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Science and Technology Parks in Two Lagging Regions of Spain: A Comparative Evaluation Using an Innovation Network Approach

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Science and Technology Parks in two lagging regions of Spain: A comparative evaluation using an innovation network approach

Abstract

Science and Technology Parks (STPs) have been widely used as innovation support and regional development instruments in most European countries. In Objective 1 regions of South Europe STPs projects were developed during the 90s through regional, national or EU structural funds as tools for promoting innovation and technology upgrade.

Most studies cast doubt on the effectiveness of parks in achieving their objectives, focussing on the traditional measures of the parks added-value (profitability and growth) to the tenant companies, the university-industry linkages developed and the development of high-tech clusters. Recent developments on innovation systems stress the role of networks and interactions for knowledge creation and diffusion. In this study we use a network approach as an evaluation framework focusing on the development of interactions, linkages and cooperation inside as well as outside its area. The quantity and quality of linkages inside and outside the STP area and its operation as an innovation cooperation promoter in the regional and broader space are used in this assessment.

The present work uses the network approach to assess the performance of two parks in Objective 1 regions of Spain (Asturias and Andalusia). The study shows in general low levels of interaction and linkages developed although there are significant differences between the two cases. The parks are far from becoming network facilitators inside their broader environment. The comparison also reveals that the park structure and its intangible services can have a positive role in transforming the park to a network facilitator.

Keywords: science and technology parks, innovation networks, performance evaluation, lagging regions

Introduction

Science and Technology Parks (STPs) structures have been widely developed in Europe and worldwide during the last 40 years (Storey and Tether, 1998). In less developed regions of South Europe they were mainly developed during the 90s in -the so-called third wave of STP creation(Kelesidis,1999). Their objectives range significantly and there is great heterogeneity concerning their form and characteristics. Existing academic work on STPs evaluation has looked into the capacity of Parks to fulfil their expected benefits including the support for New Technology Based Firms (NTBFs) creation and growth, development of linkages between university or research centres and industry and the support of high tech clusters creation. In general conclusions have been rather negative casting doubt on their effectiveness. An alternative approach to the parks evaluation focuses on the role of parks as network facilitators looking into the development of different forms of cooperation linkages both inside the limited park area as well as at broader geographical scale (Hansson, et al., 2004;Mäki, 2002;Phillimore, 1999;Shin, 2000).

Following this approach, the present study analyses in comparison two Spanish STPs in regions of Objective 1 status, testing the development of important cooperation networks between the tenants and the outside space and the role of the park in their creation. Following a review (Section 1) of the existing evaluation literature, Section 2 describes the methodology used in the study and in Section 3 we present briefly the two cases, their structure and evolution. In Section 4 we present the results of the study on the presence of networks and character. Section 5 attempts to identify the park characteristics that play a role in the development of these networks and we close with a summary of the results, general conclusions and suggestions for possible further research.

Section 1- Literature review

There is no universally accepted definition of science and technology parks. IASP¹ widely cited definition states that “... *a science park is an organization managed by specialized professionals, whose main objective 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 achieve these goals a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; facilitates the creation and growth of innovation based companies through incubation and spin-off companies; and provides other added-value services together with high quality space and facilities.*” (IASP, 1998). The definition of IASP is a rather inclusive one that covers a wide variety of possible structures that use different labels such as “science/technology/research parks or innovation centre”. More importantly, the definition stresses the main two elements of the parks, the physical (facilities and space) and the operational (value-added services, creation and growth of firms and flow of knowledge and technology). The two dimensions are not separate but interact and enforce each other. The high quality space and provided financial incentives are important to attract high-technology tenants and create a critical mass, but ultimately it is the presence of services, linkages and knowledge flows that enrich the park’ space, attract new tenants and embed their operation in the specific location (Mäki, 2002).

The greatest part of the academic literature on STPs focuses on an evaluation of their performance, assessing their operation and the fulfilment of their stated objectives. While there is significant variation from case to case, in general conclusions tend to be rather negative. Massey et al.(1992) highly cited work on UK parks used a number of testing criteria including the technology level of the companies located in

¹ International Association of Science Parks

the Park, the creation of high-tech employment, the formation and growth of new technology based firms and the facilitation of different types of linkages between the academic/research institutions and the Park firms. Their conclusions were that the parks count for very little in promoting technology transfer and are unlikely to support the creation of university-industry linkages. Focusing on entrepreneurship support, the added value of science park location for NTBFs has been tested in many different environments inside and outside Europe - usually expressed in terms of increased profitability, growth and innovative capacity of the tenants in comparison with a control group outside the park (Felsenstein, 1994; Löfsten and Lindelöf, 2002a;b;2003;Siegel, et al., 2001;Siegel, et al., 2003;Westhead, 1997;Westhead, et al., 1994). While most of these studies do find an important innovative character of the parks' tenants, the evidence was much more mixed concerning a higher relative R&D productivity² of the hosted NTBFs. Concerning the development of university-industry linkages in the park, Löfsten and Lindelöf (2002a;2002b) analysis of Swedish Parks supports that STP firms are more prone to cooperate with HEIs and Universities. In his study, Vedovello (1997) in UK (Surrey Technology Park) and later on (2000) in comparison with Taguspark in Portugal did find linkages developed from a number of firms in the parks mainly of an informal type but concludes that parks are only a modest university industry interactions mechanism.

Looking into the role of parks as regional development tools, scholars have attempted to identify correlation between the park presence and employment growth (Luger and Goldstein, 1991), R&D centres attraction (Appold, 2004), high tech cluster creation (Doloreux, 2002;McDonald and Deng, 2004;Wallsten, 2004) and venture capital attraction (Wallsten, 2004) comparing with other regions where no park is established. None of the above studies found any clear connection of the park creation and operation with a better performance of the region at any of the above variables.

The network-based approach to STP evaluation

The above literature casts clear doubt on the role and effectiveness of the parks leading many researchers to the conclusion that they achieve much less than they are expected to. Some scholars (Massey, et al., 1992) argue that in reality parks are nothing more than prestigious real estate projects that follow a linear approach to innovation. Komninos(2002) suggests that in the modern interactive and networked innovation process, the spatially limited park model becomes more and more irrelevant in comparison to more flexible – non-space constrained–structures and Hannsson et al. (2004) proposes that we should look for an alternative “...interactive, dynamic and network oriented understanding of science parks instead of the narrow [understanding] of scientific innovation and regional development.”

An alternative approach for analysing and evaluating parks is to consider parks as network facilitators. The network concept was introduced from Mark Granovetter (cited in Shin, 2000) to describe relationships economic actors and other agencies and individuals that stand between the market and hierarchies. Networks are based on strategic decisions for access to complementary and multiple resources where information can be exchanged. They are mechanisms for inter-firm learning and exploration and exploitation of possible synergies in the pursuit of new opportunities. Networks are characterized by trust relations between participants, long-term perspective, redundancies of options and partners, competition co-existing with cooperation (Koschatzky, et al., 2001). The networking concept has been widely used in recent years for the analysis of innovation systems (e.g. Britton, 2004;Keeble, et al., 1999;Larsson and

² Expressed as outputs (patents or new products/processes) to inputs (R&D expenditure/R&D personnel).

Malmberg, 1999) examining the actors that participate, the type of linkages developed, their strength and spatial scale.

Some scholars have applied the network concept in the analysis and evaluation of STPs, looking for the development of interactions and the role of the park tangible and intangible parameters as network facilitator. Phillimore (1999), in Western Australian Technology Park, looked for horizontal and vertical linkages and interactions of firms inside and outside the park area. He found linkages –of different forms, intensity and importance- developed at many different scales in parallel. Shin (2000) also used an innovation network approach to assess the embeddedness of Daeduck Science Park (Korea) into its broader region by examining linkages of the park firms including markets (clients and suppliers), the sources of human and financial capital and their R&D cooperation at different spatial scales. He concluded that the park tenants are strongly embedded into the local/regional environment and he tested- how the park and regional institutions/mechanisms contribute to this process. Mäki (2002) work on 5 Finnish parks assessed parks as networks facilitators by looking into linkages of firms with R&D centres and other companies – without applying any specific spatial limitation. The results showed that over 60% of the firms had some form of innovation cooperation developed. He examined the role of the park –as a support mechanism in the development of these networks but found a rather passive contribution based mainly on the collocation of actors in the same area.

Section 2 – The study design

In this study we used a similar network based approach to analyse the linkages of the park tenants, including the research centres and the firms located in the park and looking for the presence of various possible forms of interactions and knowledge transfer mechanisms inside and outside the park area. We attempted to identify linkages of different types (market or cooperative, formal or informal) of the park tenants at different spatial scales. At the same time we looked into the role that the park – through its physical (infrastructure) and operational (business and cooperation support services) elements - plays in the development of these networks analysing the reasons for firms location in the park, the perceived added value during the time of operation in the park, the satisfaction from provided services and the existing obstacles for cooperation.

Our empirical evidence is based on data collected during a research project for a larger number of parks in South Europe Objective 1 regions. The two cases of the Technology Park of Asturias and Cartuja93 were selected from the larger population of STPs in Spain³ at a two-stage process. In the first stage we limited the sample to those with a minimum 10 years of operation – to ensure a minimum level of maturity and development. At a second stage, data from secondary sources (articles, internet) were used to classify the parks in terms characteristics and relative success. Past evaluations of parks performance in Spain (Ondategui, 2001;2002) present the Technology Park of Asturias as a relative failure case while the park of Cartuja93 has been illustrated – although with dissenting views (Castells and Hall, 1994;Palma, 2006, personal interview) – as a success case.

Data in each case (Table 1) was collected through a combination of semi-structured recorded interviews with the management team of the parks, its shareholders, the research centres/organisations and a questionnaire-based survey of the park tenants (firms) sent by electronic and surface mail or filled-in during

³ The Association of Technology Parks of Spain (APTE) has currently 25 full and 47 associated members APTE,2005

arranged personal interviews. The data were complemented by a number of interviews with experts and representatives of players/actors at a regional scale were contacted

Table 1 - Field work interviews

	PT Asturias	Cartuja93
Interviews with key actors in park	2	4
Interviews with regional players and experts	6	4
Number of R&D centres interviewed	1	8

Table 2 – Characteristics of firms in the survey sample

	PTA	Cartuja93
N	92	147
n	24	27
Sector⁴		
ICT-related	33% (26%)	30% (40%)
Biotechnology	- (0%)	11% (3.5%)
Medical/pharmaceutical	4% (3%)	4% (7%)
Business services/engineering	38% (40%)	37% (39%)
Manufacturing	8% (12%)	11% (0%)
Other	17% (19%)	7% (10.5%)
Years of location in park		
<1	4%	11%
1-3	17%	19%
4-6	54%	44%
>7	25%	30%
Size		
<5	21%	11%
5-15	25%	26%
16-50	42%	26%
>50	13%	30%
No data	-	7%
Origin		
Spin-off firms	-	15%
Start-ups	21%	22%
Firms relocated from inside the region	58%	41%
Firms relocated from outside the region	-	7%
New branch of existing company	13%	15%

Source: Survey

The initial survey population included all entities currently operating in the parks excluding public agencies and basic services companies⁵. The objective was the development of a representative sample, stratified

⁴ Numbers in parentheses refer to the share in the total population

⁵ In the case of Cartuja93 the population included firms characterised as advanced technologies (excluding universities and training organisations) and business services (total of 147 firms).

according to sector of activity – as information concerning years of location in the park, size and origin of the tenants was not available. The sample used here is based on responses received in the period 15/12/2005-15/04/2006 that represent 18% of the population of advanced technology companies in Cartuja93 and 26% of the companies of the Technology Park of Asturias (Table 2).

Section 3 – Presentation of the two cases

The parks' location and objectives

Both cases in our study belong to the third wave of parks created in the South Europe during the early 90s as part of regional technology upgrade strategies (Storey and Tether, 1998). The Technology Park of Asturias (PTA) is located in the centre of the region of Asturias, in the triangle formed from its the three main urban centres, Oviedo, Gijon and Aviles. Cartuja93 Science and Technology Park (Cartuja93) in Andalusia was developed on the island of Cartuja next to the centre of the city of Seville. Both regions are among those with the lowest GDP per capita in Spain and their economies are based on traditional low/medium-low technology industry and services sectors (Table 3). Asturias focuses on the traditional sectors of mining, metallurgy and basic metal processing (75% of secondary sector employment) that experienced a significant decline and unemployment during the 70s and 80s (Rodríguez and Menendez, 2005;Vazquéz and Lomba, 2000). In Andalusia and Seville services (mainly tourism) have a great role in the economy (Ferraro, 2000) together with agro-food and basic metal processing. High-technology sectors and activities are limited in both regions. R&D and innovation are still weak with low share of R&D expenditures - mainly dependent on the public sector activities – and low innovation outputs.

Table 3 – Economic and innovation indicators of the regions of Asturias and Andalusia

	Asturias	Andalusia
Population (millions)	1.1	7.4
GDP/capita in 2000 (EU15=100)	70.9	61.2
GDP growth rate (1995-2004)	2.2	3.8
% of workforce in high and medium high technology sectors (2003)	5.5	4.0
R&D expenditure (% of GDP)	0.7	0.89
Private sector participation in R&D	38%	35%
Patents/million population (2000)	9.3	6.5

Source : Eurostat

In the specific environments, the parks have been considered as development tools to support the upgrade of the two regions. PTA objective is “...*the promotion of industrial updating and renovation, the advancement of technological innovation and the activation of existent endogenous resources, as well as the procurement of outside investment...*” (IFR, 1991) while the park management representative added the objective of “*diversification of the regional economy*” (Pola, 2005 ,personal interview) from the traditional low-tech activities. In the case of Cartuja93, Manuel Castells and Peter Hall initial proposal targeted “ *the creation of a global scale innovative medium (medio de innovación) that would include research centres and companies of both national, regional as well as of international character and whose activities should be looking/projected to the global market north-south cooperation in the area of technology transfer*” (Cartuja93, 1994,19-20). However, this ambitious objective was modified in 1999 following the first years of the park operation due to limited demand for the establishment of international firms and possibly an increasing public pressure for relaxation of admission towards business and

administrative activities (Vazquez-Barquero and Carrillo, 2004). According to the park management the new approach has “... a more endogenously focused strategy for the attraction and establishment of local/regional companies” (Benjumea, 2006 ,personal interview).

Facilities and Services

Both parks provide significant space/plots (Table 4) for the establishment of firms’ own premises, higher education institutions (HEI) and research centres. The important role of space puts both cases in the category of parks that Kelesidis et al. (1999) characterise as property-led initiatives.

Table 4 - Main characteristics of the parks

	PTA	Cartuja93
Year of creation	1991	1992
Size	61 hectares	82 hectares
Initiator/owner	Regional government (100%)	Regional and national government
Plots	YES (29 hectares)	YES (35.6 hectares)
Incubator	YES	NO (only office space but no services)
HEI/Research centres	1 technology centre	29 research centres + 16 university faculties
Management entity	Regional government development agency (IDEPA)	Cartuja 93 S.A. Shareholders: National, Regional and Local authorities
Basic services to firms	Private entity with participation of land owners	Private entity with participation of land owners
Business/technology support services	IDEPA relevant units and CEEI	From tenants in the park in public and private sector

Source: Cartuja93, 2004;IDEPA, 2006

In both cases basic services and maintenance of infrastructure are managed through private entities where all landowners are shareholders. More advanced services in the two parks are developed through different mechanisms. In PTA, it is the management entity (IDEPA)⁶ and its subsidiary organisation, CEEI, that manages the park incubator. IDEPA services are provided through the units of regional innovation and business support but there is no dedicated department only for the park tenants⁷. They have access to regional support programs and activities similar to all firms and organisations in the region (Pola, 2005, personal interview). Only CEEI offers specialised services of business support nature to the incubator tenants. Concerning cooperation support, there are no specifically developed cooperation support mechanisms/structures inside the park to promote networking in a constant/on-going basis besides an annual tenant meeting, although park facilities are also used for partnership events organized through regional, national and European programs (Pola, 2005, personal interview). In addition, tenants have access to the network⁸ of Spanish parks’ tenants developed by APTE⁹. Finally, there are mechanisms developed

⁶ Regional development agency

⁷ Park related activities represent only 10% of IDEPA total annual budget

⁸ A web-based matchmaking mechanism for parks’ tenants

from organisations outside the park, such as FADE¹⁰, FICYT¹¹ and Club Asturiano de Innovación (a public-private partnership for the promotion of cooperation).

In Cartuja93, the management entity of the park focuses on the promotion of the park profile, admission of new entrants, the diffusion of information through printed and electronic material, organisation of partnership events (more than 2 per month) and cooperation support. Such activities have been given increased focus during the last years (Benjumea, 2006, personal interview). Business support services in Cartuja93 are provided from private companies, an important number of which operate in the park. The park tenants association (Circulo de Empresarios) created in 2001 – with over 70 members – promotes tenants common interests, cooperation support and knowledge diffusion (González, 2006, personal interview). At a regional scale firms have access to a number of “soft” web-based activities/services focusing on networking and partnership support (RAITEC and RATRI) developed from the regional government and its entities. Similar to PTA, Cartuja93 tenants have access to the APTE network of park tenants but also to partners at an international scale through agreements with parks in Europe and worldwide (Gil, 2006, personal interview). Concluding, while both parks offer similar basic services, it is clear that Cartuja93 tenants have access to wider range of cooperation/networking support mechanisms both inside and outside the park area.

Evolution of the parks

Both parks experienced an initial period of low occupancy rates and it was only after a number of years that they managed to reach high tenancy levels (Table 5). In Asturias there are currently over 100 tenants operating occupying more than 700 employees – a result of the park evolution of the last 4-5 years. Only CEEI incubator had a high occupancy with more than 15 firms at a constant base since the first years of its operation and a good graduation rate (10 companies annually). In 1997 only 3 companies had been established in their own plot and at that time there was a relaxation of the admission criteria as implied in IDEPA report (IDEPA, 2004) and confirmed by the regional industry (FADE) representative (González, 2005). The high growth of tenant numbers occurred after 2001 when a real estate firm established two office space buildings (Centro Elena I and II) currently hosting over 40 firms.

Similarly, Cartuja93 experienced low –although higher than PTA – initial occupancy rates. During the first years the main park entries were public national or regional research centres (e.g. CISIC, CNA) many of which were located in the park because of its quality facilities/infrastructure but also due to political decision to support the park viability¹². The positive turn in the park occupancy and activity levels occurred after 1998, linked – according to the park management and the tenants association – with the decision to allow the sale of land plots to firms¹³ (Benjumea, 2006, personal interview; González, 2006, personal interview). Since 2000, the park has experienced a rapid increase in occupancy and activity levels with a total of over 300 entities currently located in the park occupying over 10 thousand employees, representing over 12% of the total product of the province of Seville (Cartuja93, 2002).

⁹ Association of Spanish Technology Parks.

¹⁰ Industry Federation of Asturias

¹¹ Foundation for the promotion of scientific research and technology in Asturias

¹² 4 of the 8 research institutes representatives interviewed stated political decision as main reason for location in the park.

¹³ The initial status provided for the renting of land to firms for a period of 30 years.

Table 5 - Number of tenants and employees (in parentheses) in the park¹⁴

	1994	1998	2001	2005
PTA	9 (322)	28 (420) ¹⁵	31 (?)	104 (>700 ¹⁶)
Cartuja93¹⁷	98 (2760)	167 (4290) ¹⁸	195 (7590)	291 (10.470 ¹⁹)

Source: IAT, 2004; IDEPA, 2004; Ondategui, 1999

Research organisations in the parks

One of the important differences of the two parks is the absence of research organisations in the park of Asturias (1 technology centre-ITMA), in contrast to a total of 29 R&D institutes/organisations, 4 university departments and 16 training institutes/centres in Cartuja93. ITMA (Technological Institute of Materials) is a semi-public technology centre focused on the provision of technology services to companies in metallic and non-metallic materials fitting very well with the main industrial activities of the region but not relevant for the great majority of firms in the park. Its 75 employees perform limited basic and applied research activity and focus mainly on application/adoption of existing technologies to the regional –mainly- and national industry through R&D contracts, testing and certification, use of equipment and personnel training but has a very low innovation creation record with no patents or spin-offs companies (Pastor, 2005, personal interview).

On the contrary, Cartuja93 has an important research base of 29 research and technology institutions/entities that covers a very wide research spectrum including agriculture and biotechnology, energy and environment, materials science, industrial processes and automation. In 2004 the research centres accounted for around 7% of total economic activity and 20% of personnel (IAT, 2004) in the park. There is great variability in the nature of activities with the 3 research institutes of the National Centre of Scientific Investigations (CISIC) and the National Accelerator Centre (CNA) focusing on basic and applied research while other organisations like the Institute of Technology of Andalusia (IAT), CITAGRO and AICIA²⁰ focus more on new product development and implementation of technology in industry. Most of them have high scientific publication records and R&D projects participation, although fewer (mainly AICIA) have a strong record and focus on new products and processes, patents and spin-offs creation²¹.

Technology character of park tenants

Examining the activities of the park tenants, in both cases we can observe an important number of entities that do not fit with the high tech character/label of the park (sales/distribution units). In PTA, among those with a technology character (Table 2) the majority of firms belong to the services sectors of informatics (software and Internet services) and in engineering/technical services (including construction) with a small number of manufacturing firms ranging from pharmaceuticals (1) and machinery (2) to textiles

¹⁴ Refers to total number of entities in the park

¹⁵ Data for 1999

¹⁶ Estimate of park management

¹⁷ Cartuja93 numbers include all types of entities in the park (tenants belonging to technology related services represented 60% of total and 80% of employment)

¹⁸ Data for 1998

¹⁹ Data for 2004

²⁰ It is the research and industrial cooperation association of the engineering school of University of Seville forms from the university professors and administrates the use of university research results and its services.

²¹ AICIA has created 8 spin-offs, 1 located in the park and 7 in the region.

(2). A low 21% in our survey sample stated R&D as an important activity, 33% developed new software while 46% have consultancy/testing as main activity but also a high 33% sales and distribution. According to representative of the regional industry association (FADE) “...while the park has some companies with importance for Asturias economy, they do not have any high-technology content and any important R&D activity” (González, 2005, personal interview). A similar view was expressed from the representative of FICYT²² (Suarez, 2005, personal interview).

Table 6 - Summary of activities of firms in the survey sample (% of firms stating)

	PTA	Cartuja93
n	24	27
Main/prime activities		
R&D	21%	43%
Software development	33%	36%
Product design/engineering	13%	14%
Production/Manufacturing	8%	14%
Consultancy/analysis/testing	46%	75%
Sales/distribution	33%	21%
Other	7%	18%
Innovative character		
R&D employment over 5% of total	46%	48%
R&D expenditure over 5% of sales	38%	37%
New products/services introduced during the last 3 years	30%	63%
Share of new products in total sales over 50%	10%	19%

Source: Survey results

Similarly, in Cartuja93 there is an erosion of the high technology nature of the park envisioned in Castells and Hall proposal. While over 75% of the firms are classified in the park directory as belonging to advanced technologies and services from the park directory, a closer analysis shows a number of them being regional delegation/sales offices of national and multinational firms (21% in our sample)²³. The number of tenants with important R&D activity is double that of PTA (43%) although again a very high share (75%) mentioned consultancy and testing as the most important activity. In addition, an important part of the park –not included in the survey population - is occupied by regional government agencies and media/communication companies²⁴ (newspapers, radio/TV channels) that only remotely fit with the technology park character (Cartuja93, 2005).

Section 4- Cooperation networks

Our analysis already points to a deviation of the parks from the park high-tech model. Still –despite the presence of less relevant activities - both cases represent – especially in the specific environments- an important concentration of technology/innovation related activities including firms and research and

²² FICYT (Fundación de Fomento de Investigación Científica Aplicada y de Tecnología) is a private foundation for the promotion of R&D cooperation in Asturias and has developed the regional R&D and innovation plan.

²³ 16 firms contacted declined to respond stating that they are only regional delegations/offices and did not consider the survey relevant/applicable for them.

²⁴ Some of the tenants in the above two categories are classified in the park directory as advanced technology services.

technology organisations that in combination with the provision of support services could facilitate networking and interaction.

As a first step in our analysis we looked into the spatial scale of park tenants markets – including clients and suppliers of standardized and customised inputs (Table 7). In both cases, we can observe a strong role of the regional markets with a high share being also active at a national level. This applies both for clients as well as the providers of standardized and customized products. For a smaller but still important number of firms (20% of both samples) the parks’ area is also considered an important market. The strong role of local flows of goods and services reveals an important level of integration of the park firms operation in the regional markets. Such supplier-customer relations are important media for technology transfer –in the form of embedded knowledge- and could also facilitate more advanced interactions. However, it can also be explained with the dominant role of the services sector activities of the parks’ tenants. Indeed, comparing the importance of the regional market between firms in the sample with and without important consulting activity (Table 6), we found a significantly higher role for the first group²⁵. The comparison of the two cases reveals that in Cartuja93 there is an important share of tenants where international markets also have an important/very important role.

Table 7 – Location of important clients and suppliers of park tenants (% of firms stating specific market medium or high importance)

	PTA				Cartuja93			
	Park	Regional	National	Foreign	Park	Regional	National	Foreign
Clients	18%	87%	55%	19%	21%	75%	46%	32%
Suppliers	20%	81%	77%	24%	16%	67%	77%	46%

Source: Survey results (Companies were asked to characterise the importance of their clients/supplier from 0: not existent to 5-very important).

At a second stage, we focused on the presence of knowledge flows and exchange testing the presence/development of innovation-related linkages and networks of cooperation (Table 8). Cartuja93 tenants show a significantly higher tendency for cooperation with universities and R&D centres (knowledge creation organisations) –at levels close to other similar studies (Phillimore, 1999; Vedovello, 2000). This is

Table 8 - % of firms reporting important innovation cooperation partnerships

	PTA (n=20)	Cartuja93 (n=27)
Universities***	15%	54%
R&D centres**	16%	58%
Clients	43%	53%
Suppliers	44%	16%
Companies in same sector/competitors	30%	23%
Companies in same group	40%	42%

Source: Survey results - % of firms stating different innovation cooperation partners as of medium, high or very high importance for their firm *** Mann-Whitney test difference significant at 0.01 level ** Mann-Whitney test difference significant at 0.05 level

²⁵ A Mann-Whitney test showed a significant difference (at 0.1 level) in the role of the regional market of 1 at a scale of 1-very low importance to 5-very high importance

possibly linked with the higher share of firms with significant R&D activity in Cartuja93 as these firms show higher tendency for cooperation with research centres and universities²⁶. On the contrary, there are no significant differences concerning inter-firm cooperation. A bit less than 1 in 2 firms in both parks have some type of cooperation developed.

We tested the spatial character of the innovation partnerships asking firms to identify the location of their partners (Table 9). There is no clear spatial scale that is more important for innovation cooperation – following the conclusions of some part of the literature (Doloreux, 2002;Freel, 2000;Fukugawa, 2005) that argues that firms look for appropriate innovation partners in all possible spatial scales. The parks space does not seem to be a place with more dense linkages. Given the incompatibility of ITMA activities with most tenants, there are no partnerships with research organisations in the park and firms look at broader scales for cooperation. In contrast, in Cartuja93 – with an important research base - an important 30% has important cooperations both inside the park and at the regional level – both of horizontal and vertical nature.

Table 9 - Location of innovation partners (% of respondent tenants)

	PTA (n=20)	Cartuja93 (n=26)
Cooperation with HEIs/R&D centres		
- in park***	0%	30%
- in region	40%	52%
- in country	40%	38%
- foreign***	0%	31%
Cooperation with firms (clients, providers, competitors)		
- in park	10%	19%
- in region	35%	44%
- in country	40%	54%
- foreign**	70%	38%

Source: Survey results (Firms were asked to state the location of all important cooperation partners)

*** Mann-Whitney test difference significant at 0.01 level ** Mann-Whitney test difference significant at 0.05 level

We also asked firms to specify the types of links developed – formal or informal²⁷ – with Research Organisations/HEIs and other firms (clients, suppliers, competitors) at different locations (Table 10). While there was a low response rate (a number of firms stating the presence of cooperation did not specify the form of cooperation) in Asturias, we can still see a significant difference among the two that further strengthen the previous conclusions. Over 30% of Cartuja93 tenants have developed formal and/or informal linkages with companies at all spatial scales. A significant part of them are inside the park or at the regional level. We also see that informal cooperation with R&D centres/HEIs is more common– a result

²⁶ The Mann-Whitney test showed statistically important difference (0.01 level) at the level of importance attributed (1.7 higher at 5 point scale).

²⁷ Formal links with RO/HEIs include: Research results licensing, R&D contracts, Joint ventures, Provision of technology services/consultancy

Informal links with RO/HEIs include: Use of equipment/facilities, Information on R&D activities, Exchange/recruitment of personnel/researchers, training of personnel, social/interpersonal interactions

Formal links with firms include: R&D contracts/projects and joint ventures

Informal links with firms include: Shared equipment, Exchange of personnel, interpersonal relations

similar to other studies (Phillimore, 1999;Vedovello, 2000). By contrast, in Asturias, linkages and cooperation are relatively limited. A small number of firms report development of informal linkages in the form of training and hiring of personnel (mainly with the University of Oviedo) while an even smaller part (less than 15% of the sample) make reference to formal or informal linkages developed with other firms in the region.

Table 10 – Formal and informal linkages of parks tenants (number of firms)

	With ROs/HEIs		With firms	
	PTA (n=24)	Cartuja93 (n=27)	PTA (n=24)	Cartuja93 (n=27)
<i>Formal linkages</i>				
- in park	-	5	1	7
- in region	-	12	5	6
- in country	2	9	3	10
- foreign	1	8	3	9
<i>Informal linkages</i>				
- in park	1	10	1	7
- in region	7	18	1	11
- in country	5	12	1	6
- foreign	2	10	2	4
Not responded	14	7	13	8

Source: Survey results

Concluding, in Cartuja93 we can observe -beyond the market based relations- cooperation networks developed at the park and regional scale from a number of tenants. These include both research organisations as well as firms partners. Around 30% of Cartuja93 firms have multiple partnerships of different types that extent to various spatial scales, in contrast with PTA where R&D networking relations are very limited –almost anecdotal - to a very small number of firms.

Section 5 – The parks as network facilitators

In the second part of the study we attempted to identify the variables that may explain those differences, we looked into the role of a number of possible parameters focusing on the physical and operational parameters of the park.

We asked the tenants of the two parks to state the reasons for locating in the park and the added value derived from operating in it during the years of operation. Following the existing literature, their responses (Table 11) reveal that the most important parameter is the prestigious park address/label – similar to other studies (e.g. Bakouros, et al., 2002;Massey, et al., 1992;Monck, et al., 1988) – the quality of the provided infrastructure and the convenient geographical location. However the comparison of the two cases reveals that incentives related with possible cooperation play an important role only for the tenants in Cartuja93. In contrast, in Asturias only infrastructure related variables are stated as important, making the park look very much like a high quality industrial park.

Table 11 - Percentage of respondent tenants stating as important reason for location in the park

	PTA (n=20)	Cartuja93 (n=27)
Prestige of the park	65%	69%
Park location	85%	62%
Quality of infrastructure	50%	54%
Presence of relevant firms for potential cooperation	0%	46%
Presence of research centers for potential cooperation	5%	31%
Financial incentives	10%	27%
Advanced business services and technology transfer support	15%	23%
Access to basic support services	15%	19%

Source: Survey results (tenants were asked to state the 5 most important reasons for deciding to locate in the park)

Asking the tenants to assess the perceived added value from their operation in the park (Table 12). The overall assessment is very low with no parameters having high or very high role. Still, the tenants verify to a great extent their initial expectations stating the prestige of the park address and its quality infrastructure as parameters with a positive role. Parameters related to cooperation such as the presence of possible partners and the development of a communal environment have a secondary role. Again, we can observe important differences between the two cases concerning the role of other possible partners. In Cartuja93 there is a higher realised added-value from the collocation with research centres and firms and the development of a cooperative/synergetic atmosphere – while in PTA such variables are very close to be considered completely irrelevant.

Table 12 - The added value from the location inside the park – average grade (1-very low, 5-very high)

	PTA (n=20)	Cartuja93 (n=25)
Prestige of the park**	2.6	3.52
Quality of infrastructure	2.75	2.85
Access to basic support services	2.55	2.15
Presence of synergetic atmosphere	1.60	2.15
Financial incentives	1.75	1.56
Presence of relevant firms for cooperation*	1.30	1.96
Presence of research centers for cooperation***	1.00	2.15
Access to skilled personnel	1.40	1.26
Advanced business services and technology transfer support*	1.00	1.78

Source : Survey (Tenants were asked to assess the park location added-value given a choice among 6 options: 0-not applicable, 1-very low, 2-low,3-medium,4-high,5-very high)

*** Mann-Whitney test difference significant at 0.01 level ** Mann-Whitney test difference significant at 0.05 level

Assessing further the role of the intangible services provided, tenants made an assessment of a number of business support services offered in the park – either from the management team or from other entities (Table 13). As we can see the majority of tenants give a negative or very negative assessment concerning almost all different types of services available in the park environment including those related with cooperation promotion and support. The parks' intangible services are still not very well developed even though the parks representatives graded them as with high or very high marks (Benjumea, 2006; Pola, 2005, personal interviews). In addition there is a high share of tenants –especially in PTA - that have never used the existing support services and consider the park contribution only in relation with its provided

infrastructure. Between the two cases, Cartuja93 tenants show a higher level of satisfaction in cooperation related services (technology transfer, identification of partners).

Table 13 – Satisfaction from support services offered in the park

	PTA (n=20)		Cartuja93 (n=25)	
	No use	Average grade	No use	Average grade
Information provision services	20%	1.9	20%	2.6
Business/management/marketing support	40%	1.2	44%	1.3
Support in participation in R&D and innovation related projects	35%	1.25	28%	1.6
Technology transfer support	50%	0.95	28%	1.6
Support in identification of innovation partners	35%	1.05	24%	1.8

Source: Survey (Tenants had a choice among 6 options: 0-not know or not use, 1-very low, 2-low, 3-medium, 4-high, 5-very high)

Finally, the above conclusions are reinforced from the responses of firms concerning the obstacles for developing cooperation activities (Table 14). Geographical distance does not play a role for most tenants – weakening the role/importance of the park as a physical agglomeration of possible partners. Neither do firms consider that there is absence of possible partners with whom they could develop cooperation partnerships. What they stress are issues of cost, culture (in some cases explained as fear or lack of trust) and the absence of necessary support schemes. These are all obstacles that parks –through the development of intangible support services – should be able to address, but our analysis so far suggests that have not – especially in PTA case.

Table 14 - Obstacles in developing cooperation in R&D activities - % of respondents stating as important

	PTA (n=18)	Cartuja93 (n=23)
Costs of coordination/cooperation	61%	43%
Absence of cooperation culture	39%	57%
No scheme to support cooperation	28%	39%
No interest of own firm	17%	9%
No interest of other firms	17%	22%
Absence of competent/possible partners	17%	13%
Geographical distance	0%	9%

Source: Survey results (firms were asked to state all possible cooperation obstacles)

Discussion

The study analysed two Science and Technology Parks in Spain using a network-based approach to analyse the presence and scale of cooperations and innovation linkages/flows developed and testing the possible role of the parks as network facilitators.

Overall, we did not identify widely developed cooperation relationships –formal or informal. The role of parks' space and services as facilitators of network relationships is limited. The park high prestige label and the “hard” parameters of the park such as infrastructure and facilities are considered much more important

for the tenants operation – as proposed from the majority of the evaluation literature - while knowledge flows and cooperation incentives have only a secondary role.

However our comparative analysis revealed important differences between the two cases. While in both cases the tenants are strongly integrated in the regional economy through market based customer-supplier relationships, in PTA only very few of them have developed R&D cooperation and partnerships. PTA is closer to a high quality industrial park with limited knowledge flows both inside as well as outside the park area. In Cartuja93, a number of tenants have moved towards higher-density networks and cooperations the span across many different spatial scales. Next to a significant share of tenants with low technology and innovation content, we find some firms that actively seek for knowledge sources through horizontal and vertical linkages and at various spatial scales. Although our evidence does not support the creation of the “innovation medium” envisioned by its initial proponents – we can argue for the development of a space that is more than an industrial/business agglomeration.

Looking for the parameters that affect the network development performance, the absence of a strong knowledge base in the park of Asturias –in stark comparison with Cartuja93- is clearly not supportive for the development of R&D cooperation but does not seem to be the main obstacle. What the comparison shows as more important is the absence of mechanisms to overcome constraints/obstacles related to cooperation culture (issues of fear and lack of trust) and the perceived cost for organising cooperation. In Cartuja93 such mechanisms have been more actively developed from its park management- especially during the last years- although still considered insufficient from the majority of tenants in contrast to PTA where the park management has not –at least- so far given priority to the development of cooperation mechanisms.

A relevant possible line of investigation could be a comparison of different types of park structures. The two Spanish parks follow similar models concerning the role of property for the attraction of tenants. They both followed the property led model (Kelessidis, et al., 1999) where the real estate parameter and the need to fill in the provided space plays – as we illustrated in both cases – an important role. Following their classification other park structures have more lean approaches where property is not considered that important and intangible services have priority early on. An extension of this research could be to assess if there are differences in terms of networks formation and cooperation and the role of the park between the two different types.

Finally we should note that our study looked for cooperation network relationships inside and outside the park area and without limiting to any particular spatial scale. However our data sources are based on responses from park tenants complemented with some inputs from outside players. While this allows us to map the linkages developed with the park we can only infer the importance of the park location as a place of interaction and networking facilitation for outside players. Additional data from firms, research organisations and other important players could strengthen the validity of our conclusions.

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