that they have the highest mean of technology transfer staff.
Apart from recent SPs, data show that "New" tend to cooperate more than others with Universities and (to a lesser extent) PRIs, especially in financial, R&D, and education/training partnerships.

Ownership The analysis of SPs according to the ownership lead also to some interesting aspects (Table 8). First, public SPs seem to be larger than

Table 8: Descriptive statistics of SPs **by ownership** (standard deviation in brackets)

	Mixed	***Public***
Turnover (million of euros)	2.0	6.9
	(2.2)	(7.1)
Buget share from direct public funds	28.4	31.9
	(33.7)	(40.3)
Area (Thousand meters)	14.0	22.1
	(22.5)	(26.5)
Total staff	18.3	61.3
	(21.6)	(73.1)
Incubation staff	1.7	3.9
	(1.4)	(4.2)
Technology transfer staff	2.5	19.2
	(1.7)	(42.5)
Firms within the park	25	30
	(26)	(29.8)
Firms served (inside and outside the SP)	82	133
	(134)	(208.8)

the mixed ones: their turnover, surface, and total staff are in fact usually higher. Also the number of firms settled/served is bigger in absolute value for public SPs; however this result does not hold if we take into account the surface.
Direct public funds are on average higher for public science parks, however excluding a public SP created in the last years, the result is reversed. Therefore, mixed SPs seem to be, paradoxically, more dependent from public direct funds. On the other hand, no differences arise in the variation of turnover and public funds in the last 5 years. Concerning the cooperation strategies, mixed SPs tend to be more connected with universities and PRI than their public counterparts. The higher degree of cooperation is more evident in R&D projects and, for PRI partnerships, also in the reciprocal

use of infrastructures.
Finally, even though there is no difference in terms of services provided, three public SPs declared that "Partnership" is their most important activity whereas none of the mixed science parks have such activity as core. The reverse occurs for "Project management" which is core for three mixed SP and none public SP.

Sectors Before continuing SP analysis let us look at Table 9 which lists the frequencies and the percentages of all SP firms operating in each sector. Not surprisingly, the table shows that the main represented sectors among

Table 9: Number of in-SP firms per sector

Sector	Freq.	Perc.	Cumul.
Manufacture of food products	3	0.71	0.71
Manufacture of coke and refined petroleum products	2	0.47	1.18
Manufacture of chemicals and chemical products	7	1.65	2.82
Manufacture of basic pharmaceutical products and pharmaceutical preparations	6	1.41	4.24
Manufacture of rubber and plastic products	5	1.18	5.41
Manufacture of other non-metallic mineral products	4	0.94	6.35
Manufacture of fabricated metal products, except machinery and equipment	2	0.47	6.82
Manufacture of computer, electronic and optical products	22	5.18	12.00
Manufacture of electrical equipment	6	1.41	13.41
Manufacture of machinery and equipment n.e.c.	13	3.06	16.47
Manufacture of motor vehicles, trailers and semi-trailers	3	0.71	17.18
Manufacture of other transport equipment	3	0.71	17.88
Manufacture of furniture	1	0.24	18.12
Other manufacturing	6	1.41	19.53
Repair and installation of machinery and equipment	7	1.65	21.18
Electricity, gas, steam and air conditioning supply	5	1.18	22.35
Waste collection, treatment and disposal activities materials recovery	1	0.24	22.59
Construction of buildings	2	0.47	23.06
Specialized construction activities	6	1.41	24.47
Wholesale trade, except of motor vehicles and motorcycles	19	4.47	28.94
Land transport and transport via pipelines	2	0.47	29.41
Food and beverage service activities	1	0.24	29.65
Publishing activities	3	0.71	30.35
Motion picture, video and television programme production, sound recording and music publishing activities	2	0.47	30.82
Programming and broadcasting activities	1	0.24	31.06
Telecommunications	4	0.94	32.00
Computer programming, consultancy and related activities	96	**22.59**	54.59
Information service activities	21	4.94	59.53
Financial service activities, except insurance and pension funding	2	0.47	60.00
Activities auxiliary to financial services and insurance activities	1	0.24	60.24
Real estate activities	3	0.71	60.94
Activities of head offices management consultancy activities	24	5.65	66.59
Architectural and engineering activities and related technical consultancy	47	**11.06**	77.65
Scientific research and development	70	**16.47**	94.12
Advertising and market research	2	0.47	94.59
Other professional, scientific and technical activities	5	1.18	95.76
Rental and leasing activities	1	0.24	96.00
Employment activities	1	0.24	96.24
Services to buildings and landscape activities	4	0.94	97.18
Office administrative, office support and other business support activities	3	0.71	97.88
Education	4	0.94	98.82
Libraries, archives, museums and other cultural activities	1	0.24	99.06
Repair of computers and personal and household goods	2	0.47	99.53
Missing data	2	0.47	100.00
Total	425	100	

the SP firms are Computer programming and other information services (in which operates the 22.6 per cent of the firms), Research and development (16.5 per cent) and Architectural and engineering activities (11,1 per cent). This confirms the high-tech propensity of SP firms, however we do not know how these sectors are represented within each SP: are science parks focused,

namely specialized, in particular industry sectors or they tend to support innovation, no matter the scientific field is? The question is not trivial because the specialization of a SP in one field may on one hand attract and promote firms in a specific sector, hence the potential creation of industrial districts; on other hand it may hamper the birth and/or the development of worthy businesses/research projects not related to the SP sector of specialization.
A possible way to see whether there are SPs specialized in Italy is to look at the economic sectors where the firms inside a SP are operating. To this purpose, we performed a cluster analysis based on the number of firms and the sectors where they operates.[14] Using these variables we can define four groups of SP:

1. **general:** firms are scattered in many sectors (8 SPs)
2. **mixed:** the number of sectors and the concentration of firms is neither high, nor low (6 SPs)
3. **specialized:** featured by a high concentration of firms operating in few sectors (6 SPs)
4. **not-hosting:** characterized by the absence of firms operating in the science park (5 SPs)

First, none of the clusters has a particular ownership structure. On average "specialized" group is made of younger SPs compared to the other clusters. On one hand this may suggest a policy change towards the creation of specialized SPs. On the other hand, "specialized" group may actually reflects the "age" of a SP rather than a real specialization: a young park needs time to attract firms from different sectors. Science parks, like Toscana Life Science and Virtual Reality, seem to confirm the former interpretation. Nevertheless, the second hypothesis is supported by the fact that "general" SPs, which are also the oldest, tends to be larger in area, staff as well as number of firms established (see Table 10). Consequently, the answer requires time to see whether specialized SP will be so also when they grow up. Keeping in mind this caveat, we will continue to distinguish the SPs according to the clustering definition made above.
Concerning the degree of cooperation with universities and PRIs, specialized and general SPs are on average more cooperative than the other groups. The same occurs about the number of services provided to firms. Surprisingly, not-hosting SPs are the least cooperative with universities and PRIs.

[14] We do not discuss here the clustering method applied to our data. For whom interested, see Appendix A.

[15] Data about Specialized group is related to four SPs

Table 10: Descriptive statistics of SPs **by ownership** (standard deviation in brackets)

	General	*Mixed*	*Specialized*	*Not-hosting*
Turnover (million of Euros)	6.6	4.0	1.1	4.1
	7.8	3.5	0.9	5.9
Buget share from direct public funds	14.5	23.5	52.0	45.5
	14.5	38.0	48.2	41.9
Area (Thousand meters)	89.4	18	1	9
	149.4	13.63	0.55	8.47
Total staff	68.0	30	9	33
	86.1	35.47	5.52	33.18
Incubation staff	6	3	0	3
	4.65	1.83	0.45	1.76
Technology transfer staff	30	3	4	4
	54.77	1.52	2.54	3.06
Firms within the park	56	23	-	21
	27.35	8.96	-	15.67
Firms served (inside and outside the SP)[15]	175	122	82	17
	229.63	185.77	123.62	14.45

5 SP Firms Descriptive Analysis

In the previous section we had several insightful results about SP activity. We now focus on our second research question about science parks, namely whether in-SP firms benefit from SP services in terms of better performance than out of park firms. To address this issue, we check whether SP firms are actually different than other out of SP firms in terms of innovative capacity and/or balance sheet results.
In order to have a first overview of the characteristics of the firms settled into SPs and to understand if these firms show peculiar features, we selected all the firms located outside the techno-poles that share the same age, geographical area, and industry sector of the SP firms. Such selection leads us to a sample made of more than 330,000 firms. In tables 11 and 12 we display the average values in 2011 of some variables of interest referred to the firms located, respectively, outside and inside SPs.

As can be seen from the two tables, SP firms display higher average values than NSPs firms for all the considered indicators of performance, profitability and investments. In order to check whether the average values of the two groups of firms are statistically different, we perform a t-test on the difference between the two means for each of the considered variable (table 13, second column). SP firms show statistically higher indicators as regard both the general performance (sales, net worth, value added) and profitability (gross operating margin over total assets, ROA). Concerning the investment profile, no significant differences are found for the ratio between investment in intangible assets and sales while total investment over

Table 11: Summary statistics about NSP firms. Year=2011

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Sales (th. euros)	314666	454,5	764,8	0	4502
Value added (th. euros)	297810	153,0	240,2	-19	1346
Net worth (th. euros)	299710	269,4	482,7	1	2910
ROA	289877	1,0	4,8	-15	17,75
Gross Operative margin / assets	290496	7,0	9,0	-11,1	37,25
Investments/sales	242910	-0,02	0,1	-0,5	0,58
Intangible assets (th. euros)	331475	341,0	71015,2	0	40000000
Number of patents	331475	0,0	0,0	0	1
Age (years)	331475	12,8	12,2	1	166

Table 12: Summary statistics about SP firms. Year=2011

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Sales (th. euros)	312	779,1	1010,9	0	4385
Value Added (th. euros)	276	282,4	319,5	-19	1291
Net worth (th. euros)	325	328,6	515,3	1	2814
ROA	351	1,7	5,2	-14,75	17,56
Gross Operative margin / assets	341	10,1	10,0	-10,96	36,41
Investments/sales	347	0,01	0,1	-0,5	0,53
Intangible assets (th. euros)	401	25168,5	438873,5	0	8779002
Number of patents	401	0,00	0,00	0	0
Age (years)	401	12,6	15,2	1	146

sales are higher for SP firms. Therefore firms located within parks seem to invest more than their counterparts, but not when we look separately at investment in intangible assets. Also the innovation profile of the SP firms, measured in term of patents application, is similar to NSPs firms. In particular, in 2011, no SP firms applied for a patent and few NSP firms have one (at most) application in progress.
The t-test is a benchmark test that implies the normality distribution of the considered variable, an assumption that is not necessarily met for balance sheet and patent data. Therefore we performed the one-sample Kolmogorov-Smirnov test and the Skewness-Kurtosis tests to asses the normality of the distributions. The results of both tests always rejects the normality assumptions for all the tested variables in the two groups of firms,[16] leading us to assess the difference between the two groups using other non parametric tests. We perform the two-sample Kolmogorov-Smirnov test for equality of distribution functions and the Kruskal-Wallis equality-of-populations rank test (table 13, third and fourth columns). These tests completely confirm the results obtained using the t-tests.

Table 13: Difference between the 2 samples: "yes" reports a statistical difference and a + means higher average values for SP firms

Variable	T-test	K-Smirnov	K-Wallis
Sales	yes +	yes +	yes +
Net worth	yes +	yes +	yes +
ROA	yes +	yes +	yes +
Gross Operative margin / assets	yes +	yes +	yes +
Value Added	yes +	yes +	yes +
Investments/sales	yes +	yes +	yes +
Intangible investments/sales	no	no	no
Intangible assets	yes +	yes +	yes +
Number of patents	no	no	no

In addition to the comparison of the unconditional means of treated and not treated firms, we compare also the means of the two groups conditioning on the sector of activity and on the geographical area. This is made running for each of the considered variables in the previous analysis a regression where an independent variable is a dummy that is equal to 1 if the firm belongs to the treated group, and all the other regressors are sectoral and geographical dummies. We find significant and positive coefficients for the treatment dummies for the majority of the considered outcomes (sales, net worth, value added, share of investments, intangible assets). The con-

[16] All the p-values of these tests are well below the 1%, for whom interested the tests can be asked upon request to the authors.

ditional means are not different for patents and for the share of intangible investments, that also in the baseline unconditional means analysis turned out to be equal between the two groups, and for two profitability indicators (ROA and gross operative margin).
Summarizing, SPs firms show better balance sheet measures than NSPs firms in 2011 for many indicators also when we control for the sector of activity and for the area where they are located. On the other hand measures of the R&D activity (intangible assets and patent applications) show no difference among the two groups of firm.
In this section of the paper we described the main characteristics of more than 400 SP firms located in 20 Italian SPs in 2011, providing a first descriptive comparison with respect to NSP firms located in the same geographical area and operating in the same sector of business.[17] Results point out, in general, better performances of the SP firms with respect to their counterparts, in terms of profile performance, investments and profitability indicators. The better performance of SP firms can be due to the benefits they obtained by being located inside SPs or to the fact that the best firms chose to locate inside SPs. In the next section we move to explain in details the matching strategy to optimally pair treated and the untreated firms, a necessary step before quantitatively evaluating the impact of the parks on hosted firms.

6 The effects of SPs on resident firms

6.1 The matching

After the descriptive analysis of SP firms, we study the effect of SP on hosted firm performance as a policy evaluation problem in which we assume that the location in a SP and the use of its facilities and services can be interpreted as a treatment. In order to compute the effectiveness of being located within a park, we perform a difference in differences estimation, that basically consists in observing the performances of the treated firms before and after the treatment, and comparing them with those of the not treated firms.
The first step of the analysis consists of finding a correct group of comparison for the treated firms. As a matter of fact, since entering in the park is usually subject to some rules or judgments by the SPs' management, it is possible that firms located within parks systematically differ from those that are outside with respect to some co-variates. This could generate a problem of selection bias, that consists in the outcome differences that would be observed between participants in the training and non-participants if the

[17] We did not compare the performance of these firms also in the pre-treatment year because many firms were born in the parks and, moreover, the pre-treatment year is different among firms of different parks, making the analysis less informative.

treatment were not implemented, and depends on pre-existing differences between the two groups.
In order to minimize this bias and to guarantee the ceteris paribus condition, we match treated and untreated firms conditioning on those characteristics that were likely to affect the probability to participate in the intervention, namely that influenced the selection process and that incorporate all relevant differences between the two groups before the start of the treatment. Basically, we construct a control sample of firms in which the distribution of the observed co-variates is as similar as possible to those in the treated sample before the treatment started. The co-variates used to perform the matching are a) firms' age, b) annual sales, c) net worth and d) gross operative margin over total assets. The choice of these variables allows us to have similar groups in terms of age, dimension of firms' business (controlling for total sales and net worth), as well as of their income profile, measured with the gross operative margin. These co-variates, in our opinion, well summarizes the status of the firm in the pre-treatment year according to different perspectives. Of course there could have been also unobservable characteristics that influenced the selection process and that could keep alive the selection bias issue (for example the fact the firms hosted in parks may be more motivated than others to perform well), but we will reduce this bias, at least partially, applying in the second step of the analysis the dif-in-dif estimation (see Section 6 for details).
Among the different matching methods, we choose the Mahalanobis matching, in which the association between treated and not-treated firms is done by minimizing a special metric, the Mahalanobis distance, that depends on the covariance matrix of the co-variates.[18] Since treated and not treated firms should have been similar before the beginning of the treatment, we take the values of these co-variates chosen referred to one year before the treatment. The identification of the year in which the treatment begins was not immediate, since we do not know the year of settlement in the park for each firm. So, we considered the year of settlement of the first firm in each SP, an information that is available from the survey, as the year of settlement for all firms that are located in that park. We are conscious that we are implicitly assuming that the majority of the firms moved inside the parks in the year of first settlement in the corresponding park or in the subsequent year. In order to reduce the possible distortions that derive from this assumption we select only the firms belonging to the 11 parks whose

[18]Other matching methods employs the propensity score (Rosenbaum and Rubin [25]), that is a synthetic and one-dimensional index based on the co-variates chosen. According to different matching methods, it is possible to pair each resident firm to one or more firms in the untreated group such that the propensity scores are as similar as possible. In our exercise the Mahalanobis matches performed better both in term of number of matched firms that in term of balancing properties of the matched samples. For a detailed overview on the propensity score analysis see also Guo and Fraser [12]

first firm's establishment date was between 2002 and 2008. On one hand, restricting the analysis to these sample of parks allows us to reduce the differences in the treatment period among firms located in the same park, since these parks are relatively young and the settlement years could not differ too much. On the other hand, this allows us to have a good homogeneity in terms of length of the treatment period also for firms belonging to different parks, since these park have a similar first settlement year. Basically, we drop the oldest Parks, for which the treatment period could have lead to a very heterogeneous treatment period among the firms located in different parks (because of very different years of first settlement among parks) and in the park itself (because of the long period of life of the park). In the exercise, we also drop the most recent parks, for which the treatment on firms could have been too weak to be detected due to their short period of living.

Finally, we restricted our analysis only on those firms that belong to the selected parks but that were established before the year of first settlement of the corresponding park, dropping those firms born in the techno-poles.[19] In this way, we are sure that for the selected treated firms there will be a pre and a post-treatment period, a necessary condition to implement the dif-in-dif approach.

Starting from these firms located, but not born, in these 11 parks, we select a control group of firms located in the same geographical area and operating in the same sectors of business of the treated firms. The treated sample is made by 90 firms and the control group was made by more than 66,000 firms. Then, for each park we match the firms according to the Mahalanobis distance based on the co-variates previously chosen and we put together all the matched firms of the 11 considered SPs in a unique sample in order to perform all the balancing tests. Our matched sample was finally made by 61 treated firms matched with 63 untreated firms. The failing matches for some treated firms were not due to the common support condition[20] but it is related to the presence of missing values in the balance sheet data. This guarantees the external validity of our evaluation.

Table 14 displays the balancing properties of the matching: for each co-variate the thresholds of 5 per cent in the bias between the two groups is respected. Also the t-tests confirms a good balancing in the groups, since no statistical differences among the sample means of the treated and not treated groups is found for any of the co-variates.

As in Section 3, we checked the normality assumption of the distributions

[19] For example, if the first year of settlement of the science park A is (say) 2005, we (do not) consider for our analysis only the firms created before (after) such year.

[20] According to the common support condition, the conditional distribution of the co-variates in the not treated group should overlap with the conditional distribution of the treated one.

Table 14: Balancing tests and matching properties

	Treated	Control	% bias	t-test	p-value
Sales	764,11	799,66	-3,6	-0,2	0,840
Gross Operative margin / assets	15,603	16,02	-3,1	-0,17	0,865
Age	12,667	12,902	-4,2	-0,23	0,815
Net worth	200,25	195,48	1,6	0,09	0,928
Observations	61	63			
	Pseudo R^2	LR χ^2	$p > \chi^2$	MeanB	MedB
	0,001	0,16	0,997	3,1	3,3

of the treated and untreated firms.[21] Again, since the normality is rejected for all the variables, we check further the balancing properties of the two sample throughout other tests that are not based on the normality distribution assumption. In table 15 we show the results of mean comparison tests in case of not normality for the selected co-variates. Moreover, we control also the balancing properties for other additional variables, in order to control the reliability of the matching according to other dimensions for which we did not control directly in the match (value added, ROA, investment/sales, intangible assets/sales, intangible assets).[22] As can be seen, no differences between the two groups is found for all the variables chosen, meaning that the matching performed well.

Table 15: Balancing Statistics

	Treated		Not treated		Difference between the samples means		
	Obs.	Mean	Obs.	Mean	T-test	K-Smirnov	K-Wallis
Sales	63	764,1	61	800	no	no	no
Gross Operative margin / assets	63	15,6	61	16,02	no	no	no
Age	63	12,7	61	12,90	no	no	no
Net worth	63	200,3	61	195,48	no	no	no
ROA	59	3,1	58	2,53	no	no	no
Value Added	59	233,4	61	239,07	no	no	no
Investments/sales	42	0,03	43	0,01	no	no	no
Intangible investments/sales	46	-0,02	45	0,01	no	no	no
Intangible assets	59	20,6	59	20,30	no	no	no

The good match between treated and untreated firms according to the observables chosen allows to net out compositional differences among the two

[21] We perform the Kolmogorov-Smirnov and the Kruskal-Wallis tests to which we add the Shapiro-Wilk and the Shapiro-Francia test for normality. We did not used the Shapiro-Wilk and the Shapiro-Francia in the previous section because these tests can be applied only for samples that goes between 4-2000 and 5-5000 observations respectively, a condition that was not met in our general analysis. These results about these tests are available upon request by the authors.

[22] We also reports the results of the t-tests as a benchmark. Moreover, the number of matched observations is lower for the investments variables because of many missing data because we construct the investments as the differences of the related assets.

groups and to move further in identifying the effect of the being located in the park.

6.2 Main results

After the matching step we move to the effectiveness of being located within a park by performing a difference in differences estimation. This consists in observing the performances of the treated firms before and after the treatment, and comparing them with the not treated ones. This approach allows to control also for time invariant unobservable characteristics that could have affected the selection process and that could be relevant for our outcome variables, generating systematic differences between the two groups.[23] Our specification is the following:

$$y_{it} = \alpha + \beta_1 \cdot POST_t + \beta_2 \cdot TREATMENT_i + \beta_3 \cdot \mathbf{INTERACTION_{it}} \quad (1)$$
$$+\beta_4 \cdot SECT_i + \beta_5 \cdot GEO_i + \epsilon_{it}$$

where subscript i corresponds to the firm and substrict t is equal to the year. The POST dummy takes value equal to one in the post treatment year (2011) and zero in the pre-treatment year, the TREATMENT dummy takes value one only for the firms located within SPs and the INTERACTION variable is made by multiplying these two dummies. Our main coefficient of interest is related to the interaction term since it captures the effects of have being located in a Park for the treated firms. We then have sectorial dummies and geographical dummies to control for the area of specialization of the firm and for its location. No other controls are necessary, since the two groups have been matched for the characteristics that, in our opinion, are relevant for the treatment and for the outcomes.
We study the effects of SPs on several outcomes:

1. **Production performance:** we include the annual sales and the operative value added, that may be affected by the favorable environment of the Parks in terms of services provided, knowledge spill-overs and product processing.

2. **Profitability performance and financial conditions:** we consider the ROA index and the gross operative margin over total assets as profitability index. These indicators are useful to verify if significant differences exist between the two groups in terms of income profile, that may depend on the supply of services by SPs. Training and project management are some of the typical services supplied by a

[23] We did not check the common trend assumption necessary for the validity of the dif-in-dif estimation because the pre-treatment year is different from park to park. In such a case, we would in fact compare firms in different periods of the business cycle to draw the pre treatment trends for the treated and not treated firms.

techno-pole that may lower monetary and time costs for the firms, consequently increasing their profitability.

3. **Investment propensity:** we look at the ratio between investment and total sales, in order to understand if SP firms invest more and if they are more dynamic.

4. **Innovative capacity:** since one of the goals of the SPs is to promote the technology transfer in terms of knowledge and innovative activities, we exploit the ratio between intangible investment and total assets as a proxy of the firms' innovation capabilities.[24] We also consider the patenting activity of the firm, using a dummy variable that takes value 1 if the firm has applied at least one patent at the European Patent Office.[25]

As shown in Table 16, the results of the dif-in-dif estimations show that the majority of the outcome variables the average effect of the training on the treated is not statistically significant. The effect on sales and on the value added is positive, even though its statistical significance is quite weak. So, moving to a SP seems to provide a better production performance it does not affect the profitability, the investment propensity as well as the innovative capability.
As regard the other covariates, in many regression North West and Center dummies are statistically significant and have a positive effect on SP firms (with the South as the reference point). The coefficient related to the post treatment period is negative for the profitability variables, capturing the effect of the recent financial crisis, while it is positive for sales and value added, meaning that the firm is growing over time.

The lack of strong differences in term of business conditions, profitability and investment suggests that the services provided to firms by SPs, as well as the proximity spillovers, do not improve SP firms performances. This could be partially related to the fact that some SPs firms may be more oriented to pure research and to innovative activities rather than to profitability or economic goals.

[24] As regard investments, we have a smaller number of observations than the other outcomes because we need to have the stock variables in two subsequent years to compute the investment.

[25] In order to correctly capture the patent stock produced during the treatment period, we cumulated the number of patents starting from two years after the settlement in the Park and to 2011, which is the last year for which data are available. The two years delay is justified by the fact that the SP firm needs some time in order to benefit of SP services. To make the comparison possible we then applied the same number of years to the pre-treatment period, going back from the year of settlement in the Park. For example, if the SP firm settled in 2005, we considered its patent application treatment period from 2008 to 2011, hence four years; as a second step we account four years of pre-treatment period (i.e. 2002-2005). Note also that few of the matched firms had a positive patent application stock, generating a very low variability of the dependent variable.

Table 16: Effects of the SPs on firms' performance (11 SPs)

	Sales	Value added	ROA	EBITDA/assets	Inv/sales	Intang. Inv/sales	Patents
training	196.2	14.0	−0.2	−0.64	0.02	−0.049	0.070**
	(200.6)	(68.2)	(1.2)	(2.6)	(0.02)	(0.05)	(0.037)
post	259.9**	117.1**	−1.5	−6.8***	−0.01	−0.016	−0.001
	(125.4)	(54.9)	(1.1)	(2.2)	(0.02)	(0.01)	(0.02)
interaction	**355.1***	**143.0***	−0.7	1.4	−0.03	0.040	−0.037
	(211.4)	(85.4)	(1.5)	(3.0)	(0.03)	(0.04)	(0.04)
geo dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
sectoral dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
obs.	223	217	213	223	152	164	223
groups	123	120	119	123	88	93	123
R2	0.22	0.19	0.15	0.21	0.2	0.09	0.12

6.3 Robustness check

Since the drawback of our approach may be the small number of firms located within parks, we extended our analysis in two directions.
On one hand, we checked our results passing from 11 to 14 science parks, namely including three parks born at the end of the '90s and at the beginning of '00s. This allow us to improve the significance of the analysis even though at the cost of an higher variance within firms in terms of treatment period.[26]
On the other hand, we increase our "tolerance" on outliers: in the main exercise we drop the balance sheet outliers with values lower than the 5th percentile and above the 95th percentile; now we drop only the 1st and the 99th percentiles. These two changes allows us to move from around 120 firms (treated and untreated) to more than 180 firms (93 treated firms matched with 91 of untreated firms). The matched samples are perfectly balanced for each of the covariates (See Table 19 in Appendix B).

Table 17: Effects of the SPs on firms' performance (14 SPs)

	Sales	Value added	ROA	EBITDA/assets	Inv/sales	Intang. Inv/sales	Patents
training	140.5	308.6	1.68	1.98	−0.039	−0.12	0.050
	(754.3)	(213.8)	(1.78)	(2.7)	(0.06)	(0.13)	(0.03)
post	1089.9**	352.4**	−1.13	−1.83	−0.09*	0.63	0.00
	(550.1)	(185.5)	(2.9)	(2.7)	(0.04)	(0.68)	(0.00)
interaction	1085.5	**535.9****	1.14	−2.15	−0.610	−0.010	
	(802.2)	(274.4)	(3.2)	(3.5)	(0.07)	(0.68)	(0.03)
geo dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
sectoral dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
obs.	352	349	352	352	255	256	352
groups	183	182	183	183	135	135	183
R2	0.37	0.34	0.10	0.11	0.08	0.04	0.32

As Table 17 shows, previous results are confirmed: for a firm the location in a SPs is not associated, in general, with different performances with

[26] About the remaining six SPs that we could have included in the counterfactual analysis, three were too old such that balance sheet data of their SP firms in the pre-treatment period were not available; while the others were too young to be included in the analysis such that it is too early SP firms moved inside these parks too recently.

Table 18: Effects of the SPs on firms' performance according to the age (14 SPs)

	Sales	Value added	ROA	EBITDA/assets	Inv/sales	Intang. Inv/sales	Patents
				Recent parks			
interaction	984.6	87.7	−2.4	−5.0	0.12	0.13	−0.09
	(621.0)	(246.8)	(4.1)	(4.5)	(0.25)	(0.22)	(0.06)
obs.	96	96	96	96	69	70	96
groups	50	50	50	50	37	37	50
R2	0.82	0.75	0.16	0.17	0.15	0.11	0.23
				Old parks			
interaction	1187.5	**713.9****	3.1	−1.04	0.07	−0.9	0.02
	(1077.6)	(370.4)	(4.2)	(4.5)	(0.05)	(0.95)	(0.04)
obs.	256	253	256	256	186	186	256
groups	133	132	133	133	98	98	133
R2	0.31	0.27	0.12	0.11	0.1	0.06	0.37

respect to those firms located outside SPs. All the interaction terms are not statistically different from zero, with the exception of the value added regression, confirming that SPs does not have an impact on the hosted firms for the majority of the selected outcomes.

In spite of this general result, one should take into account that most of the SPs have been created recently: the absence of SP impact on hosted firms may actually reflect their age, namely lack of experience, rather than their inefficiency. To check this issue we run the analysis separating firms in two groups according to the year of creation of the SP they are located within (Table 18, only the interaction term coefficient is shown).[27] Even though the two groups have different size (50 vs 133 firms for Recent and Old, respectively),[28] it is straightforward to see that no effects of the SPs are found for the firms located in the most recent parks, while a significant coefficient of the interaction term is shown for the value added in the oldest SP. Therefore, this result seems to confirm our hypothesis that the length of permanence in a SP is important for the performance of SP firms, at least for the added value. As a consequence, more effects of SPs may appear in the future, but only time can definitively clarify this point.

7 Concluding remarks

The development of science parks, which supply specialized services and foster proximity spillovers that benefit the firms they host, is one of the measures used to boost firms growth and innovative capacity in recent decades.

[27] We also addressed another interesting issue, namely whether the effect of SPs was different according to the size of the treated firms (large vs mall/medium enterprises). Unfortunately, the result shows that the effect of SPs is not different across the size of hosted firms. These results are available upon request to the authors.

[28] Note that the different size of the two groups is due to the fact that many hosted firms lie in the median year so we put them in the Old SPs.

Exploiting a survey conducted by the Bank of Italy in the spring of 2012, this paper aims to shed light on the activity of SPs in Italy and their effect on the performance of the hosted firms. To the best of our knowledge this is the first attempt to get a full detailed picture of the overall activity of Italian science parks, whose number and importance have grown in the last few years. Considering our findings, our contribution to the literature on science and technology parks is threefold.

First, we provide some stylized facts about the main features of Italian science parks and the differences among them. In this regard, we find significant differences among science parks in almost all variables (e.g. turnover, staff, firms established/served, etc.) but a common factor among all science parks is strong cooperation with universities of the home regions. Moreover, science parks with mixed ownership tends to be more connected than public ones, while a distinction by year of foundation reveals that those created during the 1990s are on average more dependent than others on direct public funds, less prone to provide services to firms, and more subject to a decline in turnover in the last 5 years.

Secondly, we tried to understand which types of firms are settled in Italian SPs and how they differ from out-of-park firms. For this purpose we compare around 400 SP firms with non-SP firms of the same area, age and branch of industry, finding that SP firms are, on average, superior to their counterparts in terms of economic performance, investments and profitability indicators.

This comparison lead us naturally to a question whose answer represents our third contribution: Did Italian SP firms get a benefit from being in a science park compared with their non-SP counterparts? Our difference-in-difference analysis shows that firms that moved into science parks did benefit from a higher value added than out-of-park firms but obtained no other benefit in terms of higher sales, profitability, investment or patenting. However, a further look at the treated firms according to the science park age confirms the finding of higher value added only for older science parks, suggesting that science parks may need time to affect the hosted firms performance.

These results raise additional questions and issues that deserve further investigation. For example, the overall heterogeneity of SPs seems to suggest that policymakers lack a unified vision concerning the nature and the activities of SPs. This aspect could be positive, reflecting an ability to create SPs in response to the needs of the time and/or the economic context. On the other hand, the lack of a clear role assigned to SPs makes it difficult to understand, evaluate and hence appreciate their contribution to national innovative capacity. A second important conclusion we draw from our comparison is that science parks are able to attract the best firms but do not significantly improve their performances. This may be due to the relatively young age of Italian science parks, but from a policy viewpoint Italian SPs clearly warrant further investigation in order to understand what characteristics need

to be strengthened so as to improve their effectiveness in supporting hosted firms.

Although our study provides some interesting results, it is necessary to consider its limitations, which actually correspond to future research paths. First, owing to lack of data, our analysis does not investigate the impact of SPs on welfare. For example, we do not study how technology transfer between firms or between firms and universities leads to the introduction of new products or processes that may benefit consumers. Moreover, we do not look at the performance of firms born in the SPs: since the difference-in-difference analysis refers to the sub-sample of firms that moved into the parks, it would be interesting to extend the performance analysis to firms that were born in the parks (i.e. incubated firms), albeit with different methods. That study could also be supplemented by a survival analysis of the firms that left the parks, another important dimension for a broad evaluation of the effectiveness of science parks.

Despite these limits, our updated and detailed analysis of science parks activity in favour of Italian firms helps to provide a broad picture of one of the tools that Italian policy makers use alongside business incubators[29] and industrial districts.[30] Further research would be useful to determine more precisely how they can best contribute to boosting Italys innovative capacity.

[29] A recent paper by Auricchio et al. [1] sheds light on the effect of Italian business incubators on firms survival capacity compared with non-incubated firms. Their work is therefore quite complementary to ours not only because of their survival analysis, but also because they look at another tool used by policy makers to improve entrepreneurship and competitiveness in Italy.

[30] For a recent analysis of the effect of industrial districts on firms performance, see Bertamino et al. [3].

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A Cluster Analysis

To check the specialization of a SP we used the name of firms provided in our survey to get their information from CeBi/Cerved and Infocamere datasets. For the purpose of this paper we look in particular at their economic sectors according to the ATECO 2007 classification, which corresponds to ISIC rev.4 and NACE rev. 2.
We have been able to get the 2-digit industry sectors of 548 firms out of 609 firms mentioned in the survey[31] covering almost the 90% of the sample. Knowing in which SP each firm is established, then we were able to see which sectors and how many firms-per-sector are present in each SP.
To detect the degree of specialization we then considered two variables. The first one is the number of sectors existing in the park thanks to the presence of a firm: the higher number, the less specialized is the park. However, this variable can be misleading because a SP may have many sectors but almost all the firms operating in a particular one while another could have fewer sectors but firms more uniformly distributed along them. Therefore we also calculated a concentration (Herfindhal) index for each SP according to the number firms per each sector existing in the SP.
We used these two variable in order to perform a cluster analysis. To avoid the sensitivity of results to different variable unit measures, we normalized the data according to the following rule

$$y_i = \frac{Y_i - \min_{1\leq j\leq N} Y_j}{\max_{1\leq j\leq N} Y_j - \min_{1\leq j\leq N} Y_j} \quad \forall\ j \in [1, N] \tag{2}$$

which is suitable for non negative values as in our case. In order to see which group of SPs naturally arise, cluster analysis is based on hierarchical methods.[32] We considered the Ward method as our benchmark because of its large use. To check the robustness of our clustering with respect to the method used we also used Centroid, Average, Weighted average and Complete methods. For all of them, the ordering of the SPs according to the dissimilarity measure is the same. Centroid did not produce a dendrogram so it was not possible to use it. Concerning the other methods, as the dissimilarity measure increases, the number of groups passes from five to three. However, in case of five groups one cluster is made of an isolated SP, a result that is difficult to evaluate. On the other hand, if we consider a higher dissimilarity level to associate the isolated SP with another group, we have three groups that differ according to the method used. Given these drawback and the higher use of Ward algorithm we use the latter.

[31] Actually, the number of firms signaled by the interviewed SP was initially 703, however a first check lead us to drop 96 of them because they were public entities.

[32] There also exists non hierarchical Cluster analysis where it is assumed *a priori* the number of groups that has to be created at the end of the analysis. For further details see Gatingnon [11].

B Tables

Table 19: Balancing tests and matching properties

	Treated	Control	% bias	t-test	p-value
Sales	2405	2383.3	0.4	0.03	0.977
Gross Operative margin / assets	13.568	13.183	2.1	0.14	0.887
Age	16.161	16.099	0.7	0.05	0.961
Net worth	330.25	318.05	2.4	0.16	0.873
Observations	93	91			
	Pseudo R^2	LR χ^2	$p > \chi^2$	MeanB	MedB
	0.000	0.05	1	1.4	1.4

C Questionnaire

Questionnaire for science parks

1. Name

2. Year of incorporation

3. Ownership

4. Since the incorporation, has the ownership changed? If so, what was the initial ownership?

5. Turnover of the science park in 2010 *(Euro)*

6. In the last 5 years, the turnover has

7. Budget share coming from direct public funds in 2010	
	%

8. With respect to the previous 5 years such share has

9. Type of links with universities
Financial (toward universities)
Financial (from universities)
National research projects
International research projects
Personnel training/hiring
Use of park's facilities
Use of universities' facilities
Other (*please, specify*):

10. Name of the main partnering university

11. Type of links with other research institutions	
Financial (toward research institution)	
Financial (from research institution) National research projects International research projects Personnel training/hiring Use of park's facilities Use of research institutions' facilities	
Other (*please, specify*):	

12. Name of the main partnering research institution

13. Surface of the science park
.000 square metres

14. Number of science park staff

15. In the last 5 years the number of science park staff has

16. Number of staff employed in providing incubation service

17. Number of staff employed in providing technology transfer service

18. Services provided by the science park	
R&D	
Partnership	
Incubation	
Business planning	
Training	
Project management	
Fund-raising support	
Patents	
Legal support	
Facilities	
Other (*please, specify*)	

19. Could you specify which is the main service (among the above mentioned)?

20. Do you have a technology transfer office?

21. Year of settlement of the first firm *(If no firm is settled, please go to question n. 23)*

22. Number of firms currently hosted in the park

23. In the last 5 years, what is the number of firms that:	
Used park services	
Were born in the park	
Left the park, while continuing their activity	
Left the park because they stopped their activity	
Left the park because of merger/acquisition	

24. Could you list the name of the firms currently settled in the park?

25. Comments/Notes

26. Contacts
Name
Position
Telephone
e-mail

27. Date