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The Role of Science Parks in Sustaining Innovative Entrepreneurship: Evidences from Italy

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Abstract

The role of SPs and Incubators as policy instruments fostering innovative entrepreneurship is still an open issue. The literature is far from conclusive in establishing whether these structures are effective in sustaining on-park firms' performances. Relying on Italian data, we carefully construct a control group of comparable off-park start-ups and we provide evidence of the different performances experienced. In particular we analyze three dimensions: (i) firms' innovative output, (ii) firms' growth in revenues and (iii) their persistence in growth. We investigate what features of SPs and Incubators act as drivers leading to the observed differences and we highlight how some of these are more relevant than others. SPs are analyzed along a number of additional dimensions, focusing particularly on their network relations with institutions such as universities, research centers and firms located in the surrounding area. In particular we suggest that both research-oriented environment and network spillovers play a key role in sustaining on-park firms' innovative and growth performances. Form a policy perspective our analysis suggests that initiatives to promote NTBFs on SPs will yield more innovative output and firms' growth than policies to help NTBFs in general, independently of being the park sector-specific or not.

Keywords: SPs, Firms' growth, Innovative performance.
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Introduction

Science Parks are complex institutions sharing private and public natures which have been increasingly used as policy instruments to foster the development of innovative start-ups and regional clusters. There is mixed evidence about the effectiveness of SPs (SPs hereafter) in sustaining on-park firms' performances and, more in general, the development of the surrounding area overall.

Felsenstein (1994) describes SPs more as "enclaves" of innovation rather than "seedbeds", arguing that their role is more innovation-entrenching rather than innovation-inducing. Wallsten (2004) finds no positive effect of SPs on regional development and, in particular, he documents evidence of no correlation with job growth, increase in the number of start-ups in the surrounding region and increase in venture capital operations. Taking this viewpoint, stories of success do exist (see for example Goldstain and Luger 1991, or more recently Battaglia, Lamperti and Siligato, 2012) but are the exception rather than the rule. On the other side Colombo and Delmastro (2002) report evidence of better performances for incubated firms, suggesting a positive role played by SPs at local level.

Our study contributes to the literature both providing additional evidence about the relation between SPs and tenants, and investigating what features, if any, drive differentials in performance between on-park firms and counterparts. We consider firms' behavior along a time interval ranging from 2004 to 2012, which is much larger than those used in the literature and, additionally, includes the recent crisis. Furthermore, we characterize SPs along a number of features including their size, age and sectoral specialization, the number of research centers they have, the projects they launch and their links with universities. In addition, we consider whether SPs have a physical structure where they directly host enterprises and research centers or not.

The paper is organized as follows. Firstly, we provide a review of the literature addressing the link between SPs and on-park firms; secondly we present our data and methodology. The third section is devoted to investigate presence and sources of differences in market and innovative performances between on and off park firms. Section four concludes our analysis and provides policy implications.

Previous Evidences About Science Paks And Firms' Performance

Many studies analyze the role of SPs as policy instruments aimed at promoting research-based industrial and innovative activity. However, the literature is not coherent about the precise definition of Science Park (Link and Scott 2003, Link and Link 2003, Saublens et al. 2007), mainly due to the fact that a plethora of similar institutional arrangements exist and each one is carrying its own name.

The International Association of Science Parks (IASP) provides one of the most used definitions: a Science Park is a business support and technology transfer initiative that

i. encourages and supports the startup and incubation of innovation led, high growth knowledge based businesses;
ii. provides an environment where larger and international businesses can develop specific and close interactions with a particular center of knowledge creation for their mutual benefit;
iii. has formal and operational links with centers of knowledge creation such as universities, higher education institutes and research organizations.

As reported by Bellavista and Sanz (2009), by incorporating diverse public and private organizations (e.g. innovative enterprises, technology-based start-ups, technology centers, research institutes and universities), SPs have become significant instruments of business innovation, regional development and integration of micro/mini and macro level stakeholders within innovation systems. In addition, the creation of a SP appears to be strongly linked to different factors: the proximity to university laboratories and research centers, the presence of incubators, the creation of networking opportunities, the role of the bridging institution providing tenant firms with suitable accommodations and technical and business services (Colombo and Delmastro, 2002; Link and Scott, 2003, 2006, 2007).

Despite the growing interest in the SP phenomenon, empirical attempts to assess their effectiveness are still limited. Moreover results are ambiguous both comparing the performances of tenants with out-of-park firms and estimating SPs' impacts on the surrounding area. Of the many assessments that exist, particularly relevant to our purposes are those relating to what Hodgson (1996) calls 'relative performance' and 'impact evaluation' analyses, i.e. studies that quantitatively investigate the links between SPs' features, activities, and outcomes. These assessments exercises generally rely on cross sections, follow simple estimation strategies, and aim to uncover relationships rather than assessing causes, as data quality and availability often constrain the possibility to fully address selection, self-selection and endogeneity concerns.

Colombo and Delmastro (2002) focused on the effectiveness of technology incubators on new technology-based firms (NTBFs). Referring to a sample composed of 45 Italian NTBFs incubated within SPs, they show that incubated firms are characterized with higher growth rates than their off-incubator counterparts. The analysis has been conducted taking in consideration many key elements: the characteristics of firms' founders, the innovative and growth performances of firms, the establishment of cooperative relations with other firms and universities, and the ability to have access to public subsidies. Results confirm that Italian SPs have been successful in attracting entrepreneurs with high quality human capital. Moreover, on average founders of on-incubator firms have a richer educational background, than their off-incubator counterparts.

A similar study has been conducted by Fukugawa (2004) on a sample of Japanese NTBFs, aiming at investigating the value-added contributions of SPs

on this kind of firms. He focused on whether on-park NTBFs are likely to establish knowledge linkage, with local higher education institutes (HEIs). The main result is that on-park NTBFs exhibit a higher propensity to engage in joint research with research institutes. Furthermore, no significant difference was found between SPs and other types of property-based initiatives with regard to the degree of encouragement provided to tenants to establish localized HEI linkage.

On the other side, Löfsten and Lindelöf (2001, 2002, 2003, 2005) conducted a series of similar studies to evaluate the impact of SPs on Swedish NTBFs both on and off a SP. The study showed some differences between the experience of firms on and off-park with respect to innovation and marketing issues. Firms located in SPs were significantly more likely to have a link with a local university than off-park firms and a rate of job creation which is substantially higher than that for NTBFs in general. One significant finding from this research is that NTBFs on SPs are not able to channel resource investments into greater R&D "outputs" (patents, etc.) than comparable off-park NTBFs. This result could be justified by the fact that R&D activities are difficult to measure and that small firms usually do not have clearly demarcated R&D departments or functionaries. Finally, SPs are probably attracting a more motivated group of entrepreneurs than off-park locations. On-park firms clearly place a greater emphasis on market research.

Another relevant contribution has been provided by Siegel et al. (2003). Therein university SPs are shown to stimulate technological spillovers. However, there is virtually no empirical evidence on the impact of these facilities on research productivity. The author fills this gap by examining whether companies located on university SPs in the United Kingdom have higher research productivity than equivalent firms not located on a university SP. Squicciarini (2009a) shows that locating inside the SPs positively relates to the tenants' innovative output performance. This fact can be attributed to the interactions and knowledge spillovers that co-location might trigger. Focusing on patent data, SPs' tenants are shown to innovate more than off-park comparable firms with SPs sustaining the pace of innovation (Squicciarini 2008, 2009b)

Mian (1996) assesses the value-added contributions of university technology business incubators (UTBIs) to their new technology-based tenant firms. The author presents empirical data on UTBIs by focusing on their value-added dimensions. The study concludes that several UTBI services, specifically some of the university-related inputs such as university image, laboratories and equipment, and student employees add major values to the client firms, making the UTBI a viable strategy for nurturing NTBFs. Finally, the study conducted by Wallsten (2004) reveals no positive effects of SPs on the regional development overall. In particular, the presence of a SP has not a positive impact on job growth, the number of firms and the amount of the amount of venture capitalist attracted to the country.

With special reference to Italy, Salvador and Rolfo (2011) investigated the relationship between SPs and spin-offs finding a positive correlation between

the number of SPs and incubators and the number of spin off in the same regional area. More recently, Ferrara et al. (2012) found a positive effect of SPs on GDP growth at regional level and show that areas with higher densities of SPs tend to exhibit higher output growth rates. The analysis of Italian SPs' effects on firms and surrounding area is limited to these contributions and the seminal one provided by Colombo and Delmastro (2002). Our analysis contributes to the literature extending it also along this national dimension.

Data And Methodology

This study relies on an original database regarding Italian SPs and about 147 firms located within parks premises or associated to parks themselves. The database includes SPs' features, associated firms' characteristics, their patenting activity, R&D expenditure and sales' growth. Firms' performances are evaluated along the period 2004-2012. Data about SPs and their features have been collected through specific surveys while firms' performances are elaborated using Bureau van Dijk's ORBIS database; patent applications are obtained though the EPO Worldwide Patent Statistical Database (PATSTAT).

Given the difficulties of exactly identifying SPs, we applied the following criteria to include them in our study. All active Italian SPs with reference to year 2012 are included in our sample if they provide services to sustain firms' research activities and host either an incubator or a research center (or more than one) in their structure. In case they act as virtual SPs, we require them to be at least associated to external research centers or Universities and to provide associated businesses access to previous structures, in order to avoid the inclusion of cases where the relationship between firms and the park is a pure formality. Incubators are organizations frequently hosted within SP premises, whose aim is to make financially viable young and innovative businesses and to enable them to 'stand on their own feet' at the end of the incubation period (usually lasting two to three years).

According to the USA National Business Incubation Association (NBIA) business incubators should nurture young firms, and help them surviving and growing during the start-up period, when they are most vulnerable. To this end, incubators should provide hands-on management assistance, access to financing, exposure to critical business or technical support services, as well as shared office services, access to equipment, flexible leases and expandable space. Previous requirements are, of course, minimum ones: whenever they are met the SP is included into the study. This procedure led to a final sample of 26 SPs, which geographically covers the whole territory of Italy with a stronger density in North-West regions. The effects of different features SPs might (or might not) have on tenants' performances are then studied in details.

A list of features was recorded for each SP: its name and location, the year of establishment, whether or not it had a specific sector focus and whether or not it had a physical structure, if there were universities/research centers located on the Park's premises, and if it hosted incubators. From this kind of

information we computed a set of variables which are then studies in conjunction with firms' performances.

Firms incubated or hosted and associated to Italian SPs constitute our treatment group. We are interested in studying the impact of SPs on firms' growth and their innovative activities. Accordingly, their performances are evaluated along five main dimensions: (i) firms' growth in sales, (ii) firms' persistency in growth with respect to competitors, (iii) firms' investments in research and development (R&D) activities, (iv) the rate of growth of these investments and (v) their innovative output, which is loosely measured as the number of patent they apply to.

To establish the effectiveness of SPs on tenants' performances we carefully constructed a control group of 146 comparable firms. This sample has been obtained applying the exact matching method (see Stuart 2010 for a recent review about matching). We randomly selected off-park firms for the control group within the same industry (2-digit NACE Rev.2 level) of those belonging to the treatment group in a way to mirror the distribution of the latter on size (number of employees), age (years from establishment) and geographical location at regional level (NUTS 2 precision). In addition, it is important to recall that, for each industry, the ratio between the number of firms within the control group and those in the treatment does not differ from the unity up to a factor of 20%. Given that we consider a total of 38 industrial segments, this implies that the distribution of non-treated firms along sectors is extremely close to that of the treated.

SPs and their Tenants: A Snapshot

Here we briefly describe SPs and on-park firms in our sample. Out of 26 SPs only 7 do not have a physical structure and act as virtual entities coordinating a number of geographically separated subjects. The majority of SPs are quite recent, demonstrating the on-going tendency in Italy of investing in this kind of policy instruments (Ferrara and Mavilia 2012). Figure 1 illustrates this feature while Figure 2 and Figure 3 show the distribution of SPs over the number of research centers they host and the linkages they have developed with either Universities or external research centers. Both the role of SPs' links with the academia and the number of hosted research centers are at the core of the empirical analysis we present in Section 4.

It is immediate to see that Italian SPs tend to host a relatively high number of research centers (the average number per SPs is 4.3) with only 3 out 26 cases displaying zero hosted research structures. SPs seem also quite active in creating links with Universities, with an average of 2.4 links per park and half of them having 3 or more partnerships. In our sample, only 1 structure does not exhibit linkages with the academia: interestingly it is among those not hosting research centers. This allows to conclude that all but one Italian SPs either have at least one internal research center or have developed partnerships with external ones or Universities.

Figure 1. *SPs in Italy by their age*

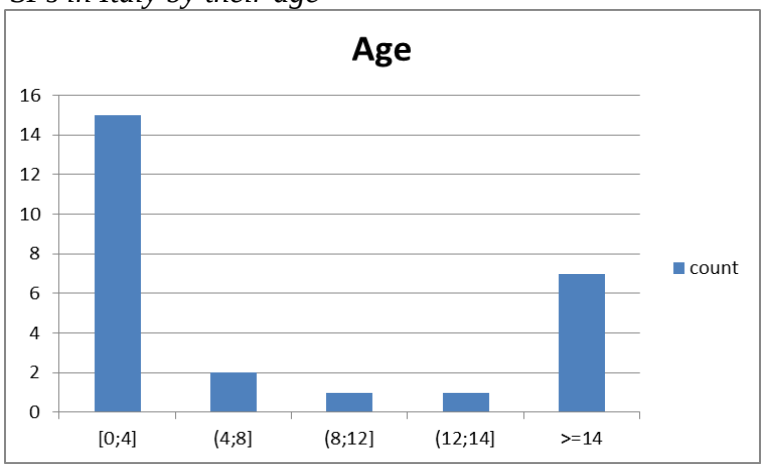


Figure 2. *SPs by the Number of hosted Research Centers*

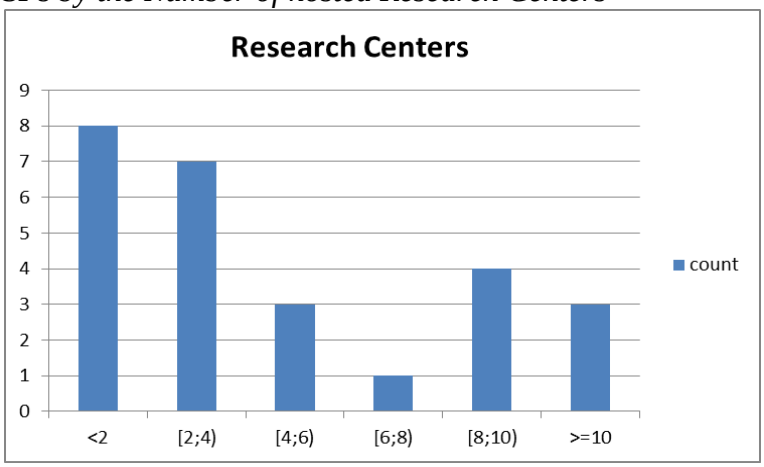


Figure 3. *SPs by the Number of Links with Universities*

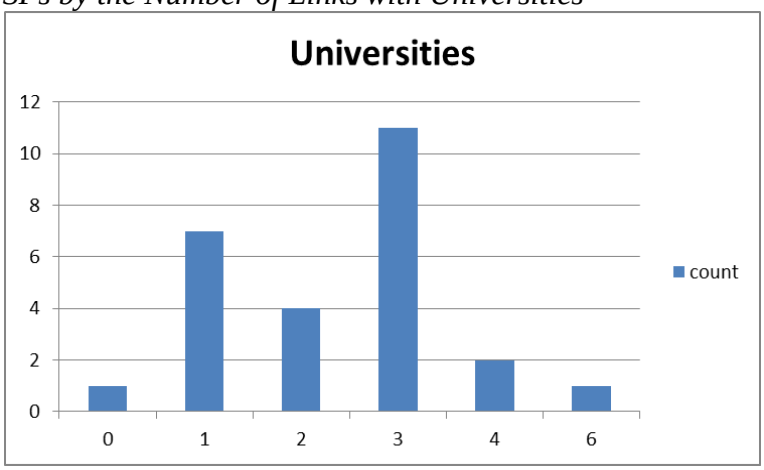


Figure 4 shows the distribution of on-park firms over macro-classes of industries, identified here by 1-digit NACE Rev.2 codes (here called with the Italian classification name, ATECO). We observe a clear prevalence of firms

within class 2, which represents manufacturing activities with the exclusion of food and beverages and furniture. Among other classes the frequency is similar with the exception of few firms belonging to classes 5 and 8, which represent transportation and support services (renting, office material, security) respectively.

Figure 4. *On-park Firms by Industry Macro-class*

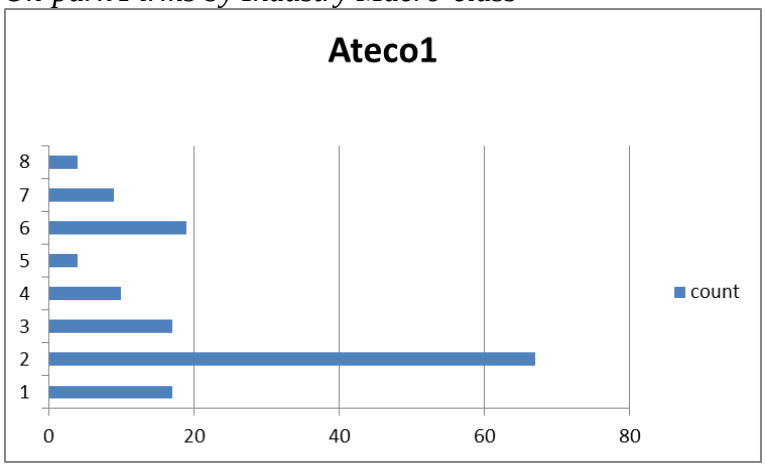


Table 1 shows other main features of Italian on-park firms once we removed outliers corresponding to big companies (above 900 employees). Provided that all variables take only positive values, the presence of extremely high standard deviations with respect to the mean shows that distributions are not symmetric and Italian SPs host and associate to a set of highly heterogeneous firms. It is particularly interesting to notice how two features of firms' data allow us to conclude that SPs in Italy mostly host both mature and small firms. First, with respect to the variable age we found that 14 out of 147 firms in the treatment group are start-ups (less than 5 year old) and consequently that the share of startups within Italian SPs has an average of 9.4%, showing that the majority of them are mature. Second, the share of SMEs in the sample is 74%, proving that almost three over four firms hosted within SPs have less than 250 employees.

Table 1. *Age, Size and Distance of Headquarter from the SP*

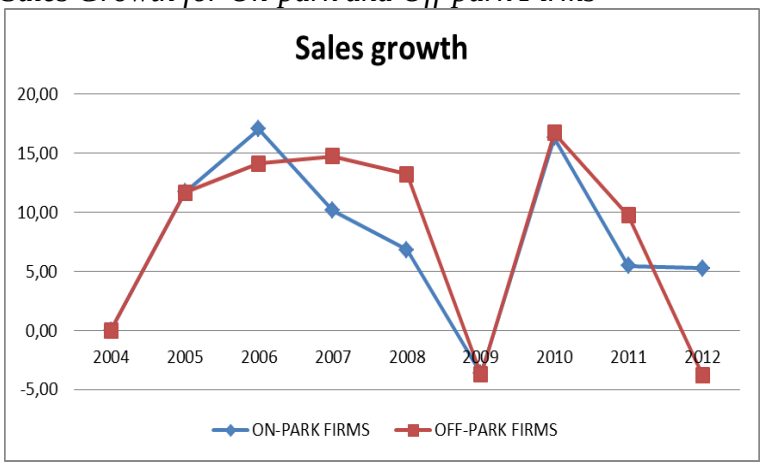
	Age	**Size**	**Distance**
MEAN	24,51	138,36	110,65
S.D.	17,69	173,56	179,51

Results

Here we present our main findings, which are organized according to three levels of analysis. The section is firstly devoted to a descriptive analysis of the empirical differences between the behavior of on- and off- park firms performances; secondly we move to the identification of the average treatment effect of being affiliated to a SP; finally, we explore what features of SPs help firms sustain their market and innovative performances.

The period we cover extends from 2004 to 2012, which interestingly includes the so-called "Great Recession". Direct inspection of the behavior of our performance variables leads to a first evidence: on-park firms do not seem to experience higher (sales) growth rates with respect to their off-park counterparts (Figure 5); rather they persistently invest much more in R&D activities and let these investment grow at higher paces.

Figure 5. *Sales Growth for On-park and Off-park Firms*



During the crisis, average R&D growth rates decrease steadily both for the treatment and control group; however, on-park firms display R&D investments' levels five times larger along the period 2008-2012. Extending the picture to pre-crisis years this evidence is confirmed and even amplified. R&D investment's levels are much larger within parks' tenants for the whole considered time span and, interestingly, during the crisis we observe a positive trend in research expenditure for on-park firms while their counterparts tend to decrease it. This evidence would suggest a positive role of SPs in sustaining firms' research activities, especially during downswings of the business cycle. Figure 6-7 show the behavior of R&D levels and R&D growth respectively, both for the treatment (on-park) and control (off-park) groups.

Firms' innovative performances are measured using cumulative patents' applications. There is evidence of a marked difference between on- and off-park firms, having the latter an average number of 3.1 applications per firm against an average of 10.9 in the former. Relying on these statistics SPs' tenants are much more prone to innovate than off park firms. Sales' growth are further analyzed using a measure of persistency which captures the number of

periods firms fall in the top quartile of the distribution of growth rates within their industry. Such distributions are estimated using data for all Italian firms sharing the same 2-digit NACE Rev.2 code.

Figure 6. *R&D Growth for On-park and Off-park Firms*

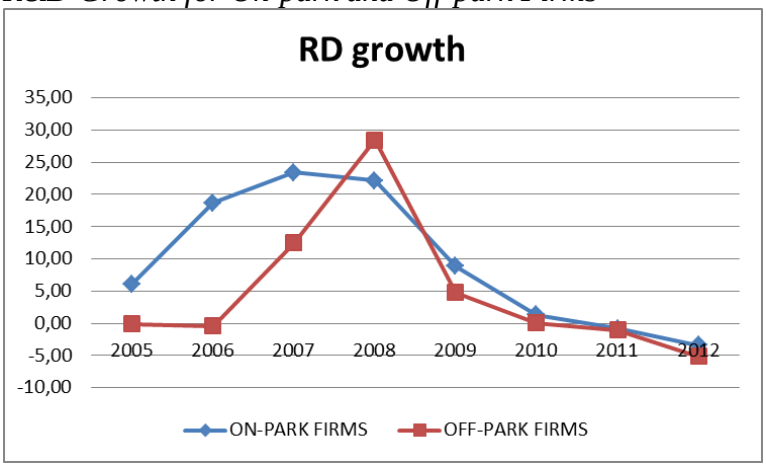


Figure 7. *R&D Investment Levels for On-park and Off-park Firms*

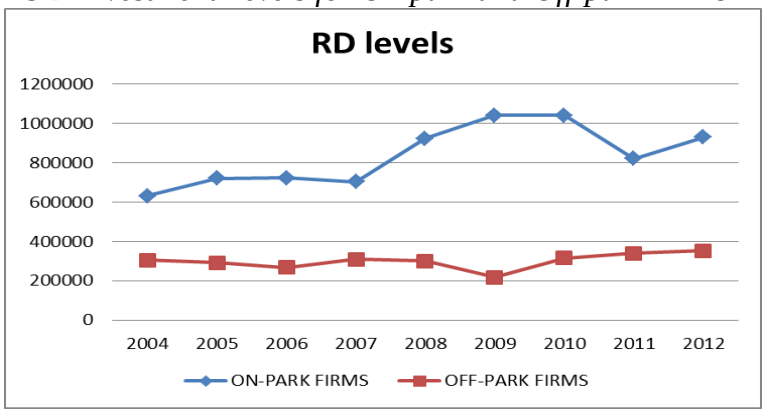


Table 2 reports the share of firms performing in the top and bottom quartiles for each year, distinguishing between the two groups. This procedure allows us to move away from a simple cross section and cross sector analysis and to study how on- and off-park firms behave within respective industries, hence evaluating their growth with respect to direct competitors.

Table 2. *Share of Firms in TOP and BOTTOM Quartiles*

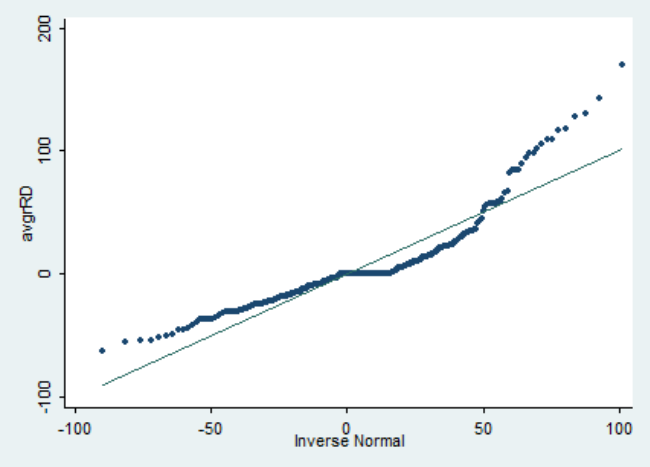
TOP QUARTILE								
year	2005	2006	2007	2008	2009	2010	2011	2012
ON-PARK	0,358	0,304	0,264	0,304	0,331	0,264	0,777	0,304
OFF-PARK	0,432	0,384	0,329	0,329	0,253	0,267	0,767	0,199
BOTTOM QUARTILE								
year	2005	2006	2007	2008	2009	2010	2011	2012
ON-PARK	0,142	0,257	0,196	0,182	0,162	0,216	0,223	0,169
OFF-PARK	0,192	0,178	0,185	0,199	0,219	0,219	0,233	0,205

More specifically, table 2 shows that only in 3 out of 8 periods, the share of firms in the top quartile is larger among SPs' tenants but, interestingly, in 6 periods the share of bad performing firms is lower among on-park firms. In addition, the difference with respect to the control group is increasing in the two recession periods after the 2007 financial crisis. The insight is clear: there is no evidence of marked differences between on park and off-park firms but, especially during the crisis period, those linked to SPs are less exposed to underperformances. Moreover, SPs' tenants seem both to invest more in research related activities and to innovate more than off-park firms; however, there is much less evidence of difference between the two groups when the focus shifts towards market performances. Following subsections are devoted to better explore and test these issues.

On- and Off- Park Firms

This subsection is devoted to test differences between the two groups along the above mentioned dimensions of firms' performances. In particular we focus on average growth of sales and R&D, R&D investments and patent applications. To detect differences between parks' tenants and comparable, we first need some information about the distributions of our performance variables in the two groups. As a general approach we prefer to rely on non-parametric statistics. This is a reasonable choice given that the literature is silent and does not provide evidence about the usual distributions of 3 out of 4 variables of interest (i.e. patent application, R&D expenditures and R&D growth rates). We start anyway by investigating the normality (and log-normality) of our variables. As expected, there is ample evidence of non-normality: Shapiro-Wilk tests always reject the null.

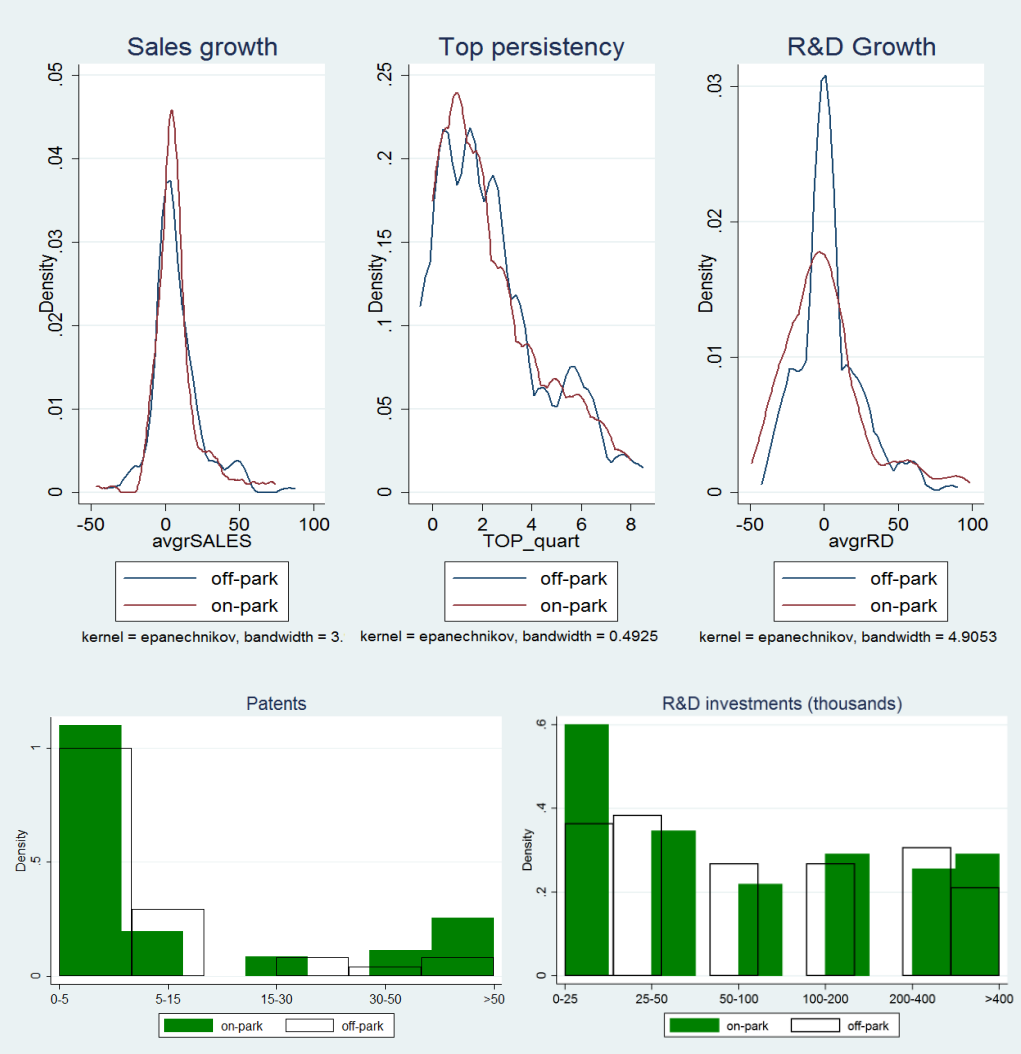
Figure 8. *Q-Q Plot for R&D Growth Rates*



Even though this test is biased by sample size, our number of observations is limited enough to prevent possible mistakes. For the only variable with a reasonable high value of the W-stat (R&D growth rates) we also present a Q-Q plot (Figure 8) which confirms relevant deviations from normality.

Furthermore, Figure 9 presents the distribution of our variables of interest with a direct comparison between treatment and control group. We find evidence of leptokurtosis and right-skewness for all our performance variables and with respect to firms' growth rates, which represents the only variable the literature gives information about, our results provide additional evidence of some of the "stylized facts" in industrial economics: growth rates' distributions are tent-shaped, exhibiting fat-tails and evidence of deviations from normality (see Dosi 2005, Bottazzi and Secchi 2006 and references therein).

Figure 9. *Distribution of Performance Variables*



Direct inspection reveals that the right tail of the average sales growth rate distribution is fatter in the treatment group and the same is true for the distribution of R&D growth rates. Both patents applications and investments in research activities are right skewed and it is relevant to see the difference in the support of the distributions: on-park firms reach twice patent applications and R&D expenditures than their counterparts.

Given the shape of these distributions, we use non-parametric tests to identify significant differences between the group of parks' tenants and the control. In particular we rely on the Wilcoxon rank-sum test, since it compares the whole distributions. However, results are exactly confirmed by other non-parametric tests on the medians (here not reported for sake of brevity). Table 3 reports the Wilkoxon rank-sum test statistic and p-values for our performance variables. We recall that the test assumes the distributions in the treatment and control groups to be identical under the null.

Table 3. *Wilcoxon Rank-sum Test for Firms' Performances*

Performance Variable	Test Statistic	P-value
Sales growth rates	-0.251	0.8014
R&D growth rates	1.125	0.2604
R&D levels	-2.668	0.0076
Patents	-3.332	0.0009

Results confirm that R&D expenditures and patent applications are much larger for on-park firms then comparable ones, allowing to conclude for a positive role of these policy instruments in sustaining and stimulating tenants' innovativeness. SPs are found to act as seedbeds of innovation, in contrast with Felsenstein's (1994) interpretation of their role as enclaves. It is interesting to see that both investments in research and their output among SPs' firms overcome those of out-of-park ones, calling for effectiveness proof of the linear model of innovation (Bush, 1945). However, SPs treatment does not allow tenants to obtain market performances, in terms of sales growth, significantly different from off-park firms. The general conclusion, which is supported by additional results presented below, is that SPs sustain innovative activities and research investments among their tenants, even though this does not translate automatically in significantly higher growth.

Average Treatment Effects

In this subsection we present estimates of the Average Treatment Effects on the Treated (ATET), that is, the effect being associated to Italian SPs plays on firms' performances. In particular, the ATET can be expressed as

$$ATET = E[Y_{1i} - Y_{0i} | D_i = 1]$$

Where D_i is a dummy which takes the value 1 if observation *i* is treated and 0 otherwise, Y_{1i} is the potential performance in case observation *i* receives treatment and Y_{0i} is the performance if the treatment is not received. The key underlying (identifying) assumption is that $E[Y_{0i} | D_i X_i] = \beta X_i$, which implies that the only source of omitted variable bias might come from a set of observable variables X_i which may be correlated with the treatment variable

D_i. In other words, we assume that the performances of on-park firms had they not be incubated or associated to any SPs does not differ from the ones of firms that have not been incubated after we control for a set of covariates X_i.

Classic examples of estimation of treatment effects might be find in Heckman and Robb (1985) and Hotz et al. (2006). After the estimation of the ATET on all our variables of interest, results show there is no significant impact of SPs on R&D investments' growth once we account for the role of R&D levels. Therefore, we do not directly report estimated ATET for growth in R&D expenditure, while that for R&D levels (avRD), sales growth rate (avgrSALES) and patents are presented in Table 4.

Table 4. *Estimates of the Average Treatment Effects on the Treated*

	avgrSALES	**avRD**	**brevetti**
ATET			
r1vs0.treat	4.442	506497.2**	7.754**
	(2.744)	(256154.7)	(3.637)
POmean			
r0.treat	6.896***	279093.4***	3.110**
	(1.847)	(52785.9)	(1.329)
OME0			
ADDETTI12	-0.00453		
	(0.00359)		
age	-0.604***		
	(0.174)		
avRD	0.00000110		
	(0.00000325)		
OME1			
ADDETTI12	-0.000778		
	(0.000692)		
age	-0.324**		
	(0.129)		
avRD	-0.000000254		
	(0.000000185)		
N	286	290	293

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

When estimating the ATET on sales growth we also include some of its standard determinants, namely size (number of employees), age and investment in R&D. However, only age appears to be relevant as a control. Being much more difficult to identify determinants of patent applications and research expenditures we only try to capture the treatment effect regressing them in both samples only on a constant. We leave to the last subsection the exploration of determinants of innovative activities.

Our estimates confirm previous evidence: there is a significant and positive treatment effect on the treated both for R&D investments and patent applications, with the second one (the effect on patent count) being stronger when compared to average levels in the control group (2.49 against 1.81). In

addition here we find a marginally significant effect of SPs on firms' growth in revenues: on-park firms benefit from a 4.44% additional growth with respect to off-park firms once we account for age, size and R&D expenditures' effects.

SPs Features and Innovation Performances

In this subsection we use simple regression analysis to investigate what features of SPs mainly affect these two dimensions of performance. Evidence that being linked to a SP induces firms to invest more in research and allow a greater success in the search for innovations is documented in previous section; here we want to test what macroscopic features of SPs lie at the basis of these differences. In particular we characterize SPs along a set of four characteristics: the number of research centers the park hosts (Research_centers), the number of universities or external research centers the park has developed links with (Universit), the degree of spatial concentration of firms around the SP's premises (geo_consistency), and the degree of sectoral specialization of the SP (entropy). Spatial concentration is measured by the share of firms associated to the SP located within the same geographical unit (NUTS-3 level) of the park itself. The degree of sectoral specialization is determined by the entropy coefficient of the distribution of two-digit NACE codes of on-park firms. Being the entropy a measure of heterogeneity (see for example Frenken and Nuvolari 2002), the higher its value the less sectorally focused the SP. OLS estimation of our regression equations are reported in Table 5.

We directly control for age and size of the firm as it is standard in the literature and we insert industry dummies at 1-digit NACE level (i.e. ATECO in Table 4). A set of direct and indirect relationships between SPs' features and firms' performances is found. Firms' innovativeness appears to be directly affected by the number of research centers hosted in the park and the number of established collaborations with Universities. Both of them have a positive impact, with the second being relatively stronger. This reveals the importance of inserting the SP within highly connected research networks in order to stimulate innovation among tenants. Previous studies (Löfsten and Lindelöf 2002, 2005 among others) found that parks' tenants show higher propensity to form academic-industry partnership; however many of them do not report differences in research output between on- and off- park firms. Here we provide evidence that such difference exists and that one important driver is played by the research network the park (and not stand-alone firms) is able to build.

A straightforward implication is that firms benefit, apart from their own knowledge networks, from those of the park they are linked with. Moreover we find a positive *direct research opportunity* effect: research centers hosted by the park can be seen as institutions offering the opportunity to carry out research with adequate tools and spaces, which could be difficult to be found outside the park. This leads us to expect that SPs with more research centers are linked to businesses which innovate more frequently or more successfully; both these hypothesis lead to expect a higher number of patents, as it is confirmed by our estimates in Table 5.

Table 5. *Determinants of Firms' Innovative Activities – OLS Estimates*

	avRD	**brevetti**
avgrSALES	358.1	-0.0632
	(4773.0)	(0.0717)
Centri_ricerca	111070.0*	1.706**
	(58568.8)	(0.768)
Universit	-84124.6	6.066**
	(191793.3)	(2.434)
entropy	108987.6	-8.017***
	(222136.7)	(2.826)
geo_consistency	-1520105.2	1.116
	(937498.6)	(12.13)
ADDETTI12	571.9***	0.0107***
	(131.1)	(0.00172)
age	8624.6	-0.106
	(8627.5)	(0.111)
2.ATECO1	469798.2	1.824
	(424843.9)	(5.439)
3.ATECO1	602818.9	-7.244
	(527542.6)	(6.723)
4.ATECO1	191243.2	-3.500
	(596953.7)	(7.692)
5.ATECO1	-163324.4	-17.87
	(905015.0)	(11.48)
6.ATECO1	177015.8	-14.81**
	(542000.9)	(6.921)
7.ATECO1	-41148.5	1.242
	(629414.1)	(8.157)
8.ATECO1	88342.2	-7.110
	(849307.2)	(10.76)
avRD		0.00000405***
		(0.000000770)
avgrRD		-0.000487
		(0.0109)
N	286	279

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Being associated to SPs does play a role also with respect to R&D expenditures. We notice again that direct contact with SPs' research centers stimulate investment in R&D activities while the existence of a network of academic-industry partnerships does not seem to produce any effect. This, in conjunction with the positive impact of R&D expenditure on innovativeness, could be read as an *indirect research opportunity* effect: the larger the number of research centers in the park, the more firms are incentivized to invest in research activities and, consequently, to produce successful innovations.

Interestingly enough, the geographical concentration of firms around SPs negatively affects R&D investments, even though the estimate is only marginally significant. Proximity of research activity clearly produces spillovers and positive-knowledge externalities and the lower these effects the more firms have to invest in research to produce additional knowledge. We finally notice that the degree of specialization of SPs produces a negative and strongly significant impact of firms' innovativeness. This evidence can be justified by the fact that innovating might require complementarities, which are naturally stronger within industries rather than across.

Conclusions

This paper explores the role of SPs in sustaining and stimulating on-park firms in Italy. To conveniently investigate tenants' performances we carefully constructed a control group via exact matching and we then move to the analysis of the two along a set of both market and innovative variables of performance. Results indicate that SPs play a remarkable role in stimulating innovative and research activities of their tenants, which exhibit levels of innovativeness (patent applications) and R&D expenditures much higher than comparable firms. From this perspective, SPs act more as seedbeds of innovation rather enclaves, in contrast to Felsenstein (1994). Evidence is still mixed with respect to the impact of SPs on market performances: we estimate an average treatment effect over the treated that is positive but only marginally significant and we do not register evidence of significant differences in average growth rates for firms along the period 2004-2012 between on- and off-park firms. However, a direct inspection of the time series for sales' growth and degree of performance persistency (share of periods firms fall in the top/bottom quartile of the overall-industry-growth-rates distribution) suggests that SPs help firms not to fall among the bad performers within respective industries, especially during the crisis period. The insight is clear: the shares of top performers (top quartile) in the control and treatment group are similar, but that of bad performers (bottom quartile) is much lower within the group of parks' tenants. Finally we found that building up research networks and hosting research centers are the most relevant SPs' features stimulating tenants' innovativeness and propensity to invest in R&D when compared with off-park firms. Policy implications are straightforward: SPs produce a positive impact on associated firms which tend to outperform comparable off-park realities. Moreover providing SPs the conditions to develop linkages with Universities and their own research centers is at the basis of their success.

References

Battaglia R., Lamperti F., & Siligato L., (2012). AREA SP: potere all'eccellenza, in Ferrara M., Mavilia R., Dai distretti tecnologici ai poli di innovazione, Egea, Milan.

Bottazzi, G. & Secchi, A. (2006). Explaining the distribution of firm growth rates. The Rand Journal of Economics, 37, 2; pp. 235-256.

Bush, V. (1945). Science - The Endless Frontier, A Report to the President. Washington: United States Government Printing Office.

Colombo, M. G., & Delmastro, M. (2001). How effective are technology incubators? Evidence from Italy. Research Policy.

Dosi, G., (2005) Statistical regularities in the Evolution of Industries. A Guide through some Evidence and Challenges for the Theory, LEM Working Paper.

Goldstain H., & Luger M. (1991). Technology in the Garden, Chapel Hill: University of North Carolina Press.

Ferrara M., Lamperti F., Mavilia R., The effects of innovation poles and SPs on regional economies in Italy, 3rd International Conference On Communication And Management In Technological Innovation And Academi, December 2-4, 2012, Recent Advances in Communications, Circuits and Technological Innovation, WSEAS Press, Paris (GRC), 2012, pp. 196-202.

Ferrara M., & Mavilia R. (2012). Dai distretti tecnologici ai poli di innovazione, Egea, Milan.

Fukugawa, N. (2006). SPs in Japan and their value-added contributions to new technology-based firms. International Journal of industrial Organization.

Frenken, K. & Nuvolari, A. (2002). "Entropy Statistics as a Framework to Analyse Technological Evolution," Eindhoven Center for Innovation Studies (ECIS) working paper series 02.15, Eindhoven Center for Innovation Studies (ECIS).

Heckman J. & Robb, R. (1985). Alternative methods for estimating the impact of interventions. In J. Heckman and B. Singer (Eds.), Longitudinal Analysis of Labor Market Data, New York: Cambridge University Press.

Hodgson, B. (1996). A Methodological Framework to Analyse the Impact of Science and Technology Parks. In M. Guedes and P. Formica (eds.), The Economics of SPs. Rio de Janeiro: ANTROPOTEC, IASP and AURP.

Hotz J. V., Imbens, G. W., Klerman J.A. (2006). Evaluating the differential effects of alternative welfare-to-work training components: A re-analysis of the California GAIN program. Journal of Labor Economics 24, 521-566.

Lindelöf, P., & Löfsten, H. (2001). SPs in Sweden- Industrial Renewal and Development? R&D Management.

Lindelöf, P., & Löfsten, H. (2003). SPs Location and New Technology-Based Firms in Sweden – Implications for Strategy and Performance. Small Business Economics.

Lindelöf, P. (2005). R&D Networks and Product Innovation Patterns - Academic and non-Academic New Tec hnology-Based Firms on SPs. Technovation.

Link A.N., & Link, K. R. (2003), 'On the Growth of US SPs', Journal of Technology Transfer, 28(1), 81–5.

Link, A. N., & Scott, J. T. (2003). U.S. SPs: the diffusion of an innovation and its effect on the academic missions of universities. International Journal of Industrial Organization.

Löfsten, H. (2002). SPs and the Growth of New Technology-Based Firms – Academic-Industry Links, Innovation and Market. Research Policy.

Mian, S. A. (1996). Assessing value-added contributions of university technology business incubators to tenant firms. Research Policy.

Salvador E., & Rolfo S., (2011). Are incubators and SPs effective for research spin-offs? Evidence from Italy, Science and Public Policy 38(3), 170-184.

Saublens et al. Regional Research Intensive Clusters and SPs, EU Commission, DG RTD, September 2007 EESC document CCMI/025 (14/12/2005) and CCMI/072 14/07/2010.

Siegel, D., Westhead, P., & Wright, M. (2003). Assessing the impact of university SPs on research productivity: exploratory firm-level from United Kingdom. International Journal of Industrial Organization.

Squicciarini, M. (2008). SPs' Tenants versus out-of-Park Firms: Who innovates more? A duration Model. Journal of Technology Transfer.

Squicciarini, M. (2009). SPs, Knowledge Spillovers, and Firm's Innovative Performace. Evidence from Finland. Economics. The Open-Access, Open-Assessment E-Journal.

Squicciarini, M. (2009). SPs: Seedbeds of Innovation? A Duration Analysis of Firms' Patentig Activity. Small Business Economics.

Stuart, E. A. (2010). Matching Methods for Causal Inference: A Review and a Look Forward. Statistical Science 25, no. 1, pp. 1--21. doi:10.1214/09-STS313. http://projecteuclid.org/euclid.ss/1280841730.

Wallsten, S. (2004). Do SPs Generate Regional Economic Growth? An Empirical Analysis of their Effects on Job Growth and Venture Capital. Working Paper, Joint Center.