The Effect of Location on Science and Technology Parks on Innovation. An Study of Service Firms

Ángeles Montoro-Sánchez[a*] and Marta Ortiz-de-Urbina-Criado[b]

[a*] Complutense University of Madrid, Madrid, Spain. mangeles@ccee.ucm.es
[b] Rey Juan Carlos University, Madrid, Spain. marta.ortizdeurbina@urjc.es

Abstract

Given that usually the productivity improvements are linked to innovation, in this work we are focussing on the role played by an instrument that has been considered as essential in the last few years to develop research, innovation and business development policies: Science and Technology Parks. Otherwise, the study of innovation in the service sector has received scant attention from researchers. In that line, one topic where there is barely any evidence is the role of geographic location and even less so location in a Science and Technology Park as a determining element for the innovating capacity of service sector companies. The goal of this paper is to analyse the impact of location in Science and Technology Parks on firms' innovative behaviour (type of innovation, innovation protection, public finaning for innovation and cooperation in research and development). A sample of 616 service firms from the Spanish Technological Innovation Panel has been used in this study.

To compare innovative behaviour from service companies located on an Science and Technology Parks with service companies that are not on an Science and Technology Parks, the differences were calculated in the innovating behaviour of companies located on a park compared to off-park companies using the Chi squared test. In addition, the value of the relationship was calculated using as association or effect measures such as the Odds ratio.

Results show that there are significant differences depending on whether the company is located in an Science and Technology Parks or not in terms of innovation in their processes. We have demonstrated that location of a firm in a Science and Technology Parks makes it more likely that there will be service innovation, process innovation and innovation in activities supporting the process, public financing and cooperation in research and development compared to firms which are not located there. Moreover, the results strongly suggest that location in an Science and Technology Parks is a major determining factor for innovative behaviour.

Introduction

Given that usually the productivity improvements are linked to innovation, in this work we are focussing on the role played by an instrument that has been considered as essential in the last few years to develop research, innovation and business development policies: Science and Technology Parks (Bellavista & Adán, 2009). Science and Technology Parks are one of the most-used support infrastructures for innovation worldwide and their aims include creating

and developing innovative companies. In this respect, the prior literature demonstrates the existence of a relationship between innovation and the Science and Technology Parks, given the results obtained in studies carried out in different countries and at different moments in time.

Studies on innovation have been done at a company level mainly in manufacturing industries (Gallouj & Weinstein, 1997). The study of innovation in the service sector has received scant attention from researchers (Colombo & Grilli, 2006; De Brentani, 2001). In order to compensate for decades of neglecting services in innovation studies, a strand of literature has emerged, which examines the nature, types, and causes of innovation in services (Mansury & Love, 2008). However, one topic where there is barely any evidence is the role of geographic location and even less so location in a Science and Technology Park as a determining element for the innovating capacity of service sector companies. In that sense, services amass around 70% of the economic activity in the majority of industrialised countries. Growth in this sector has significantly exceeded accumulated growth in these countries over the last few decades, which has led to a continuous increase in service sector weighting within the total economy making it the largest economic sector, even ahead of the manufacturing industry or the primary sector. The most recent data available from the National Statistics Institute (INE, 2009) show that, in Spain, out of the total number of companies in operation in 2007 (3,422,239), 78.2% belonged to the service sector (over two million companies, whose turnover exceeds a billion Euros).

For all these reasons, the aim of this work is to analyse the innovating behaviour of service sector companies located in science and technology parks. To meet this objective, working from data from the 2007 Technological Innovation Panel in Spain, a sample of 616 service sector companies were selected, half of which are located in a Science and Technology Park and the differences in innovating behaviour were analysed and quantified (type of innovation, innovation protection, financing for innovation and cooperation in research and development) for the companies located inside and outside the science and technology parks.

Theoretical background

According to the International Association for Science Parks (IASP, 2002), a science park is an organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a science park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities.

The concept of science parks originated back in the late 1950s. The development of science parks in Europe clearly received its early impetus from the United States of America experience. In many European countries, it was not until the 1980s and 1990s (United Kingdom included) that significant numbers of science parks were established (Storey & Tether, 1998). This diffusion and relevance of the science and technology parks movement motivated several studies to engage in the difficult task of systematically evaluating and comparing the performance of the parks. The main motivation for these studies lay in examining whether the established science parks achieved their role, as stated in the above definition, or if they constituted prestigious real estate developments (Barkourus, Mardas &

Varsakelis, 2002). Their aim has been to shed light on the effectiveness of parks as innovation policy instruments but there is no consensus in the literature on science and technology parks performance. Along this line, this paper aims to investigate the role of science and technology park as seedbeds of innovation.

The literature review shows that previous studies have analysed the relationship between innovation and location in a science and technology park in different countries. Felsenstein (1994) analyses the effect of science and technology parks in Israel in terms of innovation in its companies, finding positive effects. Link and Scott (2003) find similar effects for the American case, Löfsten and Lindelöf (2001) and Lindelöf and Löfsten (2004) in the parks in Sweden and Lee and Yang (2000) in Taiwan. Alternately, although the relationship is not statistically significant, other studies do find that companies located in Science and Technology Parks, compared with others that are not, are more intensive in research, development and innovation, such as works by Westhead and Storey (1994) and Westhead (1997) that studied parks in the United Kingdom. Other authors also obtain similar results for Italy (Colombo & Delmastro, 2002) and for Sweden (Lindelöf & Löfsten, 2003).

Independently of the type of analysis carried out, evidence is mixed with regard to the science and technology parks' effectiveness, suggesting that this controversy unambiguously requires more empirical studies, in order to clarify the effectiveness of science parks. Therefore, previous literature on the relationship between science and technology park and innovation does not prove or disprove the hypothesis of science and technology park representing effective innovation policy tools. Evidence is mixed regardless of the unit of analysis, the performance measurement and the specific econometric tool used. In this paper we follow ideas by Squicciarini (2008) and Felsenstein (1994) looking at the role of science and technology parks as seedbeds, or at least "enclaves" (in case the seedbed hypothesis is supported only under certain conditions), of innovation. Furthermore, in this study, we add the need to distinguish the results depending on whether companies carry out service activities. In this respect, given the scarce evidence regarding service sector companies, we will centre our attention on this activity. In particular, we are going to contrast whether locating on a science or technology park means that service sector companies have greater innovation in its different types (product innovation and its subtypes: goods, service innovation and process innovation and its subtypes: methods of manufacturing, logistics systems, support activities), greater protection for innovation, greater access to sources of public financing for innovation and whether they cooperate more in research and development activities.

Methodology

For the empirical study, a sample of companies was selected from the Technological Innovation Panel drawn up by the Instituto Nacional de Estadística. This panel originated from the Technological Innovation survey. This survey forms part of the General Plan for Statistics on Science and Technology approved by Eurostat. Working from the Technological Innovation Panel for the last available year, 2007, companies included in the service sector have been selected (CNAE-93: 50-93). The total number of service companies is 4,766 of which 308 were located on an science and technology park (6%). Given the low percentage of companies located in an science and technology park, with the aim of correcting the sampling differences to estimate the logistic regression models, balancing has been done on the sample following this criterion: for each of the 308 companies located in the science and technology parks, another off-park company was selected from the same activity sector (same CNAE-93

code) and from the same category (public, private or research association). The final balanced sample includes a total of 616 companies of which half are located on a science and technology park.

To identify the location of companies in the sample, a dichotomic variable was used, included in Technological Innovation Panel, that takes a value of 1 if the company is located in a science and technology park and 0 if not. To reflect the innovating behaviour of the companies, several aspects were considered: type of innovation, innovation protection, public financing for innovation and cooperation in research and development. Table 1 summarises the measurements for all these variables.

Table 1. Measuring the variables

Concept	Variables	Measurement
Location (2005-2007)	Park	Dummy: 1- Firm in a science and technology park
Types of Innovation (2005-2007)	Product innovation	Dummy: 1-The firm innovates in products
	Goods innovation	Dummy: 1-The firm innovates in goods
	Service innovation	Dummy: 1-The firm innovates in services
	Process innovation	Dummy: 1-The firm innovates in processes
	Innovation in manufacturing methods	Dummy: 1-The firm innovates in manufacturing methods
	Innovation in logistics systems	Dummy: 1-The firm innovates in logistics systems
	Innovation in support activities	Dummy: 1-The firm innovates in support activities for processes
Innovation protection (2005-2007)	Patents	Dummy: 1-The firm registered patents
	Using utility models	Dummy: 1-The firm has used utility models
	Use of factory trademarks	Dummy: 1-The firm has used factory trademarks
	Use of copyright	Dummy: 1-The firm has used copyright
Public financing for innovation (2005-2007)	Financing from Local and Regional Administration	Dummy - 1-The company has obtained public financing from Spanish local and regional Administrations during the period 2005-2007
	State public financing	Dummy - 1-The company has obtained public financing from the State during the period 2005-2007
	European Union public financing	Dummy - 1-The company has obtained public financing from the European Union during the period 2005-2007
Cooperation in R&D (2005-2007)	Cooperation in research and develpmente	Dummy: 1-The company has cooperated in research and development
Size	Size	Number of employees

Results and Discussion

To compare innovative behaviour from service companies located on an science and technology park with service companies that are not on an science and technology park, the differences were calculated in the innovating behaviour of companies located on a park compared to off-park companies using the Chi squared test (table 2). Secondly, the value of the relationship was calculated using as association or effect measures such as the odds ratio. In this work, the odds ratios are calculated by setting several logistic regression models (as 'exp (B)' can be interpreted as the odds ratio for the corresponding variable) to be able to find out about the meaning of the effect and its value. In the latter case, table 3 only compiles the results from the logistic regression models where significant effects have been obtained for the on-park location variable, that in all cases correspond to the variables whose value for the Chi squared demonstrated a significant value.

Regarding the analysis of the relationship between location and product innovation and each of its types, the results indicate that on-park location is only determining for service innovation. The results for the Chi squared dependence test show that there is no dependence or association between the global product innovation variable, or for the individual goods innovation category related to the location of the company on an science and technology park, meaning that there are no significant differences for these two variables between on-park and off-park companies (table 2). In this respect, the results from the logistic regression model (table 3) demonstrate that on-park companies are 1.315 times more likely to innovate in services than off-park companies. No significant effects were obtained for product innovation and goods.

The results obtained for the different types of innovation complement the existing empirical evidence. Prior studies have analysed the role of science and technology parks as seedbeds of innovation although in many of them this hypothesis could not be proven. This work has obtained interesting results that show that service companies located in science and technology parks are innovating and prefer to innovate in services and processes. Taking into account that there are differences between how industrial companies and service companies innovate, these results support two ideas: on the one hand, that the service sector is innovating (Mansury & Love, 2008) and on the other hand, that science and technology parks are infrastructures that facilitate and strengthen business innovation (Felsenstein, 1994).

Regarding innovation protection, Table 2 shows that there is only a dependence relationship (sig. 0.000) between the use of factory trademarks and the location of the company on an science and technology park. However, for the use of patents, utility models and copyright there were no differences seen in companies' behaviour inside or outside an science and technology park. The results from the table 3 show that companies located on-park are almost twice (1.954) as likely to use factory trademarks as methods for protecting innovation than companies that are off-park; however, no significant effects have been found concerning on-park location when registering patents, the use of utility models and the use of copyright. In this respect, we should indicate that we might usually consider that the number of patents registered by a firm remains a widely used output measure of the level of technology diffusion (Chakrabati, 1990; Mogee & Kolar, 1994). For example, Monck et al. (1988) found that a larger proportion of Science Park firms had lodged at least one patent in the last two years than had off-Park firms; however the difference was not statistically significant (Westhead, 1997). The results obtained in this work reach similar conclusions,

meaning that we cannot find any significant differences between the tendency to register patents by on-park and off-park companies. One possible explanation for this result lies in the way of making the patent measurement operative (dichotomic variable). In this respect, the result obtained only allows us to affirm that both the companies located in the science and technology park and the off-park companies register patent requests, but we cannot know if there are differences related to the number of patents registered and granted.

Table 2. Firms' innovative behaviour and location in a science and technology park

Innovating behaviour		Off-park	On-park	Total	Chi squared
Product innovation	No	110	96	206	1.43 (sig. 0.232)
	Yes	198	212	410	
Goods innovation	No	176	166	342	0.66 (sig. 0.417)
	Yes	132	142	274	
Service innovation	No	172	152	324	*2.60 (sig. 0.107)*
	Yes	136	156	292	
Process innovation	No	150	124	274	*4.44 (sig. 0.035)*
	Yes	158	184	342	
Innovation in manufacturing methods	No	211	202	413	0.60 (sig. 0.44)
	Yes	97	106	203	
Innovation in Logistics systems	No	285	279	564	0.76 (sig. 0.385)
	Yes	23	29	52	
Innovation in support activities	No	201	178	379	*3.63 (sig. 0.057)*
	Yes	107	130	237	
Patents	No	260	245	505	2.47 (sig. 0.116)
	Yes	48	63	111	
Using utility models	No	293	286	579	1.41 (sig. 0.235)
	Yes	15	22	37	
Use of factory trademarks	No	255	219	474	*11.86 (sig. 0.000)*
	Yes	53	89	142	
Use of copyright	No	299	296	595	0.44 (sig. 0.505)
	Yes	9	12	21	
Financing from Local and Regional Administration	No	201	134	335	*29.38 (sig. 0.000)*
	Yes	107	174	281	
State public financing	No	204	136	340	*30.35 (sig. 0.000)*
	Yes	104	172	276	
European Union public financing	No	261	228	489	*10.80 (sig. 0.001)*
	Yes	47	80	127	
Cooperation in research and development	No	145	111	256	*10.17 (sig. 0.001)*
	Yes	126	167	293	

As far as the relationship between public financing for innovation and location on or off-park is concerned, differences are seen for financing from local and regional Administrations, the State and from the European Union (table 2). Regarding the logistic regression models, table 3 demonstrates that for all the sources of public financing significant effects are obtained, meaning companies located on-park are more than twice as likely to use local and

regional public financing (2.432) and state financing (2.485) and 1.967 times more likely to turn to European Union public financing than off-park companies. These results widen the conclusions obtained in the work by Un and Montoro-Sánchez (2010) on public financing for innovation in the service sector. The authors found empirical evidence on how funding type affects Spanish service sector companies' decision to innovate, focusing especially on public funding from national and international agencies for innovation and research and development activities. With these results we can state that in the service sector in Spain, public financing for innovation is very important and that companies located in the science and technology parks are more likely to use this source of financing than companies outside.

Table 3. Logistic regression models

Explained variable	Factor	B	Sig.	Wald	Exp (B)	Good fit indicators
Service Innovation	Park (1)	.274	*.092*	2.837	*1.315*	Chi^2: 6.78**: "-2LL": 845.52; Nagelkerke R^2: 0.015; Clasif matrix: 56.7%
	Size	.000	*.074*	3.197	*1.000*	
	Constant	-.287	.015	5.903	.750	
Process Innovation	Park (1)	.362	*.027*	4.878	*1.436*	Chi^2: 12.23***; "-2LL": 834.20; Nagelkerke R^2: 0.026; Clasif matrix: 57.1%
	Size	.000	*.032*	4.590	*1.000*	
	Constant	-.029	.807	.059	.971	
Innovation in Support Activities	Park (1)	.353	*.037*	4.371	*1.424*	Chi2: 24.13***; "-2LL": 797.80; Nagelkerke R^2: 0.052; Clasif matrix: 63%
	Size	.001	*.001*	10.133	*1.001*	
	Constant	-.781	.000	37.687	.458	
Use of Factory Trademarks	Park (1)	.670	*.001*	11.612	*1.954*	Chi^2: 11.99***; "-2LL": 653.18; Nagelkerke R^2: 0.029; Clasif matrix: 76.9%
	Size	.000	.883	.022	1.000	
	Constant	-1.567	.000	104.144	.209	
Financing from Local and Regional Administraton	Park (1)	.889	*.000*	28.668	*2.432*	Chi^2: 30.11***; "-2LL": 819.11; Nagelkerke R^2: 0.064; Clasif matrix: 61.2%
	Size	.000	.497	.462	1.000	
	Constant	-.614	.000	25.363	.541	
State Public Financing	Park (1)	.910	*.000*	29.883	*2.485*	Chi^2: 30.71***; "-2LL": 816.59; Nagelkerke R^2: 0.065; Clasif matrix: 61%
	Size	.000	.765	.089	1.000	
	Constant	-.681	.000	30.671	.506	
EU Public Financing	Park (1)	.676	*.001*	10.834	*1.967*	Chi^2: 12.36***; "-2LL": 614.52; Nagelkerke R^2: 0.031; Clasif matrix: 79.2%
	Size	.000	.212	1.556	1.000	
	Constant	-1.750	.000	116.834	.174	
Cooperation in research and development	Park (1)	.559	*.001*	10.427	*1.749*	Chi^2: 12.18***; "-2LL": 746.4; Nagelkerke R^2: 0.029; Clasif matrix: 57.6%
	Size	.000	.197	1.667	1.000	
	Constant	-.176	.158	1.996	.838	

Note: Park (1) is the value 1 for the dummy variable "Park": the firm is on-park.

As far as the relationship between research and development cooperation and location on-park is concerned, the data in table 2 shows significant differences (sig. 0.001) in the tendency

to cooperate with other companies on R&D activities. In this case, we can see that the on-park companies are 1.749 times more likely to establish research and development cooperation agreements than off-park companies (table 3). In this respect, some studies have demonstrated that the location of a company in an science and technology park makes it easier to create business networks or cooperation agreements with other organisations, particularly with universities and/or research centres (Fukugawa, 2006; Löfsten & Lindelöf, 2005; Phillimore, 1999).

Conclusions

In that paper, we have demonstrated that location of a firm in a science and technology park makes it more likely that there will be service innovation, process innovation and innovation in activities supporting the process, public financing and cooperation in research and development compared to firms which are not located there. Moreover, the results strongly suggest that on-park location is an important determining factor for innovative behaviour. Prior work such as Westhead (1997), has explored the premise that science and technology parks firms are more innovative than comparable firms not located on a park. However, their results show similarities between independent Science Park and comparable off-Park firms which are striking, rather than the contrasts. On the other hand, our work does demonstrate that there are differences in the innovative behaviour of companies located inside and outside an science and technology park.

Therefore this work makes three main contributions. Firstly, it makes an important contribution of empirical evidence on the relationship between the location of companies on science and technology parks and innovation. Secondly, this study provides specific evidence for the relationship between innovating behaviour and location on an science and technology park for the case of service sector companies. Given their special features and the scarce evidence analysing innovation for the service sector, this work constitutes an important contribution of empirical evidence to the existing literature. Finally, the origin of the sample used also completes the relevance of this empirical evidence. Spain is the fifth most important country in the Eurpeand Union -27 in terms of business volume from service sector companies. Knowing, detecting and analysing their innovative behaviour, and particularly their differences in terms of location, is particularly interesting evidence both privately and for the administrations of countries and the European Union in order to know how to improve and encourage firms' innovative capabilities and the importance and effect of science and technology parks for this aim.

So then, the evidence obtained must be taken within the context of the sample used and the instrument used to analyse the information. To do this, in order to bypass some of the limitations of this work, it would be best to obtain more itemised and complementary information on each of the variables analysed in the study, in addition to carrying out in-depth studies on each of the science and technology parks in Spain, or at least the most important in terms of number of companies and their innovative capacity. This would allow us to offer other explanations for the results by analysing other complementary aspects to companies' innovative behaviour.

References

1. Bellavista, J., & Adán, C. (2009). Los Parques Científicos y Tecnológicos en el Desarrollo de la Ciencia, la Tecnología y la Empresa *SEBBM*, 161, 6-11.

2. Gallouj, F., & Weinstein, O. (1997). Innovation in services. *Research Policy, 26,* 537-556.
3. Colombo, M.G., & Grilli, L. (2006). Supporting High-Tech Start-Ups: Lessons from Italian Technology Policy. *International Entrepreneurship and Management Journal, 2,* 189-209.
4. De Brentani, U. (2001). Innovative versus incremental new business services: Different keys for achieving success. *Journal of Product Innovation Management, 18*(3), 169–187.
5. Mansury, M.A., & Love, J.H. (2008). Innovation, productivity and growth in US business services: A firm-level analysis. *Technovation, 28,* 52-62.
6. Storey, D., & Tether, B. (1998). Public policy measures to support new technology-based firms in the European Union. *Research Policy 26,* 1037– 1057.
7. Bakouros, Y.L., Mardas, D.C., & Varsakelis, N.C. (2002). Science park, a high tech fantasy?: An analysis of the science parks of Greece. *Technovation 22,* 123–128.
8. Felsentein, D. (1994). University-related Science Parks –'seedbeds' or 'enclaves' of innovation? *Technovation, 14*(2), 93-110.
9. Link, A.N., & Scott, J.T. (2003). U .S. science parks: the diffusion of an innovation and its effects on the academic missions of universities. *International Journal of Industrial Organization, 21,* 1323–1356.
10. Löfsten, H., & Lindelöf, P. (2001). Science parks in Sweden: industrial renewal and development?. *R&D Management, 31,* 309– 322.
11. Lindelöf, P., & Loftsen, H. (2004). Proximity as a resource base for competitive advantage: university–industry links for technology transfer. *Journal of Technology Transfer, 29,* 311 –326.
12. Lee, W.H., & Yang, W.T. (2000). The cradle of Taiwan high technology industry development—Hsinchu Science Park. *Technovation, 20,* 55–59.
13. Westhead, P., & Storey, D. (1994). *An Assessment of Firms Located on and Off Science Parks in the United Kingdom*. London: HMSO.
14. Westhead, P. (1997). R&D inputs and outputs of technology-based firms located on and off science parks. *R&D Management, 27,* 45– 62.
15. Colombo, M., & Delmastro, M. (2002). How effective are technology incubators? Evidence from Italy. *Research Policy, 31,* 1103– 1122.
16. Lindelöf, P., & Löfsten, H. (2003). Science park location and new technology-based firms in Sweden: implications for strategy and performance. *Small Business Economics, 20,* 245– 258.
17. Squicciarini, M. (2008). Science Parks' tenants versus out-of-Park firms: who innovates more? A duration model. *Journal of Technology Transfer, 33,* 45–71.
18. Chakrabarti, A. K. (1990). Scientific output of small and medium size firms in high tech industries. *IEEE Transactions on Engineering Management, 37*(1), 48–52.
19. Mogee, M. E., & Kolar, R. G. (1994). International patent analysis as a tool for corporate technology analysis and planning. *Technology Analysis and Strategic Management, 6,* 485.504.
20. Monck, C., Porter, R., Quintas, P., Storey, D., & Wynarczyk, P. (1998). *Science Parks and the Growth of High Technology Firms*. London: Croom Helm.
21. Un, C.A., & Montoro-Sánchez, M.A. (2010). Public funding for product, process and organisational innovation in service industries, *Service Industries Journal, 30*(1), 133-147.
22. Löfsten, H., & Lindelöf, P. (2005). R&D networks and product innovation patterns—academic and non-academic new technology-based firms on Science Parks *Technovation, 25,* 1025–1037.
23. Fukugawa, N (2006). Science parks in Japan and their value-added contributions to new technology-based firms. *International Journal of Industrial Organization, 24,* 381– 400.

24. Phillimore, J. (1999). Beyond the linear view of innovation in science park evaluation: an analysis of Western Australian Technology Park. *Technovation, 19*, 673–680.

Acknowledgement

The results of this paper are supported by the research projects ECO2009-13818, ECO2009-10358 of Spanish Ministry of Science and Innovation and BSCH-UCM project of the Research Group "Estrategias de Crecimiento Empresarial" (940376) and by Cátedra Bancaja "Jóvenes Emprendedores"-Complutense University of Madrid and Cátedra Iberdrola for Research in Business Management and Organization-URJC.