Science and Technology Parks in the less favoured regions of Europe: an evaluation of their performance and the parameters of success

Thesis submitted for the degree of Doctor of Philosophy

by

Achilleas Tsamis

The London School of Economics and Political Science

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Abstract

Science and Technology Parks (STPs) have been promoted during the last 40 years by governments as key instruments to support innovation, technological development and economic growth. They were motivated by the success of places like the Silicon Valley and based on what theory identified as the positive role of physical proximity between R&D and production activity for knowledge exchange, technology transfer, synergies development and the creation of innovation. However, there is mixed empirical evidence in the literature regarding the success of STPs in technologically advanced countries and regions that cast doubts about their viability and their theoretical underpinnings. Yet despite this mixed evidence, governments and decision-makers have increasingly resorted to STPs as a means to promote innovation and growth in lagging European regions.

This study examines this paradox by assessing the feasibility of creating successful STPs in lagging regions of the European Union (EU) and examines how the local regional context, their design and characteristics affect their performance. The analysis compares the innovation intensity, the linkages supporting knowledge and innovation creation, the formation of New Technology Based firms, and the broader regional impact of the STPs in four Parks located in four lagging regions of Southern Europe.

The results support the initial hypothesis that lagging regions are not supportive environments for the creation of successful STPs. The Parks have remained primarily real-estate projects. They do concentrate R&D and innovative activity at levels above those of their regional context but linkages and knowledge and technology transfer remain largely absent and the NTBFs formation records poor. Their role in their regions' technological

development is marginal, as most technologically advanced activities tend to remain disconnected from their local economy. A weak local technological base and the absence of genuine demand for the STPs' mechanisms and cooperation processes limit critically their impact. The comparison of the four cases reveals however that professional management structures, increased and dedicated public resources, the promoters' long-term commitment and their integration in broader regional innovation support strategies enhance the Parks' prospects of success.

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The writing of these acknowledgements signifies the end of my PhD endeavour. It has been a period of intensive and persistent effort, at times characterised by frustration, anxiety or even disbelief that a final result is achievable. In this effort a number of people have played an important role and I would like to thank them.

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Abreviations and acronyms

AICIA - Asociación de Investigación y Cooperación Industrial de Andalucía

AGESA – Sociedad Estatal de Gestión de Activos (State Asset Management Company)

APSTI - Associazione Parchi Scientifici e Tecnologici Italiani

APTE – Asociación de Parques Cientificos y Tecnológicos de España

CERTH – Centre for Research and Technology Hellas

CPERI – Chemical Processes Research Institute

CEEI – Centro Europeo de Empresas e Innovación

CSIC – Consejo Superior de Investigaciones Científicas

FORTH – Foundation for Research and Technology Hellas

FING – Federation of Industries of Northern Greece

GSRT – General Secretary for Research and Technology (Greece)

IASP - International Association of Science Parks

IAT – Instituto Tecnológico de Andalucia

IDEPA – Instituto de Desarollo Economico de Principado de Asturias

ITMA – Instituto Tecnológico de Materiales

IFR – Instituto de Fomento Regional

KIBS – Knowledge Intesive Business Services

KIHTS – Knowledge Intensive High Tech Services

HEI – Higher Education Institutes

NTBFs – New Technology Based Firms

PRTOs – Public Research and Technology Organisations

RTP – Regional Technology Program

RITTS – Regional Innovation and Technology Transfer Strategy

SEPVE (ΣΕΠΒΕ) – Federation of Information Technology Industries of Northern Greece

STEP-C – Science and Technology Park of Crete

STEP-C/MDC : Science and Technology Park of Crete Management and Development Company

STP - Science and Technology Park

TTP - Thessaloniki Technology Park

TTP/MDC - Thessaloniki Technology Management and Development Company

UKSPA – United Kingdon Science Park Association

VC - Venture Capital

1 Chapter 1 - Introduction

1.1 The STP paradox

Science and Technology parks (STPs) are today an international phenomenon. Initiated in the 1950s and 1960s with a small number of cases (Standford Science Park in California, Research Triangle Park in North Carolina, Sophia-Antipolis in France, Cambridge Science Park in the UK) the spread of Science and Technology Park (STP) labeled-structures during the last 30 years has been quite remarkable. The American University Research Park Association (AURPA) had a total of 174 members[1] in 2008, with their spread appearing to fit quite well with an s-shaped diffusion curve (Link and Scott, 2003, p.3;Sofouli and Vonortas, 2007). In Europe, STPs were first established in the UK. By 1987, out of the 52 British universities, 34 had a science park operating in their vicinity. Other technologically advanced countries and regions – Germany, Netherlands, Belgium, Denmark and Sweden – developed STPs during the 1980s and were followed by the less developed countries in Southern Europe (Greece, Spain, Portugal and Southern Italy). According to Storey (1998) and Maltez (2004), by 1998 there were already 310 STPs in 15 European countries that hosted more than 14,800 firms and employed 240,000 employees. Following the same trend, and with the support of the European structural funds, most of the new member states have STP structures already in operation or in the planning stage. Outside Europe, parks have already been developed in Asia (including Japan, Korea, Taiwan and China, as well as Kazakstan, Mongolia and Iran), in Australia, Latin America and Africa (IASP, 2007). The International Association of Science Parks had in 2007 342 members, spanning 71 countries and hosting around 200,000 firms (IASP, 2008) while, according to Luger(2001),

[1] Many AURPA members are not members of IASP

there must have been more than 1,000 Science and Technology Park labeled structures operating at a global scale in 2001.

What are the reasons and the driving forces behind this wide adoption of the STP policy? STPs have been linked with a number of knowledge-based regional growth objectives that include the attraction of non-local high-tech firms involved in leading edge technologies, the creation and growth of new technology based firms, the promotion of technology transfer from universities to industry and the development of innovation cooperation and synergies (Massey et al., 1992; Storey and Tether, 1998; Souitaris and Daskalopoulos, 2000). There is great variation in the STPs structures and not all parks target all of the above stated objectives, but most focus on at least two of them (Tsipouri, 1998b). Employment creation and the revitalisation of the local and regional economy are the broader impacts expected to come from their operation (Geenhuizen and Soetanto, 2008).

Against this continuous spread of the STP policy tool, in the late 1980s academics and policy makers started to debate whether STPs actually achieved any of the stated objectives, whether they represented solid investments and "value-added entities" (Souitaris and Daskalopoulos, 2000). A number of evaluation studies focused on technologically advanced countries, mainly the UK but also other countries, where the STPs were primarily developed. The general picture is that, while individually successful cases are indeed present (Felsenstein,1994; Komninos, 2002), the majority of the evaluation literature revealed limited, if any, results and raised strong doubts regarding most aspects of the expected contribution and role of STPs.

Monck et al. (1988) concluded that park-firms tend to have a higher level of technology-intensity than off-park firms, but not greater levels of connection with Higher Education Institutes (HEIs) or innovative activity. The same picture of an absence of important linkages with HEIs was found in Van Dierdonck and Debackere's (1991) study of Belgian and Dutch STPs and Vedovello's (1997) exploration of the Science Park of Surrey. Massey et al.'s (1992) broadly cited work found that, in most respects, UK parks failed to achieve their objectives, contributing very little to technology transfer and the creation of new technology based firms (NTBFs) ; they conclude that they were mainly high-profile real-estate developments and characterised them as "high-tech fantasies". The studies of Lindelof and Lofsten (2002; 2003; 2005) on Swedish parks showed a more positive performance in the development of linkages with the local HEIs, but this was again not linked with higher levels of innovative activity. Felsenstein's (1994) study of three parks in Israel concludes that the parks operated more as technology enclaves rather than seedbeds (supportive environments) of innovation. Chorda's (1996) study of French STPs suggests poor results in terms of networking, the promotion of entrepreneurship and the attraction of innovative companies. A few studies have taken a more macro view, examining the parks' role in the broader region in which they are established; again, the overall picture appears similarly negative. Luger and Goldstein (1991) in the US examine the general employment creation derived from the parks operation, Doloreux (2002) in Canada focuses on the role of STP presence in high-tech employment creation, Appold (2004) examines the attraction of private R&D labs and Wallsten (2004) observes the attraction of venture capital in the respective regions. In all the above cases, the researchers conclude against a causal linkage between the presence of a Park and growth in any of the above development indicators. What they usually find is a selection bias, namely STPs developing primarily in areas that already had high-levels of high-tech activity. Following Komninos (1993), the success of a region is more generally the determining parameter for the respective success of a Park.

Against this background and the strong doubts about the Parks' possible role and success in technologically advanced countries and regions, the development of STPs in regions characterised by low-levels of local knowledge and a weak technological base represents a paradox. Lagging regions – also named as less-favoured (Landabaso,1997) or lower order regions (Cantwell and iammarino,2003) in the European context - are characterised by lower GDP per capita levels and tend to have less dynamic and attractive home markets. They also have markedly low levels of R&D activity, very few firms in high-technology and knowledge intensive sectors and low levels of human capital (EC, 2003). Firms in lagging regions tend to invest primarily in embodied technology and show very low levels of investment in R&D, low interest in collaboration with other firms and organisations and limited responsiveness to relevant policy programs (Tsipouri and Gaudenzi, 1998). In most cases, public R&D activity remains unrelated to the needs of industry. The attitude towards cooperation is limited by low levels of trust, increased uncertainty of the benefits from cooperation and limited experience (Tsipouri and Gaudenzi, 1998). Their characteristics are in direct conflict with the STPs operation, as they are based on a concentration of significant levels of R&D and other knowledge-intensive activities, the development of knowledge flows, linkages and synergies and the creation of new technology based firms to exploit new knowledge from the public and private sector. If anything, they provide a much more challenging context that that of the more advanced countries and regions.

It is this identified paradox that is the motivation of this research. Given what appears to be a limited success of STPs in countries and regions with a significant R&D base, a strong foundation and tradition in research and technology and a much greater level of relational capacity from the different regional/local players, what can one expect from STPs in regions which lack most of the above elements? Can such structures become real and successful STPs, fulfilling their expected role as laid down in their definition? Or do they simply become high-profile real-estate projects, fitting policymakers' need to develop "hard" and visible infrastructures, but with no real role in technology transfer, knowledge exchange and innovation creation?

1.2 Hypothesis formulation and research approach

The starting hypothesis of this research is that the lagging regions' socio-economic and institutional context decreases the possibility of creating successful Science and Technology Parks. It is expected that the Parks' context does not support their development towards innovation-intensive spaces, characterised by high-levels of innovative activity, knowledge-based links between universities and industry, synergies and a seedbed environment for the creation of new technology-based firms. It is thus expected that the Parks shall have limited success in the above prime objectives. As a consequence, it is also expected that STPs will have a limited role/contribution in supporting the transformation of the respective regions towards knowledge based economies.

To test the hypothesis, this thesis uses a comparative case study approach of four STPs in Objective 1 regions of Southern Europe. The multiple case-study approach is the most appropriate in order to accommodate the variation in the types of STPs with the need for in-depth analysis of each case in order to assess the operation and evolution of the STP internal processes and mechanisms and their connection and dependence from the broader regional context. Following Yin (2003), the comparative multiple case study approach is the preferred method for the researcher to investigate a contemporary phenomenon within its real-life context where the boundaries between the phenomenon (the STP characteristics and performance) and the context (the regional environment) are not clearly evident.

Among the various lagging contexts, Southern Europe lagging regions provide a good base for a cross-case comparison. All have fairly similar socio-economic characteristics and all belong to the same lagging group among the European regions in terms of overall innovative performance (EC, 2003). In almost all, the STP policy was transferred and rather widely adopted during the late 1980s and early 1990s with the support and guidance of the European Union as part of the more general support that was received through the EU regional policy programs. They represent in many relevant respects a rather homogeneous group which supports a cross-case comparison.

The analysis of the Parks is based on a framework that brings together the wide range of theoretical streams that are applicable to STPs' operation. Economics of innovation, entrepreneurship theory, management of technology, network theory, industrial geography and regional development provide insights concerning some parts of the STPs' expected operation and explanations of the relevant activities developed. The main point of reference, however, is the literature on territorial innovation models (Moulaert and Sekia, 2003), a generic name referring to models of regional innovation which explain the creation and operation of innovation intensive environments and which have provided the theoretical foundations for the STP policy since the 1980s (Komninos, 2002). Based on the above framework, the researcher has identified three broad functions on which to assess the Parks' success:

- the type and knowledge-intensity of activities attracted or developed inside the Parks' space supporting the formation of innovation intensive environments
- the presence (or not) and the form of linkages and synergies among the STPs' tenants and their external environment and the role assumed by the Parks' mechanisms to facilitate them
- the creation and growth of technology-based firms and the form of support provided by the Park structures

In all the above functions of the STPs, the focus is on the way they are affected by the regional context and how the STPs' mechanisms succeed (or not) in addressing possible limitations.

The four cases selected, from an initial group of 47 STPs, are: Thessaloniki Technology Park in the region of Central Macedonia (Greece), the Science and Technology Park of Crete (Greece), Cartuja93 Technopolis in Andalusia (Spain) and the Technology Park of Asturias (Spain). They have all been in operation for more than ten years, thus allowing for the greatest possible level of maturity reached by their respective processes, a key element according to the relevant literature (Luger and Goldstein, 1991; Castells and Hall, 1994; Bakouros et al., 2002). Furthermore, their selection represents the two main types of STP development strategy that were identified. The two Spanish parks are based on large scale property developments that focus on the attraction of firms and research organisations. The Greek cases are, on the contrary, much smaller in size, with greater focus given to the support of the creation of new technology based firms and the development of support services and mechanisms with reference to the broader region.

The secondary evidence collected at the beginning of the research from all Parks shows that the four cases had followed different evolution patterns and activity levels. STEP-C in Crete and Cartuja93 in Andalusia appear to be, in relative terms, more successful than Thessaloniki Technology Park and the Park of Asturias respectively.

This variation in performance is intented to help identify the common elements that affect the development and operation of STPs within the context of lagging regions, and point to the internal design characteristics that may or may not address the limitations presented from the regional context, increasing the chances of success. Hence, while a multiple case-study research approach may not produce results generalisable to the total population of STPs, especially since "every science park should be seen as a specific project" (Komninos, 2002, p.61), it shall contribute to a greater understanding of the interaction of the the STPs operation and their context. It will also help to guide policy-making in relation to the general feasibility/appropriateness of promoting STPs in such regional contexts and, in addition, could identify the design parameters that can increase the opportunities of success or, at least, help to avoid failure.

1.3 Thesis structure

The structure of the thesis is as follows. Chapter 1 (Introduction) introduces the objectives of the research, the context and the structure of the thesis. Chapter 2 provides a review of the STP related literature, bringing together the theoretical analysis of the STP model with existing practical experience. The focus is on explaining the STP concept and identifying its expected role as a policy tool. The starting point is an analysis of the innovation process and the role that space, proximity and the broader environment have in its development. This, in turn, leads to an analysis of the various territorial innovation models and their implications concerning the characteristics of environments conducive to innovation, thus providing the basis for an analysis of STPs as technology policy and planning tools, identification of the main elements of their operation and the expected functions that should characterise successful STPs and their contribution to the regions development. The presentation of a continuously increasing pool of empirical evidence, mainly from advanced regions, is used to identify the relevant measurement indicators for the expected functions, but also highlights the critical parameters of operation and success. The last part of Chapter 2 analyses the proposed STP paradox by examining the ways and forms in which the lagging regions' context is expected to affect the Parks' operation and success.

Chapter 3 is the methodology and case selection chapter. The first part provides a justification of the research methodology of the thesis and presents the criteria used for the case selection. The second part includes an analysis of the existing STPs in the Objective 1 regions and their main attributes and objectives and guides the reader through the selection of the four cases. The last part provides a detailed account of the field work and the data sources used.

The next two chapters present the four cases and the results from the fieldwork. The four STPs are examined in pairs, starting with the two technology-led Parks of Greece (Chapter 4) followed by the Spanish property-led cases (Chapter 5). Following an analysis of the STPs' regional context and their relevant strengths and weaknesses, the researcher provides a historical account of the Parks' creation and evolution, analyses the promoters' objectives and examines the structure and operation of the STPs. The STPs' performance is then presented, based on data from the fieldwork, and the STP model is used to identify the drivers of their operation and the way internal and external elements play a role. The last section provides an assessment of the Parks' actual contribution to regional development and their contribution to the broader innovation system. The presentation of the STPs in pairs was selected in order to avoid repetition of some common elements, but also to better illustrate differences in the role that various STP actors and parameters, both internal and external to the Parks, assume in the Parks' operation.

Chapter 6 brings together the analysis of the four examined cases in order to reach broader conclusions concerning the operation of STPs in the context of the lagging regions and the feasibility of success: the central question of the thesis. It focuses on the three main areas: the creation of an innovation intensive space, the development of linkages and synergies and the creation of NTBFs, the researcher examines which parts of the STP models have worked, which haven't and why. Based on evidence from the four cases and the comparison, the way that that the parks interact with the regional context and how the latter inhibits the Parks' operation and success is identified. The variation of the four cases allows the detection of those internal and external parameters that increase or decrease the STPs' chances of success. Given the STPs' operation and the limitation of the broader context, Chapter 6 closes with an assessment of the actual role that the STPs can assume in the regional environment. In Chapter 7, the thesis concludes with policy implications concerning the development of STPs in the lagging regions context in view of the uptake of the STP trend in Eastern European countries, and with some proposals for further research.

2 Chapter 2 - STPs evaluation framework and integration of the lagging regions context

2.1 Introduction

For any study of Science and Technology Parks, the review of a sizeable and expanding body of literature reveals the multiplicity of theoretical approaches and explanations that are used to define what an STP is, how it is supposed to operate and what it is expected to achieve. Economics of innovation, entrepreneurship, strategic management, industrial geography and regional development theories are used by scholars, policy makers and practitioners to explain the STPs' expected role and operation. In addition, a constantly increasing number of empirical studies analyse STP structures and operations, classify them according to different criteria, and attempt to assess their performance against their stated objectives and identify so called success parameters/factors.

The aim of this chapter is to bring together the diverse theoretical perspectives and the respective empirical evidence to build an analysis and evaluation framework for the STPs, integrating the Parks' operations and functions within their regional context. This will allow the identification of the implications of developing STP-labeled structures in less advanced environments such as those of Objective 1 regions of Southern Europe.

The literature review starts with an examination of the role of innovation and the innovative firm in regional development. The analysis of the innovation process, ranging from the linear approaches/views to the more complex models, is linked with the role that location and space assume in its development. The examination of various territorial innovation models (Moulaert and Sekia, 2003) serves as a basis for the analysis of the STPs' operation and the identification of the important tangible and intangible operation elements and the expected functions. These functions are then linked with the regional development literature to explain how STPs are expected to contribute to regional development. Following on from that, the theoretical model is compared with the existing empirical evidence, mainly from studies in technologically advanced countries and regions, in order to highlight their weaknesses and limitations and/or point to ineffective implementation. This analysis paves the way for an examination of the transfer of the STP model from more advanced to less developed regional contexts. The profile of the lagging regions of Southern Europe is compared with the STP model, highlighting the limitations posed for the STPs' operation and success and substantiating the presence of a paradox. The review closes with the identification of possible alternative scenarios/outcomes that involve smaller or higher levels of deviation from the described STP model.

2.2 Theoretical context: innovation, economic development and space

2.2.1 The role of innovation in economic growth

Scholars as far back as Marshal in 1890 have noted that knowledge is the most prominent engine of growth. Solow's (1957) seminal work established that more than 40% of the increase in aggregate output of the US economy could not be explained by the accumulation of capital and labour and should be connected with technical progress and knowledge enhancing processes: the Solow residual. Ever since, researchers have verified the important role of technological change in economic growth. It is nowadays acknowledged that innovation and technological change have a critical role in the economic growth of countries, regions and cities (Audretsch et al., 2002).

However, the views on the ways that knowledge and technology affect economic activity and lead to growth have shifted over time. Early neo-classical models viewed knowledge and technology as completely exogenous to the system and assumed that the same technological opportunities were equally available, something like manna from heaven (Antonelli, 2003). This implied that, in the long-run, technological progress would be the same everywhere and, as a result, growth paths of regions should converge over time. In contrast, new growth theory models (Romer, 1986) propose that technological knowledge and innovation are endogenous to the system and come as the result of directed actions and investments in human capital and knowledge creation activities. These activities are characterised by increasing returns and they have a cumulative and path-dependent character, whereas prior actions determine the character of innovative activity in subsequent stages. Technology also assumes a more private character, even though it is still liable to spillovers, based on the use of intellectual property rights and other forms of protection that provide temporary monopoly power to new or existing firms. Bringing the two elements together, it follows that not all firms and not all regions are expected to be equally able to generate innovation and benefit from it. Innovation assumes a disequilibrating role in the growth process (Howells, 2005), giving rise to pervasive differential growth between geographical areas.

Globalisation and the increasing role of information technologies further accentuate the critical role of innovation in gaining comparative advantage and supporting economic growth. The gradual vanishing of man-made borders and the development of a global economy based on increasing levels of trade and flows of capital and resources has opened national and regional economies to new social and economic influences, introducing greater levels of competition between firms, countries, regions and cities (Storper, 1998). In the context of the European Union, this integration has advanced even further with the establishment of the single European market and the gradual abandoning of national barriers. The above processes are accentuated further by the development of information technologies and the Internet. Their advancement has strengthened the interconnection between economies, increased access to necessary/valuable information, allowed for new types of organisation of the production process and new forms of division of labour that modify regional and national frontiers (Castells and Hall, 1994). The contemporary multinational corporation has a had a key role in this process as they have gradually moved from centralized and home based innovation development towards network-based innovation development structures extending along interconnected affiliates in multiple locations (Cantwell and Iammarino,2003). They seek to tap into local knowledge to exploit local compeiences extend existing competencies or diversify into new fields. 'Through such networks, technology skills and assets are transferred from the parent firm to subsidiaries and the other way round' (Cantwell and Iammarino,2003:15).

In this increasingly integrated and interdependent world, a country's or region's comparative advantage is less and less linked with the capacity to allocate efficiently existing resources and use cost-reduction strategies and more and more with the capacity of their firms (the main agents of economic activity) and also of organisations and society to innovate (Komninos, 2002). The innovative firm, the firm that can constantly renew and improve its operations, products and services and access new markets, is regarded as the motor of economic growth. From the policy perspective it has thus become increasingly important for governments to understand the process of innovation creation and to take effective measures to foster it in order to encourage economic growth.

2.2.2 The innovation process – from the linear model to complex innovation networks

Innovation is an equivocal term as it refers to both the process and the final product. In its most common form, innovation refers to the transformation inside a firm or an organisation of products and services, methods of production or organisation processes. It also includes the use of new raw materials for the production of existing products or the opening of new previously unexploited markets (Komninos, 2002). Freeman (1991) distinguishes four types of innovation. Innovation may be incremental when it concerns the improvements/changes to an existing product, process or organisation form or radical when it refers to the development of new technologies or the creation of a completely new product. A third category refers to the changes to a whole technological system, affecting more that one sector of the economy and based on a combination of innovations across many firms which leads to the creation of whole new sectors. Finally, linked to the theory of the waves of economic development, innovation may bring changes to the techno-economic paradigm based on massive transformations that affect the whole of the economy and the way things are done. Such types of innovation are those associated with the use of steam power and electricity or, more recently, electronics and information technologies (Monck et al., 1988).

In all cases, the innovation process is not only the creation of a new idea, a new device or process, in other words, invention. The innovation process involves the use of these new ideas, sketches or devices and the organisation of the necessary resources to bring them into final use (Audretsch et al., 2002). In the economic sense, the expected final use refers to commercial exploitation (bringing into the marketplace) with the objective of creating economic value and exploiting market opportunities. The expected results for the firms can be to enhance their productivity and efficiency levels, strengthen their position in existing markets or access new ones. Increased competitiveness against their rivals, local, national and international, leads to higher level of sales and/or profits, higher levels of investment and, at least in the long run, new employment creation. Closely linked with the innovation process is also the concept of the entrepreneur as the actor, referring to the individual or the firm, that is able to recognise a market opportunity and to act upon this perception to move technology forward by organising all the necessary resources to turn invention into innovation (ibid.). In that respect, innovation may rely on inventions developed inside the firm, but may also be based on ideas, resources and technologies developed elsewhere. The adoption of existing inventions or innovations developed elsewhere becomes an important part/element of the innovation process.

Irrespective of the exact type, innovation depends more than any other economic activity on the creation and use of knowledge. While not the only source of knowledge, formal R&D and scientific activity is an important mechanism for the increase of firms' and individuals' existing stock of knowledge, scientific discovery and invention creation, all critical inputs to the innovation process. Furthermore, R&D activity and knowledge creation allow firms to interact with other organisations that hold relevant knowledge and to make decisions regarding the merits of other innovations or the need to purchase other technologies (Audretsch et al., 2002). It is thus clear that investment in formal R&D activity is an essential element in the creation of innovation.

But how does R&D effort transform into innovation? Up until the 1980s, the dominant model was that of a linear and direct link between the performance of R&D activity, the design and development of a new product or technical solution, and its introduction in the marketplace. It was a model that also fitted rather well with the dominant role of the research and development labs of large enterprises in the post-war period that was characterised by high shares of standardised products (mass consumption), large scale Fordist production systems and a clear separation between the invention, the production and the commercialisation process (Komninos, 2002). Researchers in R&D labs, largely isolated from the market and the other firms' departments, created new ideas and blueprints for new products that were then transferred to the production plants for production. In this context, public sector R&D activity, in universities or government research centres, was developed in order to address knowledge creation market failures linked to the uncertainty of its returns and the appropriability problems that discouraged firms from investing in such research. It also targeted, based on basic investigation, the opening of new areas of enquiry where research was considered too expensive and the expected returns small or slow to deliver (Audretsch et al., 2002).

This linear model, however, provides a limited view of the innovation process (Monck et al., 1988; Massey et al., 1992). In reality, innovation is a more complex process based on feedback and interaction among the different departments/units inside the firms, but also on their capacity to use external resources of information and knowledge coming from customers, suppliers, competing firms, knowledge creation or business services organisations. The innovation cycle does not necessary begin with formal R&D and is a much more chaotic process. Critical knowledge may come from the firms R&D departments, but in other cases it may be found in the production phase, in the marketing departments or reside outside the firm with the end-user (Von Hippel and Tyre, 1995) who knows best how products fail to meet his/her needs. "Learning by doing", "learning by using" and "learning by interacting" (Dosi, 1988) are all critical inputs in a process with a strong cumulative character that depends on previous accumulated knowledge and tends to develop along trajectories.

This interactive and evolving view of the process and the increasing importance of external resources are also linked with the emergence of new and more flexible forms of organisation of production. Beginning in the early 1970s, a new post-Fordist era emerged based on product differentiation and quality and a need to achieve faster rates of innovation. It is connected with the more prominent role of the small-sized and specialised firm, the vertical disintegration of large firms or their restructuring towards more flexible and autonomous units, the development of firms' networks and an increasing use of outsourcing and sub-contracting (Tödtling, 1995). What is also observed is a gradually increasing division of innovative labour supported from an increasing standardisation of parts of R&D activity (Howells, 1999; Arora et al., 2002).

Nowadays, innovation is seen as a process in which firms – small and large - need to be able to effectively combine internally developed knowledge with external sources. When knowledge is cumulative and specific to the products and processes of the firm and when learning plays a key role in future technological development, firms may decide to internalise the knowledge creation process through investment in their own R&D or other knowledge creation activity (Antonelli, 2003). In other cases, external sources may be preferred if internal development is too costly, too specialised or constrained in some other form from becoming part of a firm (Feldman, 1994). Such decisions vary among sectors, the type of technology and the stage in the life cycle of its development and are considered to be strategic decisions of each firm (Howells, 1999).

External sources may be universities that develop R&D activity and have a pool of skilled researchers, industrial R&D labs that specialise in relevant/complementary activities or producer services providers that offer specialised market, management and technical expertise. In some cases, firms participate in cooperation networks with other firms in similar or complementary sectors and with relevant research and technology organisations. These networks include multiple formal and informal interactions and assume a dynamic nature of learning-through-interacting (Freeman, 1991; Koschatzky, 2001; Pyka et al., 2003). They operate as mechanisms for inter-firm learning, exploration and exploitation of possible synergies in the pursuit of new opportunities and lead to the development of various forms of interdependencies among firms and organisations that create positive externalities and reduce the costs of innovation for each of them.

2.2.3 **Innovation and space**

The recognition of the increasing importance of linkages and cooperation with customers and suppliers and other external knowledge sources in a complex and uncertain process and the cumulative character of innovation gives space and location a particularly important role (Feldman, 1994). Indeed, one of the most evident features of the geography of innovation is the strong concentration of both R&D and innovation activities in a few areas/regions, such as Silicon Valley in California, Route 128 in Massachusetts, Cambridge in the UK, Ile-de France (Paris) in France, Baden-Württemberg and southern Bavaria in Germany. These areas represent “islands of innovation” (Komninos, 2002) and are surrounded by regions with low levels of innovation creation. These areas appear to provide a particularly supportive environment for the development and diffusion of technology and innovation.

The apparent spatial concentration of innovative activities is connected with a number of advantages of physical proximity. Industrial economists and geographers have focused on the role of knowledge flows among the different innovative actors and the presence of localised knowledge spillovers based on the spatial limitations in the diffusion of knowledge (Feldman, 1994; Audretsch, 1998). It is based primarily on the idea that, while some parts of knowledge can be codified and thus easily transferred across space, a significant part of knowledge is tacit and embedded in the individuals and firms that created it. Tacit knowledge is acquired by experience and interactive learning (Morgan, 2001) and requires face-to-face interaction. As a result, it cannot be easily transferred across space and it tends to be sticky and geographically immobile. Its role is particularly important in relation to activities in the initial stages of the creation of new products and processes where uncertainty is high and dominant designs and standards are absent (Smith, 2007). In that respect, the geographical concentration of firms and public research and technology organisations (PRTOs) provides advantages to the firms' own innovation process through the flow of knowledge and ideas and the transfer of technology (Muller, 2001). The idea of the importance of spatial proximity and of a spatial decay in the diffusion of knowledge is also supported by the empirical evidence provided by Jaffe (1989), Feldman (1994) and Acs et al. (2002) that identifies strong collocation between universities and industrial R&D labs and finds that it has a positive impact on patents and innovation creation. Similarly, the concentration of R&D labs in specific areas and the importance of regional specialisation in the innovation process has been highlighted by researchers (Malecki, 1980).

The above studies rarely offer an explanation of how and why these spillovers actually take place. This is usually left to the pure probability of contact between the economic actors, something that is expected to increase in a limited geographical space (Capello and Morrison, 2005). Regional economic theory provides additional elements in this respect. Industrial organisation, sociology and the network approach are brought together to explain the rise, growth and performance of specific regions. The spatial concentration/clustering of firms from the same or from different sectors is linked with a number of agglomeration benefits for the firms' operation and particularly for their innovative activity. They are based on the decreased costs of the sharing of resources and inputs and the benefits derived from the availability of a greater range of services and specialised suppliers, from access to a skilled labour pool with specialised expertise and knowledge and from the exchange of information through informal interaction among employees, through observation and comparison (Gordon and McCann, 2000; Malmberg and Maskell, 2001). These locations become particularly advantageous as they offer a combination of relevant/supportive inputs where greater levels of innovation can be achieved. It turn, such positive forces can attract new activities, bring along additional resources, allow an even greater specialisation and division of innovative labor and further support the creation of innovation. The limits to increasing concentration are linked to congestion, increased competition and higher input costs.

Economic sociology and the social-network model contribute to the theory of pure agglomeration by bringing forward the role that context-specific institutions play in the organisation of innovation activity and the transfer of knowledge. Concepts such as relational space (Camagni, 1995), embeddedness (Granovetter, 1985) and institutional thickness (Amin, 1995) refer to the types of relationships and the interdependencies built among firms, institutions and actors. The relational space integrates the various types of local relationships (market relationships, power relationships, cooperation) that stem from a sense of belonging and a developed capacity for cooperation. The strength of these relationships is described as the level of embeddedness. They are based on the presence, or emergence, of formal (regulation, agencies, associations) and informal (routines, conventions, norms and common language) institutions and mechanisms that support trust-based relationships, decrease opportunistic behaviours, increase risk-taking and support interaction, cooperation (Gordon and McCann, 2000) and collective learning processes (Capello and Fagian, 2005). Altogether, they constitute what Amin (1995) calls the "institutional thickness" of a place/region. Critically, there is no one single set of institutions and norms that is appropriate to support learning processes and innovation. These supportive conventions in success areas such as the Silicon Valley, the Third Italy or Baden-Wurttemberg are the result of different historical processes and ongoing collective actions. Furthermore, institutional thickness may support, but does not guarantee, the development of collective learning processes. Nor does this mean that regions cannot succeed in its absence; the M-4 corridor in South-East England is considered to be such an example (Amin and Thrift, 1995).

Based on the above ideas, a number of territorial innovation models such as innovative milieus, industrial districts, new industrial spaces, regional innovation systems and learning regions (Moulaert and Sekia, 2003) have been developed by scholars integrating, in different forms, physical proximity with the social, cultural and organisational parameters. The innovative milieu (Aydalot, 1986; Maillat, 1995) stresses the role of the environment and the relationships and synergies of the firms in related sectors. These relationships build a support space that is available to the firm as a deposit of supplies/inputs. For the milieu, the innovative firm is part of the local system and a product of it. The importance of the socio-economic community is also stressed in the industrial district model, although it goes further in the analysis of the trust relationships and the way the district "penalizes" agents who behave in an opportunistic way. The regional innovation system and the learning region models integrate more the evolutionary and cumulative nature of knowledge and the innovation process. Considered as a lower-scale offshoot of the national or sectoral innovation systems(Moulaert and Sekia, 2003), regional innovation systems (Cooke et al., 1997) focus more on the organisational part of the innovation process, the presence of different elements (R&D centres, technology transfer organisations, consultants, firms, financing institutes, education/training organisations, markets) in a region. The learning region model shares many common elements with the innovation systems literature although it places greater stress on the role of institutions and routines and their co-evolution with technology(Morgan, 1997).

Irrespective of the specific model adopted, the common element is that the innovation process is linked with the concentration of knowledge intensive activities and supportive institutions, mechanisms and relationships that create an environment favourable for process and product renewal. In each case, innovation emerges through different combinations of resources and support mechanisms (Komninos, 2002).

It should be noted, however, that the strong connection of innovation, space and physical proximity and a tendency to overemphasise the role of local linkages and interactions is questioned from a number of viewpoints, especially in relation to the link made between tacit knowledge and physical proximity (Bathelt et al., 2002). Tacit knowledge diffusion may be supported by spatial proximity and face-to-face interaction, but above all it requires that participants have the necessary relational (absorptive) capacity for cooperation (Cohen and Levinthal, 1990). Especially when it comes to knowledge-intensive activities and high-technology sectors, these knowledge exchanges tend to take place among communities of practice (Boschma, 2005) that can extend at broader scales based on scientific, professional, personal/friendship ties. Academic or professional networks and strategic partnerships among distant players/firms, so called pipelines (Smith, 2007), usually cross spatial boundaries.

There is also an apparent globalisation of innovative activity accelerated by the role of multinational companies (MNCs) and the increasing inrterdependence and interconnection among the units of MNC in multiple locations (Iammarino and Cantwell,2003). Archibugi and Iammarino (1999) identify different mechanisms through which innovations are produced and used from multinational firms in the global markets. Along with the traditional export of products or the establishment of production units in different countries to exploit innovations produced in their home base, MNCs transferred back to the parent company innovations developed by their affilitiates in different locations and apply them to other units of the firm. There is also documented increase of international techno-scientific collaborations among large and small firms and organisations in the same of different sectors (Archibugi and Iammarino, 1999; Hagedoorn et al., 2000;Arora et al., 2002).

Sectoral production and innovation systems (Carlsson and Jacobsson, 1997) span across regions and countries governed by standards and dominant technologies. Trust is substituted by formal agreements or built over time through a sequence of interactions (Bathelt et al., 2002) and the partners are selected based on routines that include reputation, associations or trade fairs or public sector mechanisms such as the EU R&D framework or Eureka programs (Caloghirou, et al., 2003). In order to facilitate the firms' learning and competitive advantage building, it is the access to global supply chains, markets and sources of knowledge that is more critical rather than the local environment (Simmie, 2004).

The compromise view suggests that the two types of linkages have complementary and mutually reinforcing roles (Bathelt et al., 2002). On the one side, technology standards that are essential for interaction among global players are usually developed in a few centres of innovation. On the other side, the innovative milieu actors are not limited to the local linkages and interactions, as knowledge created outside can provide an important input for the milieu's continuous renewal (Maillat, 1995). Local linkages that are too close or exclusive may lead to technological lock-in and stagnation (Gertler, 2003). Furthermore, while connections with external organisations may appear a-spatial in many cases, they serve as the mechanism to access broader milieux. Links with a company in Silicon Valley can be more important for the opportunity for further connections and networks than for the specific company's know-how itself (Capello and Faggian, 2005). Local collective learning processes and access to broader networks take place in parallel, bringing technological changes for firms and regions and supporting their comparative advantage.

2.2.4 Conclusion - from theory to policy

The links between knowledge, technology and innovation creation with economic growth, the recognition of the complex and cumulative character of the innovation process and the critical role of the external environment for the creation, operation and growth of innovation intensive firms have been the base for a number of policies (Komninos, 2002). Financial support – subsidies or tax cuts - for private R&D and the development of public research and technology centres attempt to address the appropriability problem of new knowledge creation and the limited resources of smaller firms. Promotion of innovation collaborations/networks, creation of technology transfer support mechanisms and intermediaries and producer services are mechanisms that should strengthen the local environment and promote knowledge flows and interactions with local and non-local firms. A third policy measure that received particular attention during the 1980s and 1990s in Europe and combined the concept of physical proximity with the creation of supportive technological infrastructures, targeting the emulation or recreation of technology districts and innovative milieux, was the establishment of Science and Technology parks.

2.3 Science and Technology Parks: structure, operation and expected results

2.3.1 Working definition

One of the most common problems that any researcher faces when examining Science and Technology Parks (STP) is the absence of a unanimously accepted definition of what a STP is. Multiple definitions proposed by scholars and practitioners reflect the different theoretical bases used, as well as the variety in the practical implementation of the general concept. Even more problematic for any analysis is the use of a range of terms/labels (e.g. Science Park, Technology Park, Research Park, Technopole or Technopolis, Innovation centre) that are generally rather interchangeable when describing similar structures (Amirahmadi and Saff, 1993).

The two most cited definitions are those provided by the United Kingdom Science Park Association (UKSPA) and the International Science Park Association (IASP). In its attempt to identify and differentiate its members from other property-based initiatives, UKSPA defined the Science Park as:

- a property based initiative;
- with formal operational links with a university, higher education institution or major centre of research;
- designed to encourage the formation and growth of knowledge-based business and other organisations, normally resident on site;
- with a management function that is actively engaged in fostering the transfer of technology and business skills to the organisations on site (UKSPA, 1996).

Being more focused on the management and organisational parameters of the STPs, the International Association of Science Parks defines a Science Park as:
"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, 2007).

While the above definitions use the term Science Park, IASP suggests that this can be replaced by "Technology Park", "Research Park" or "Technopole" and that the above provides a common denominator. Others scholars (Ondategui, 2001; Komninos, 2002; Kang, 2004; Hu et al., 2005) differentiate between the above labels, suggesting a range of possible typologies based, among others, on the type of infrastructures developed and the priority of specific types of activities from the tenants or services from the management team. In relation to the actual label they use, Research Parks usually focus on research and, in most cases, prohibit manufacturing, Science Parks have a greater share of development/prototype production activities, while Technology Parks are designed to accommodate firms engaged in the commercial application of high technology and include a greater range of activities from R&D to sales and services provision. In contrast to the previous two, there is a greater emphasis on commercial application and production. An Innovation Centre usually has as a prime objective the development and marketing of new technological products and services and the creation of new high-tech business and in most cases there is no distinct role for university and research units; thus, it does not fit with the previously provided definitions (Komninos, 2002). On the contrary, technology incubators, as distinct from business incubators, are usually linked to a university or research centre and focus on the creation of academic/research spin-offs (Aernouldt, 2004).

Furthermore, against the above clearly spatially defined and limited projects, terms such as "Technopole", "Science City" and "Technopolis" are also used to refer to the spatial concentration of technological activity without deliberate planning. Preer (1992) used "Technopolis" to describe whole regions (Silicon Valley, Route 128, Orange county in California, the M-4 corridor in the UK) that generate sustained and propulsive activity through the creation and commercialisation of new knowledge. Under the term "Technopole", Castells and Hall (1994) include both planned and unplanned concentrations of high-technology activity. Recently, Virtual Science and Technology Parks have been proposed based on the use of ICT for the provision of services and other functions of Technology Parks without the presence of a real/physical space, although possibly connected with one or more real STPs (Komninos,2002). Overall, it is clear that labels provide only partial guidance and a closer examination is always necessary to confirm the nature of activities developed.

In this study, the focus is on this subset of structures, labeled as Science and Technology Parks, that fulfill the following set of pre-conditions:

- they are spatially-defined property-based initiatives
- they are created by the public and/or private sector with the objective to construct a technology-intensive area
- they host or are formally linked with one or more public and/or private research and technology centres
- the have facilities created to host new and/or existing technology and knowledge based companies
- they have a dedicated management function responsible for the operation of the Park and the provision of support services to their tenants.

The above definition focuses on the characteristics that should separate STPs from business incubators, industrial parks and innovation centres – based on the presence of technology oriented activities and public research organisations. At the same time, it separates them from unplanned Technopoles with no clear physical/spatial limitations or from Virtual Parks that have no spatial element. However, it allows, at the same time, for variation in terms of the facilities developed and the focus/priority areas of activity.

2.3.2 The main elements of operation – structures and mechanisms

Following the theoretical model they are expected to replicate, STP operation is based on the parallel presence and development of two main elements, the physical/tangible element referring to the park property, infrastructures and the physical proximity, and the intangible element of organisation, coordination and support mechanisms.

2.3.2.1 Tangible elements – the physical space

The physical element of the STP is the visible and concrete basis of Science Parks and serves as the mechanism for the concentration of technology and related activities in a given location. It refers to the Parks' built environment that includes the plots for large firms, the office spaces for smaller establishments, the modular incubation facilities, the conference/meeting rooms and other common areas, along with the support infrastructures (sewage, electricity, gas, telecommunication systems) that address the operational needs of their tenants (UKSPA et al., 1990; Komninos, 1993).

In most STPs, low or medium density building requirements and other restrictions are set to ensure the creation of a quality and pleasant working environment, considered appropriate for the attraction of highly-skilled and high-wage employees (Komninos, 1993). The property element integrates flexible design and the high-tech architecture characteristics that create a high-tech image, along with common spaces structured to promote interaction and communication.

Not all Parks include all the above elements. Smaller Parks may be limited to the incubation spaces for small size firms next to a services provision area and a research and technology organization or university while larger ones cover sizeable areas with plots for large firms, offices spaces and other supportive amenities. Different STPs have different priorities (Komninos, 1993; EC, 1996). This does not change the common objective of creating knowledge and innovation intensive spaces aiming at supporting interaction, networking and innovation creation. Nor does it change the importance of the parallel development of the more intangible elements responsible for the organisation and coordination of the STP operation and the provision of support services.

2.3.2.2 Intangible elements – organisation, coordination and support mechanisms

While the hard property element is the visible part of the STPs, the intangible element is the most important part of their operation (Komninos, 1993; Nijkamp et al., 1994). It refers to the general management and organisation of the Park operation and the provision of advanced business, management and technical services for the Park tenants.

Park management involves basic services like the maintenance of common spaces and facilities, postal and security services that complement the Park infrastructure and its objective is efficient operation. The central provision from the Park management serves as a mechanism to achieve scale economies and cost-cutting for its tenants. Furthermore, they control important functions such as admission to the Parks and, in the case of incubators, graduation processes or the promotion/marketing of the Park for the attraction of firms and other organisations from outside. Maggioni (2002) suggests that the Park management functions secure the positive elements of the spatial concentration inside the Park, while preventing the over-exploitation of common resources as may happen in an non-organised innovative cluster.

However, the most critical functions concern those advanced services that focus on the development of networks, interactions and knowledge flows and the supporting of tenants' operations. Without being exhaustive, the commonly cited (Grayson, 1993; Komninos, 1993; Nijkamp et al., 1994; EC, 1996; Kelessidis et al., 1999; Westhead and Backstone, 1999; Komninos, 2002; Sanz, 2002; Guillermo, 2003) services involve:

- Technology and innovation-related information dissemination services
- Promotion/support of communication, networking and cooperation – both among the tenants as well as with other regional, national and international partners
- Management/business/marketing consultancy services
- So called real technology services (technology brokerage, audit, watch services)
- Support/advice in the areas of intellectual protection and property rights
- Training in technology and management issues
- Dedicated support mechanisms for new firms (start-ups, spin-offs) and creation (pre-incubation and incubation services)
- Provision of innovation financing (VC, seed fund) and/or support for access to other relevant organisations/schemes

The above services are developed internally from the STPs' management teams in some parks, but in other cases they come about through cooperation with technology transfer or innovation centres/agencies residing in the Park (e.g. PRTOs liaison and technology transfer offices, technology centres, business services centres) or are outsourced to specialised private firms. According to Mäki (2002), STP managers should focus only on those activities related to information dissemination, communication and a networking role and make sure that the remaining services are effectively supplied by others in order to address the tenants' needs.

Irrespective of who actually provides them, the intangible elements of the STP are responsible for "energising the technological environment of the STPs" (Komninos,1993:125). They constitute the organisation, coordination and Technopolitan culture development function (Benko, 2000) or the synergies-creation mechanism (Castells and Hall, 1994). In relation to the territorial innovation models, they are the mechanisms that support knowledge flows, synergies and innovation creation and are a substitute for the social linkages and trust relationships that develop during long, historical processes. Nijkamp (1994) sees the STP management as being the main element of the Park operation that creates a sense of unity and differentiates it from a simple industrial area.

In a fully operational Park, tangible and intangible elements are expected to function in a complementary manner. In the ideal successful STP a financial circuit would link the two (Komninos, 2002). Income from the sale and rent of facilities, based on the Park's profile and the agglomeration benefits, should be the source of support for the development and provision of advanced services that are costly and usually raise only limited income. Their provision, however, is what increases the Parks' attractiveness and its real-estate value, financing in turn their further development. "When equally developed they set in motion a process transforming the park to a quasi-technology district" (Komninos, 2002: 68).

2.3.3 **Science and Technology Park functions**

The presence/development of the STPs' tangible and intangible elements are expected to lead to functions and outcomes that represent the core of the STPs' operation and characterise any successful STP:

- attraction and establishment of knowledge-intensive and innovation oriented activities
- technology transfer and linkages between firms and public research and technology organisations (PRTOs)[2]

[2] The term Public Research and Technology Organisations (PRTOs) is used - unless explicitly stated- to refer to all public entities that conduct research – universities, government research and technology centres

- interaction, cooperation and synergies among firms
- creation of spin-offs and new high-tech firms (NTBFs)

These functions are strongly interrelated and they are all critical for the Parks' operation although, depending on the type of Park, they may be given greater or lesser priority.

2.3.3.1 Creating innovation intensive environments

The attraction of knowledge-intensive and innovation oriented firms and research organisations and their concentration in the Parks' space serves as the base for the creation of the STPs' innovation intensive environment and the starting-point for all other functions.

The location of public research organisations or universities, the institutional strengthening of the parks' space (Ondategui, 2001), is part of the initial stages of most STPs' development (Luger and Goldstein, 1991; Komninos, 1993) and can provide a vital input to the Parks' high-tech environment. In the case that they are not the promoters, PRTOs may be brought to the Parks to support them in response to political decisions from the government, as an opportunity to move to new upgraded premises with new facilities or as part of their strategy to open up more to the market and support a better understanding of market needs; hence, strengthening the relevance of their performed research (Charles and Howells, 1992). This may come from internal recognition of a need from the side of the academics, but also from the increasing external pressure for a greater contribution from universities to regional development (Smith, 2007). In the case of UK STPs, where universities are more often than not the main promoters, it has also been connected with significant cuts in direct funding by central government. The STPs were, in this case, linked with the potential to increase research contracts from industry, but also with opportunities for real-estate exploitation (Massey et al., 1992; Tsipouri, 1998b). Komninos (1993) suggests that the STP scheme provides a possible answer to the increasing need of PRO to link with industry and the market without, at the same time, losing its independence and its academic and training orientation.

Irrespective of the specific motivations, universities, particularly the research-oriented institutions, are connected to three important/critical tasks for the STPs (Castells and Hall, 1994). The first is the generation of basic and applied knowledge through R&D activity of both quality and quantity. The second is the provision of training and skilled graduates that can contribute to the Parks' labour pool. The third is the so-called entrepreneurial character, based on the active pursuit of the exploitation of research results and the development of necessary support structures and mechanisms such as technology transfer offices and services. Castells and Hall (1994) warn against government-controlled research organisations that have little interest or incentive to diffuse their research findings into industry and also against universities that are either simple teaching factories or do not support entrepreneurial activity.

As a general rule, an initial institutional phase should be followed by the business phase of the Park operation where private firms, both existing and new, local and non-local, move inside the Park's space (Komninos, 1993). In the institutional phase, local and non-local firms are likely to be attracted to the Park's space by the quality infrastructure, financial and other incentives, the convenient location, business support services or a marketing effect from the Park's high-tech profile. Access to specialised research equipment and other facilities necessary for the firms' R&D and innovation activity can operate as an incentive, especially in the case of small firms with limited internal resources. As the Parks evolve, the infrastructure- related attraction should be accompanied by the benefits of agglomeration and knowledge spillovers from the concentration of public and private sector activities (Koh et al., 2005).

The type of activities attracted by all STPs is a critical parameter and the analysis of the Park's tenants' characteristics is the focus of all STP studies (e.g. Monck et al., 1988; Massey et al., 1992; Westhead et al., 1994; Vedovello, 1997, 2000; Colombo and Delmastro, 2002). In general, the attracted firms are expected to have a highly-technological and innovative character, although this is not always straightforward. Park managers, in many cases, give priority to firms in the so-called high technology and knowledge-intensive sectors[3]. Aircraft/aerospace, information and communication technologies (ICT - hardware and software), electronics, pharmaceuticals, scientific instruments, biotechnology and technical/engineering services are nowadays considered to be the more advanced and knowledge-intensive sectors and tend to be preferred among STP promoters. Furthermore, some of them (especially ICT) are considered to be particularly important for the economy, as they provide technological inputs to most of the other sectors in the economy and have a broader innovation diffusion effect (Castells and Hall, 1994).

For the Parks and the development of the innovation intensive environment, the sectoral classification is not sufficient; the activity developed is seen as a more appropriate criterion. Organised research and development departments and labs are considered to be prototype tenants (Luger and Goldstein, 1991) but other activities in the product development process such as production design, testing or the development of software are also seen as suitable

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[3] OECD (2007) classifies industries as high, medium-high, medium-low and low-tech depending on their R&D intensity. Pavitt's (cited in Peneder, 2003) taxonomy and later extensions (ibid.) provide more elaborated analysis, bringing together elements related to the type of innovation performed (product/process), the sources of innovation and the means of appropriability.

for the Parks' space (Massey et al., 1992; Vedovello, 2000). Pure production, sales or administrative functions, on the contrary, do not fit the Park environment. It is thus important that the less knowledge-intensive activities are accompanied by knowledge and/or innovation creation functions.

In the Park evaluation literature, the high-tech character of tenants is examined through a combination of parameters such as the share of R&D personnel and expenditure, the occupational mix, the sophistication of the technology used/developed (leading edge or high-tech, new or existing in relation to the local or the international markets) or the actual outputs measured in terms of new products or patents (Monck et al., 1988; Massey et al., 1992; Westhead et al., 1994; Vedovello, 1997, 2000; Colombo and Delmastro, 2002). In many Parks, a minimum level of R&D or other innovation intensity indicators are explicitly defined as part of the admission criteria. The assessment of the innovative character of new entrants, and in many cases the relevance with other firms and the PRTOs in the Park, is an essential function of Park management.

The origin of the tenants, e.g. local firms or not, is linked to the promoters' development strategy. Large multinational firms are considered, in some cases, to be of particular value as they bring along external knowledge and technological resources and can enhance the Park's profile and prestige (Luger and Goldstein, 1991; Ylinenpaa, 2001). Nevertheless, again the main criterion is the technological and knowledge intensity of the activities attracted. Simple production, services provision or sales units (branch plants) with no upstream and higher knowledge intensity functions are an indication of weak application of the admission criteria and are considered a failure (Chorda, 1996).

2.3.3.2 Promoting technology transfer: research – industry linkages

The transfer of knowledge and technology from public research organisations and universities through the development of linkages with industry (thereafter R-I linkages) is seen by scholars (e.g. Massey et al., 1992; Komninos, 1993; Felsenstein, 1994; Vedovello, 1997) and policy makers (Landabaso, 1997) as a prime function/objective of any STP structure.

There are many different methods by which knowledge and technology can be transferred from public research organisations such as universities and research centres to industry. Charles and Howells' (1992) classification refers to research and technology links (collaboration to create new knowledge and use of facilities), information transfer (use of existing knowledge like licensing of patents or advisory services), movement of personnel (students or staff) and transfer of economic activities through the formation of new firms (spin-offs). In relation to the STPs in particular, Vedovello (1997) classifies linkages in three main categories: informal, human resources and formal linkages (see Table 2-1), reflecting also the possible different roles of STPs.

Table 2-1 - Linkages between firms and public research and technology organisations

Informal linkages
Personal contact with university and academic staff
Access to specialised literature, access to university department research
Attendance of seminars and conferences
Access to university equipment
Attendance at general education programmes.
Human resources linkages
Involvement of students in projects
Recruitment of graduates
Recruitment of scientists and engineers
Formally organised training
Formal linkages
Engagement of academic staff for consultancy
Analysis and testing in university department
Research contracts
Joint research

Source : Vedovello (1997)

The way that the STPs contribute to their own development is not always clearly defined and leads some scholars to refer to "the vagaries of spatial proximity and market forces" (Kominos, 2002:89). Some researchers (Komninos, 1993; Vedovello, 1997; Phillimore, 1999) suggest that it is primarily the informal and human capital connections that are expected to be promoted through the Parks' proximity, resulting primarily from the common use of Park facilities (libraries, meeting places) together with an element of serendipity in the interaction of skilled employees and researchers that may lead to knowledge exchanges. More formal interactions do not usually require such closeness and could equally be developed with other PRTOs outside the Park space. It is the presence of networking and intermediation mechanisms and the supportive financing tools that should induce this cooperation rather than physical proximity per se. Still, based on the relational proximity idea, it can be expected that the trust built through the informal linkages should pave the way for more advanced/formal types of interactions.

An important determining parameter for the development of linkages is the capacity of the tenants and their motivations for locating inside the Park. Firms /activities with increased innovative activity and absorptive capacity and high-quality PRTOs increase the probability for these linkages to actually take place. In some STPs, the managers attempt also to secure the development of this type of interaction by using pre-existing linkages or the relevance of firms' activities with the PRTOs as criteria for admission inside the Park space (Komninos, 1993).

2.3.3.3 Supporting firm cooperation: towards the creation of the innovative milieu

Inter-firm linkages represent the second type of interaction expected to take place inside the Parks' space (Komninos, 1993; Phillimore, 1999). The literature tends to focus on the innovation related partnerships and the evolved knowledge flows in order to assess the possible added-value from the STP location. More generally, the geographical concentration of firms may lead to a whole range of externalities that includes easier/cheaper access to relevant/complementary inputs and specialised services inside the Park space, increased information flows coming from the exchange of skilled labour, exchange of information through the interaction of firms' employees in the restaurants and cafeterias of the Park or the observation and monitoring of the neighbouring firms' activities. The development of information diffusion tools (printed or electronic) and the organisation of meetings among Park tenants by the Parks' managers are mechanisms to foster such types of exchanges. The larger the size of the Park and the greater the number of the tenants, the more probable the opportunities. In that respect, there is also a minimum critical mass and the need for admission policies to focus on complementary activity areas (Komninos, 1993).

More formal types of cooperation such as joint participation in R&D and product development projects, the development of joint ventures, subcontracting agreements or participation in technology networks are also seen as part of the STPs' role (Komninos, 1993; Phillimore, 1999). Again, such linkages do not rely on the proximity element, although the concentration of innovation-intensive firms and the informal interactions between them play a supportive role in their development. More critical though is the role of the STPs' management networking and technology transfer support mechanisms, the liaison function of the management team, that identifies such opportunities, matches tenants and solves possible obstacles such as the costs of coordination, limited experience, intellectual property management or issues of trust. The STPs' role in this respect is as a skilled and honest broker (Gibb, 2007).

At the same time, though, the operation of the Parks is also expected to support the access and integration of their tenants to broader business and technology networks; in some STPs this applies to the local firms more generally (Komninos, 2002). The Parks' high-tech profile can, by itself, serve as a promotion/marketing asset for their tenants when seeking or attracting non-local business and technology partners. More formally, though, the integration/participation of the Park in national and European business and technology support networks and the development of partnerships with other Parks can play this role. The presence of brokering mechanisms has, in this respect, an important role especially for small firms with limited own capacity and resources to develop own networking structures.

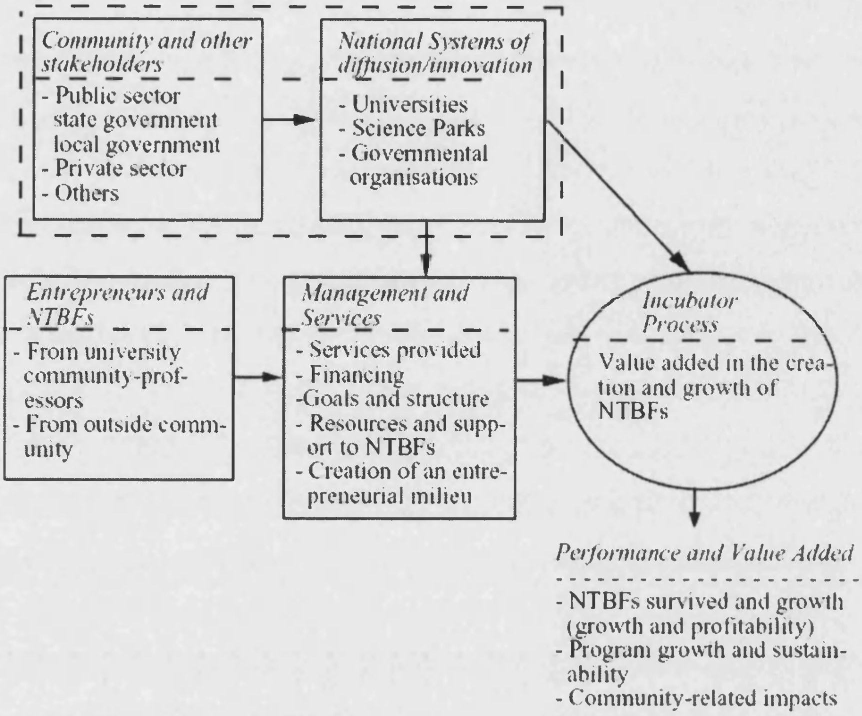
For all types of linkages and networking mentioned, but especially those related to knowledge exchange, the tenants' characteristics and interest is a clear precondition. As suggested by Cohen and Levithal (1990), own innovation intensity means increased absorptive capacity and thus increased opportunities for cooperation and a greater capacity to exploit external knowledge sources. The size and origin (local or non-local) of the firms can also play an important role. Large firms and non-local subsidiary units may serve a connector/gatekeeper role in the hub and spoke type of networks (Gibb, 2007) between the Park and other local tenants, for example, the case of Nokia in Oulu Tecnopolis (Ylinenpaa, 2001). However, they may equally remain completely uninterested in interaction, either due to the need to protect intellectual property and avoid knowledge spillovers, or as a result of organisation structures that do not favour advanced local interactions such as that documented for a long time in Sophia-Antipolis (Castells and Hall, 1994; Longhi, 1999). Small specialised firms have a much higher propensity (and need) for access to external resources and technological networking, but they also have fewer resources and a lower capacity to develop and manage them. They thus have a greater need for active forms of support.

When the STPs' physical proximity, networking support mechanisms and strong public and private knowledge and innovation come together through informal and formal linkages, STPs should transform into innovation and synergy intensive environments that support the firms' innovative activities. It is not an instantaneous process. In the case of Sophia-Antipolis, it took more than 25 years before such processes actually developed (Longhi, 1999) and required the managers to play a planning and coordination role (Castells and Hall,1994). When they develop, agglomerations forces and knowledge spillovers embed non-local firms inside the Park and the region, bring additional firms and entrepreneurs to the space and lead to the creation of new firms that support the Parks' physical expansion. This last part is also critical for the Parks' self-renewal and longer term growth (Koh et al., 2005).

2.3.3.4 NTBFs and the parks' incubation function

Strongly related to the technology transfer processes, new high-technology based firms (NTBFs) and the Parks' incubation function are given particular attention in a large part of the relevant literature (Monck et al., 1988; Westhead et al., 1994; Storey and Tether, 1998; Löfsten and Lindelöf, 2002; Ferguson and Olofsson, 2004). For the so-called incubation-led (Ylinenpaa, 2001) or technology-led (Kelessidis et al., 1999) Parks developed around universities and research centres, they are the priority objectives integrating the promotion of entrepreneurship with the exploitation of public research results, knowledge and technology transfer and innovation diffusion to the market.

Following Phan (2005:7), the STPs' incubation function may be summarised as "the provision of the social environment, technological and organizational resources, and managerial expertise for the transformation of a technology-based business idea into an efficient economic organization". A large part of the related literature focuses on the "added-value" that the STPs are expected to bring to the survival and growth of new technology based start-ups and spin-offs (Mian, 1996; Westhead and Batstone, 1998; Westhead and Backstone, 1999; Siegel, et al., 2001; Colombo and Delmastro, 2002; Löfsten and Lindelöf, 2002). Usually adopting a resource-based view of the firm, the STPs' added-value is linked to the provision of the necessary resources (infrastructures, capital and access to the park innovation milieu) and the related management and marketing services that will support their survival and growth (Figure 2-1).



Source : Löfsten and Lindelof (2001)

Figure 2-1: STPs and the incubation process

STPs and technology incubators with flexible office space and specialised lab infrastructures next to the PRTOs are seen as the natural home of university spin-offs, providing a convenient location halfway between the academic and the outside world (Charles and Howells, 1992). Infrastructure is only one part of the incubation function. Business mentoring is particularly highlighted in relation to the creation of academic spin-offs which are expected to have limited market and management experience (Ferguson and Olofsson, 2004). The presence of the STP scientific base and the complementary activities of the other firms within the Park can bring positive externalities and support networking (Bollingtoft and Ulhoi, 2005). Support towards access to markets and customers is even more critical for this type of firm, given their limited access to distribution networks and the liability of their newness. The prestige of the Park and the screening process may thus provide legitimacy to new firms and operate as a positive social signalling mechanism (Ferguson and Olofsson, 2004).

Above all, though, access to flexible forms of capital is considered to be the most critical element (Aernouldt, 2004), particularly in relation to equity type schemes (venture capital, seed funds) that also bring about pro-active and growth oriented strategies (Lindelöf and Löfsten, 2006). The STPs are connected with the correction of a market failure that comes from the absence of a track record and the high-risk character of many NTBFs (Colombo and Delmastro, 2002). Development of own venture capital schemes linked with the location in the Park's incubators is an indicator of a strong/advanced incubation function (Kelessidis et al., 1999), although, in less than 10% of the existing schemes in 2002 in Europe, the management team itself took an equity position (EC, 2002). Other public/private sources of finance such as R&D grants and subsidy schemes of EU programmes may still provide answers to the limitations that new firms face (Oakey and Mukhtar, 1999; Siegel et al., 2001).

From the perspective of the STPs' operation, the incubation function extends also to the stages prior to the decision to create a new firm. It includes mechanisms for the identification and selection of new ideas from the PRTOs research pool or the broader community (e.g. liaison office procedures such as invention disclosure) and the provision of training support and the necessary confidence to embark in a new venture creation for interested researchers, students and individuals with information (Phan et al., 2005). It concerns also the promotion of risk-taking and opportunity-exploiting attitudes among individuals based on the promotion of success stories or training. STPs cannot be expected to change dominant cultures, but can act to increase the perceived opportunities and to address/weaken some of the disincentives posed by the firms' environment.

A rather unclear issue in the relevant literature is the definition of success in relation to the STPs' incubation function. The survival of new firms has been used in some cases as the main measure (Ferguson and Olofsson, 2004). There is, however, an argument that life support is an indication of failure, since incubators are a-priori designed to maintain or increase life span (Phan et al., 2005). According to Aernoudt (2004), the STPs' incubation function should be to target the creation of high-growth oriented technology based firms. "Gazelle" or "antelope" firms[4] are proposed as the prototype firm coming out of the STP incubation process. Other studies focus on sales and employment growth as the main indicator (Löfsten and Lindelöf, 2001; Colombo and Delmastro, 2002; Löfsten and Lindelöf, 2002). Furthermore, while the firms' founders often focus on sales growth and profitability as the prime objectives, the parks' promoters may focus more on the total number of new firms created and the number of new technologies exploited from these firms, in which case their survival is – from their side - of greater priority.

The above considerations are connected with the admission and graduation policies applied by STPs. Independent of the support provided by the STP, the type of technology/knowledge involved, the skills and motivations of the founders and the broader business/market prospects are strong determinants of possible future success (Monck et al., 1988; Westhead, 1997; Colombo and Delmastro, 2002). Pirnay (2003) suggests a linkage of

[4] Two definitions for 'gazelle' firm are provided: a firm that has reached a total of ten employees after two years of operation or the firms up to five years old with more than 20% sales growth for three consecutive years. An 'antelope' firm is a new firm that reaches a total of 20 employees after five years of operation (Cieslik, 2007).

the technology/knowledge involved (tacit or codified) and the activity type (product or service) oriented with the firms' market scope, growth prospects and capacity to access finance. Firms based on tacit knowledge are connected with low profitability focus, no growth orientation and limited willingness and no need/desire to use external finance and share ownership: what is sometimes called a lifestyle type firm. Admission policies of STPs may target specific type of firms that are considered of high-growth prospects or a high-risk/high-return profile. Clarysse (2005) identified a wide range of incubation strategies of various European PRTOs that led to different outcomes in terms of the numbers of spin-offs and the growth prospects. Graduation policies based on gradually increasing rent schemes, maximum periods of operation, assessment of the growth prospects and the actual need for the Park support are often used to secure a high level of firms' turnover and to avoid transforming the incubators' purpose into life support mechanisms (Bergek and Norrman, 2007).

It should also be noted that, while university and research spin-offs or independent start-ups are the focus of STPs' promoters and of most of the STP literature, corporate spin-offs can also play an important role in the creation and growth of new firms (Löfsten and Lindelof, 2005). Corporate spin-offs may be created from the parent firms as a result of restructuring or diversification processes, as a result of joint ventures with other firms or from employees leaving the parent company to exploit under-utilised ideas (Tübke, 2004). As such projects usually count on the support of the parent firms, the STPs' incubation support is less necessary. There is evidence that such spin-offs tend to have higher growth rates than the academic ones (Löfsten and Lindelof, 2005). From the Parks' perspective, though, their creation is a strong indicator of synergies developing among the tenants and the dynamism of the Park and offers support for its renewal and growth(Koh et al., 2005).

2.3.4 STPs and regional development

STPs are above all, however, regional development projects (at least, those promoted from the public sector are) and their promoters link their creation to a number of objectives. These include the strengthening of the technological and innovative capacity of local industry, the promotion of a culture of entrepreneurship and the creation of new firms and a greater level of exploitation of the public sector research activity (Luger and Goldstein, 1991; Massey et al., 1992). Is also linked with the re-branding of regions and the improvement of their image/profile in an attempt to attract new, higher value activities (Massey et al., 1992; Shearmur and Doloreux, 2000). Employment creation in general, especially in highly-skilled jobs, and the strengthening of regional economies' new and high-tech sector activities are also common expected benefits in the long term. In their most ambitious form, the STPs are the starting point for the transformation of a regions' production and innovation system, as suggested to be the case for Research Triangle Park in North Carolina in the USA or for ZIRST Technopole in Grenoble, France (Sternberg, 1996).

Following Luger and Golstein (1991), there are two main theoretical bases used to examine the mechanisms through which STPs support regional development[5]. The first sees Parks as growth poles where development is based on an uneven concentration of innovative activity and its subsequent diffusion. The second examines them as mechanisms promoting and strengthening the existing indigenous capacity through the exploitation of existing local resources. Connected with the second base is also the approach that is derived from the territorial innovation model. The STPs are depicted as mechanisms that serve as

[5] In their book "Technology in the Garden" Luger and Goldstein use the term 'Research Parks', referring also to Science and Technology Parks.

institutional thickening of the respective regional systems (Landabaso, 1997; Cooke, 2001; Capello and Morrison, 2005) to which they represent indispensable elements.

2.3.4.1 STPs and their role as regional growth poles

The growth pole view of the STP focuses on the attraction and operation of so called propulsive activities inside the Parks' space which can, through backward and forward linkages with the broader economy and through the development of agglomeration forces, diffuse innovative and economic activity from the centre (the park) outwards (Luger and Goldstein, 1991).

Originally formulated by Perroux (1955), the growth pole theory suggests that investments in specific critical propulsive industries should induce growth through the formation of backward and forward linkages with the remaining economy. These propulsive industries are characterised by fast growth and an increase of their activity can affect the economy through linkages with the remaining sectors. Perroux' proposal was, however, a theory of economic growth and had no geographical/spatial reference. In later revisions of the theory in the 60s and 70s, scholars (e.g. Kuklinski, 1972) gave the pole a more spatial character by proposing that it represents the developing urban centres where economic activity is concentrated and from where growth will be diffused to the periphery.

STPs are suggested as a revitalisation of the growth pole theory applied in a more modern form (Benko, 2000). The large branch plants of the 1960s and 70s are replaced by the STP innovation pole and the propulsive industries are specific high-tech sectors and/or activities with potential impact on the broader economy. They refer to ICT, electronics or biotechnology, but also other R&D activities and functions in high or low-tech industries that are the targets of the STPs (Luger and Goldstein,1991). The impact of the technology diffusion and growth pole on the broader regions is expected to take place through expansion of the existing local firms based on backward and forward linkages, through new business formation in similar or complementary knowledge-intensive sectors seeking to exploit increasing demand and market opportunities, or through the attraction of outside firms seeking to take advantage of agglomeration forces and synergies. Additional secondary economic impact is also expected through income multiplier effects from the expenditures of employees of the poles' firms. The region is likely to experience a net increase in general employment and economic activity, particularly in the more advanced/high-tech sectors. The final result is the restructuring/diversification of new economy sectors and the diffusion of technology innovation through the supply chain.

The effectiveness of the STPs as growth poles rests on the assumption of a trickling down (spread) effect that depends on the type of activities developed inside the Park. While the theory itself does not provide any guidance, Luger and Goldstein (1991) suggest that the growth pole activities should be in those technology areas/sectors that should lead to the greatest multiplier and agglomeration effects for each region; they are thus context specific.

Origin, local or non-local, is an important issue in relation to the STPs' growth pole creation. The growth pole approach has been linked with exogenous development strategies which, in the case of STPs, are translated to non-local origin (national and multinational) R&D or other knowledge-intensive production and services activities (Luger and Goldstein, 1991). In this respect, STPs are connected with attempts to attract foreign direct investment and restructuring/diversification policies, focusing on high value-added sectors (Castells and Hall,1994). Luger and Goldstein (1991) indicate, however, that there is no reason why a growth pole strategy cannot be based on local-origin firms and activities. What is critical is the presence of quality and quantity in such activities so that they generate levels of demand that reach the threshold to develop the expected linkages and agglomeration forces (Luger and Golstein, 1991:18).

2.3.4.2 STPs as mechanisms for supporting indigenous capacity

Against the growth pole view/approach, Luger and Goldstein (1991) suggest that STPs' development strategy may also focus on strengthening and exploiting the existing indigenous sources.

In this case, the role of the Parks is to promote entrepreneurship and support the creation of new firms. The expected contribution to the regional economy is not employment creation or the possible multiplier effects. Few NTBFs reach a size substantial enough to have such a sizeable impact on the economy. More important is the expected technological dynamism of NTBFs: their capacity to identify new technologies and business opportunities and the entrepreneurial drive to bring them to the market (Fontes and Coombs, 2001). They serve as a technology transfer and strengthening function for the economy by using knowledge and technology developed internally or by adopting technology acquired from external sources. They may also hold a Schumpeterian creative destruction role by challenging established companies and existing technologies and strengthening the level of competition in the market. Entrepreneurialism and entrepreneurial capital, the opportunity-seeking attitude and the willingness to make profits through risk-taking, are important assets to a region's economic growth (Armstrong, 2000). An STP's success is linked not only to the actual number of NTBFs created, but also to their role as demonstration projects supporting a change towards a more positive attitude towards risk-based entrepreneurship (Monck et al., 1988).

According to Luger and Goldstein (1991), the STP's success depends on the presence of a significant local knowledge base from where new ideas and entrepreneurial projects can develop. It is also linked to the presence of economic conditions and technology oriented markets supporting the growth of the start-ups. Access to markets and customers at broader special scales can also support the NTBFs growth. Again, the question from the regional development perspective is the extent to which they will be linked with the local economy to bring about any of the above described benefits.

The Parks' indigenous support role goes beyond the NTBFs' creation and includes the intangible support mechanisms developed in the Parks that can serve beyond the limited Park space. By exploiting the presence of a supportive internal base and/or access to public funds that the local producer services firms may not have the capacity to develop (Komninos, 2002; Smedlund, 2005), the Parks' real technology and networking services may extend beyond the Parks' space. They should support the local firms' capacity to participate in technology networks and access to knowledge, develop their own R&D activity or adopt technologies and knowledge developed elsewhere, strengthening their innovative capacity and increasing their productivity levels (Hassink, 1996).

2.3.4.3 STPs' role in the regions' innovation systems

Beyond the endogenous versus exogenous dichotomy of the two views, STPs are in many instances referred to as potential key mechanisms in the operation of the regional innovation systems. Landabaso (1997) refers to Parks as interfaces between the local demand for technology and its supply: local or external. The tenants' operations and the linkages developed make the process of innovation more coherent and integrated and their linkages with industry support its transfer and diffusion. Capello and Morrison (2005) refer to STPs as networking agents, intermediaries or brokers that support collective learning processes. The focus is mainly on the STPs' intangible mechanisms and processes and the promotion of the tenants' and local firms' local and non-local linkages. Coordination of local cooperation networks and integration of knowledge and technology from outside through networking with other STPs and organisations are functions that strengthen the regional institutional base (Cooke, 2001). Based on the increasing presense and role of global technological collaborations in the creation of innovation, Acrhibugi and Iammarino (1999) refer to STPs as infrastructures to support techno-collaborations and the participation of local firms into this form of international cooperation which leads to learning and innovation.

Finally, STPs are linked to the formation of regional governance structures, the building of public-private partnerships and broader coalitions that are critical in the effective operation of innovation systems (Geenhuizen and Soetanto,2008; Komninos, 1993). The projects are high-profile, their connection with technology and innovation based development strategies are of regional relevance and the possible participation of almost all relevant public and private actors can serve as platforms for the formation of broader coalitions. The STPs' creation and operation is seen as an opportunity for the adoption of associative, consultative and inclusive governance and policy approaches based on the simultaneous presence of public governments, universities and the private sector (industry) in the Parks' management teams.

2.3.4.4 Converging development models

STPs' role and impact on regions' economic and technological development can take place through various pathways and mechanisms. The growth pole innovation diffusion role and an indigenous support role strengthen the regional innovation system and reflect regional development theories that focus on different mechanisms of the Parks' operation; however, this is only a schematic dichotomy. In most Parks, the diffusion function through the backward and forward linkages goes hand-in-hand with the promotion of entrepreneurship activities and the strengthening of local firms' technological capacity. NTBFs can serve as the linkage and diffusion mechanism between the foreign firms and the local economy, while the strengthening of the local firms' capacity or the development of support services to form a more institutionally thick environment represent important attraction parameters for foreign firms. While Parks usually start by focusing on one strategy, as they evolve they tend to pursue them all. The large French STPs focused initially on the attraction of high-tech activities created after some time, incubators and support services to assist local indigenous capacity (Longhi, 1999). Many UK incubation and technology-transfer focused Science Parks moved towards larger establishments to attract non-local high tech firms (Komninos,1993). From the regional development perspective, what is important is the extent to which the high-tech activities that should operate and develop inside the STPs, irrespective of their origin, become integrated into the broader regional environment, diffuse the developed knowledge, technology and innovation and strengthen the operation of the regional innovation system.

2.4 Empirical evidence and criticism of the STP

Against the theoretical propositions linked to the STPs' operation and the objectives stated by policy makers and Park promoters, a constantly increasing empirical body of literature has attempted to test some of the assumptions of the STP model and assess the Parks' actual added value. Single STP case studies combining qualitative and quantitative data, comparative analyses of two or more STPs with different Park structures and cross-section analyses from a large population of STPs based on broadly available data or surveys have been used by researchers. Firm-level studies (micro level) examine the added-value derived from operating in a Park. Studies focusing on STPs (meso level) examine their viability and growth and whether they have achieved the objectives set by the promoters. Regional level (macro) assessments focus on the broader impact on the region. In relation to their location, studies following the advancement of STPs in developed countries and advanced economies (primarily the United States and Western Europe) represent the majority, although increasingly there is work on less developed countries and regions.

This body of literature is reviewed here (see also the summary table in Appendix 1 – STPs evaluation literature), focusing on the STPs' proposed functions and regional development role. The objective is to shed light on the actual results of the STP model, against the general hypotheses, to identify points of criticism of the STP model and to discuss methodological issues related to the analysis and evaluation of STPs.

2.4.1 STPs' technological and innovation intensity

The actual high-tech character of the the STPs and their residents was one of the first criteria used to examine whether STPs actually respond to their described model. Workforce quality (levels of education), types of activities developed inside the Park, R&D inputs and subjective assessments of the developed technology's cutting-edge character are used to scan the activities developed in the STPs. In many studies, the benchmark used is off-park firms in similar sectors. The majority of the existing literature (Monck et al., 1988;

Massey et al., 1992;Westhead, 1997; Colombo and Delmastro, 2002) supports a general high-technology character of the STPs firms, based on a combination of high-tech sectors, focus on more advanced functions, higher than average skilled employees and R&D expenditure levels. It is suggested, however, that rather than representing leading-edge or state-of the-art activities, STP firms are more often innovation adopters or incremental innovators (Monck et al., 1988; Massey et al., 1992). What is also less evident, when other parameters are controlled for, is the presence of higher-than-average levels of innovative activity, counted either as patent applications or as new product launches (Monck et al., 1988; Westhead et al., 1994; Löfsten and Lindelöf, 2001; Löfsten and Lindelof, 2005). The conclusion reached by Massey et al. (1992) is that only a minority of firms fulfil the expectations generated by the popular conceptualisation of STPs.

While the majority of the studies focus on the NTBFs, there is less evidence on the activities of the non-local origin subsidiary units. In the high-profile cases of Sophia-Antipolis, Hsinchu Science-based Industrial Park (Castells and Hall, 1994), Cambridge Science Park (Massey et al., 1992) or Research Triangle park (Luger and Goldstein, 1991), non-local (mainly national) firms present the majority of tenants and appear to abide by a high-level benchmark with high-shares of R&D activity. The study of the French Technopoles from Chorda (1996) suggests that, with few exceptions, the majority of the Parks have not managed to attract many firms with knowledge intensive activities and have, in many cases, relaxed their criteria by accepting firms with no real R&D activity. In the Singapore Science Park, less than 40% had some type of R&D activity inside the Park (Phillips and Yeung, 2003) with many more being simple sales or production units. Local origin firms were, on average, more active. As suggested by Chorda(1996), not many multinationals are interested in creating off-shore R&D units. In a constantly increasing population of STPs and offered space, it becomes more and more difficult to base the Parks' high-tech foundation on such a strategy.

2.4.2 Supporting technology transfer, networks and synergies

Much greater criticism of the STP model comes, however, in relation to the development of linkages and technological cooperation. Technology transfer from PRTOs to Park firms has been the element most often examined, while recent studies have also looked into inter-firm networks. In some cases, the role of the Parks' tangible and intangible mechanisms was explicitly assessed through tenants' surveys, while in others it was derived through the comparison with off-park tenants.

Among the identified studies, only Lindelöf and Löfsten (2004) and Löfsten and Lindelöf (2002) in Sweden and Colombo and Delmastro (2002) in Italy provide positive conclusions in relation to the development of R-I linkages. On the contrary, the broadly cited work of Massey et al. (1992) in the UK science Parks identifies only limited formal linkages which are based on pre-existing linkages and offer no indication of the STP location playing any role. Prior personal or professional relationships appear to be behind such linkages rather than Park proximity or its support structures. Monck et al.'s study (1988) of park firms , comparing with an a similar off-park sample of firms , also did not identify a higher level of connection with the Park PRTOs for the Park tenants. Concerning formal linkages, the studies of Van Dierdonck and Debackere (1991) on a group of Belgian and Dutch Parks and of Phillimore (1999) in Australia reveal that Parks' firms tend to have more connections with non-park PRTOs and conclude that the Park's location does not play any particular role in the development of such linkages. Some studies (Westhead et al., 1994; Vedovello, 2000) point out that, while formal links were not particularly developed, informal personal and information related connections were indeed more common. What was questioned, though, was the actual role of the Parks' managers and the other intangible mechanisms in supporting formal cooperation.

Less extensive has been the analysis of inter-firm connections and the STPs' role. The scholars that have looked into this part of the STP operation (Longhi and Quere, 1997; Phillimore, 1999; Bakouros et al., 2002; Mäki, 2002) offer even less supportive evidence. Linkages between firms are rather uncommon, with most of them focusing on external linkages and seeing limited scope for cooperation. Joseph (1989) also points to the negative attitude of non-local firms, which are mainly interested in the Parks' property dimension or, as found in Sophia-Antipolis (Castells and Hall, 1994; Longhi, 1999), wish to protect their intellectual property rights. Johannisson's (1994) comparison of Ideon Science Park with Anderstorp Industrial District (Sweden) sheds light on the capacity of STPs to reproduce the social ties and synergies of Industrial Districts. Their conclusion was that Park-based firms did not develop social linkages and the connections were of an ad-hoc character. Entrepreneurs and small firms approached their location as a "shopping mall" of competences and services, while the bigger firms communicate and connect even less, as they do not see the need for most of the specialised services. While the above results are not negative in terms of the presence of some form of added-value, they reveal that the development of the "Technopolitan culture" is a much more difficult, if not at all feasible, task.

In most of the above studies, there is a clear difficulty in identifying the actual contribution of the STPs in the development of linkages, knowledge and technology transfer. Physical proximity appeared in very few cases to be particularly relevant, especially in relation to more formal types of linkages which were either absent or developed in parallel in multiple directions driven by parameters related to firms' characteristics and relational proximity. When relevant and competent tenants are indeed present, linkages will develop inside the Park as they would develop outside and there is nothing particularly special about the Parks' location (Van Dierdonck et al., 1991). What is also clearly shown is the failure of many Parks' intangible mechanisms to promote coordination and networking. Most studies (Monck et al., 1988; Hauschildt and Steinkuhler, 1994; Mäki, 2002; Chan and Lau, 2005) show that large numbers of firms are either indifferent (they do not use them or do not know they exist) or unsatisfied with the quality of the services and the expertise of the management teams.

Overall, the existing evidence casts doubt on the STPs' technology transfer and linkages promotion role. Adopting a positive view, Komninos (Komninos,1993; 2002) proposes that the necessary intangible coordination support mechanisms are not properly developed. More critical views suggest that the STPs model is rather obsolete or irrelevant in a period where linkages and interfaces at multiple scales are necessary and where information and communication technologies ease connections and interaction (Van Dierdonck et al., 1991). What remains for the Parks is their high profile address and possible economies of scale in the development and/or use of some supportive/relevant inputs and services.

2.4.3 NTBFs creation and the Parks' "added-value"

Similar to the development of Parks' linkages, and in most cases strongly linked with that, has been the assessment of the STPs' supportive role in the creation and growth of NTBFs. The typical approach to identify the STPs' added-value is to examine the NTBFs' survival rates and employment, sales and profitability growth (Monck et al., 1988; Westhead et al., 1994; Löfsten and Lindelöf, 2001; Colombo and Delmastro, 2002; Ferguson and Olofsson, 2004) in comparison to similar profile off-park firms in order identify the additional effect of the STPs. A number of studies also look into the STPs' innovation creation supportive role and examine the firms' R&D productivity, namely the transformation of R&D inputs into outputs such as patents or new product launches (Monck et al., 1988; Felsenstein, 1994; Löfsten and Lindelöf, 2001; Siegel et al., 2003).

The results confirm the STPs' location has a positive role in firms' survival, but much fewer studies show a real contribution in achieving higher than average growth rates or innovation performance. These depend, in all cases, much more on the firms' own characteristics i.e. the founders' skills, work experience and general proactive character (Felsenstein, 1994; Colombo and Delmastro, 2002). When controlling for these elements, on-park and off-park samples are rarely found to be significantly different. The added-value of the Parks is most often associated with the real-estate element (facilities and quality infrastructure) and/or the image/profile of the Parks' address (Ferguson and Olofsson, 2004). Intangible elements such as support services or proximity to other firms and PRTOs are not often mentioned (Westhead and Batstone, 1998) and the idea that the Parks are seedbeds of creativity and entrepreneurship is not supported. On the contrary, the combination of higher than average skills among the Parks' tenants and the priority given to the Park profile led Felsenstein (1994) to conclude that STPs operate more as enclaves of innovative activity. They attract skilled entrepreneurs to their space based on the prestige element, but do not add to their innovative performance nor to the development of linkages.

2.4.4 STPs and regional development

Against the rather wide range of studies examining the STPs' internal space and their added-value to their tenants, a smaller part of the literature examines the STPs' impact on regional development. Few scholars have used cross-section analyses to examine the possible connection between the presence of an STP in a region with regional development. Luger and Goldstein (1991) examine general employment creation at a U.S. county level, Doloreux (2002) and Mcdonald (2004) focus on high-tech employment creation, Appold (2004) on the attraction of R&D labs and Wallsten (2003) on the attraction of venture capital as a proxy for the promotion of entrepreneurship. All these studies conclude against any causal linkage between the presence of a Park and growth in any of the above indicators. On the contrary, they suggest a strong selection bias. STPs develop and succeed in areas with increased levels of high-tech activity, rather than play a role in their creation.

In parallel, detailed case studies have attempted to quantify the economic impact of STPs in specific regions. Luger and Goldstein's (1991) study followed the traditional evaluation scheme for spatial investments focusing on direct, indirect and derived impacts. Positive employment impacts were found to depend on the size of the Park itself and on the type of activities. Given the focus of the Research Triangle Park in North Carolina on non-local firms, the net economic and employment effect was sizeable (over 24% of total new employment created in 40 years). In the incubation-led Utah Park, the economic and employment effects were smaller (1.8% of total new employment created in 20 years) as most of the Park's firms/entrepreneurs were of local origin and would operate in the region even without the Park. In both cases, though, beyond the immediate space surrounding the Park, the impacts at broader levels were still limited (Luger and Goldstein, 1991). Luger and Goldstein (1991) also` give limited information on the type of linkages developed between the Parks' tenants and the broader regional environment, an element critical to the operation of Parks as growth poles and/or innovation diffusion mechanisms.

Other available studies show a case-specific character of the STP projects. Shin (2000) refers to a successful case in Korea (STP of Taejon) where the linkages with firms, institutions and the organisations present in the region gradually embedded the Park's operation in the locality. The main force was the availability and use of local employment, which gradually increased the embeddedness of the Park's tenants. Positive examples stated were the Technopolis of Oulu in Finland or the Mjärdevi Science Park in Linköping, Sweden (Cooke, 2001), based on the important supplier linkages of the local firms with the Parks' large companies (Nokia and Ericsson) and the increasing numbers of start-ups and spin-offs. On the contrary, Chorda's (1996) analysis of French Technopoles and Phillips' (2003) examination of Singapore Science Park found that most tenants had limited interactions with regional firms and maintained their connections with parent firms or other partners outside the region/country.

There are not many studies available nor any benchmark against which to assess STPs' performance. What is clear, though, is that very different results are obtained from similar structures, depending on the tenants' own characteristics and their compatibility with the broader context.

2.4.5 **Conclusion**

The empirical evidence reveals a rather negative picture concerning the Parks' actual success in all three levels of analysis: their tenants, their own operation and their impact on the respective regions. Despite the presence of success, failure or partial failure tends to be more common. STPs are particularly ineffective in the development of linkages, interactions and technology transfer and the expected/described causal mechanisms of theory appear rather absent. The added value for the Park tenants is rarely connected with the development of knowledge spillovers and seedbed environments, limiting their benefits to the quality high-profile infrastructure or a more efficient provision of resources and services. As regional development tools, the evidence shows that STPs do not bring radical transformation in most local/regional economies, as the expected linkages and agglomeration forces with the local economies remain, in some cases, absent.

2.5 Parameters of STPs' success

An important part of the literature focuses on identifying relevant success factors/parameters. Based on a combination of the Parks' theoretical analysis and the existing evidence from case studies, scholars (Castells and Hall, 1994; Nijkamp et al., 1994; Ylinenpaa, 2001; Koh et al., 2005) and practitioners (UKSPA et al., 1990; Sanz, 2002) identify a number of relevant/important parameters. Most of them have already been mentioned and the following section brings them together and illustrates the way they may impact upon the Parks' operation.

2.5.1 Parks' ownership and organisation structure

STPs are very often created through the collaboration of more than one set of partners (Broadhurst et al., 1993; Kelessidis et al., 1999). Local, regional or national governments or development agencies, universities of research and technology centres and private sector partners (companies, consortia or associations, banks and real-estate developers) (Grayson, 1993; Nijkamp et al., 1994) can be brought together in various organisational and ownership schemes. Most often the partnership takes the form of a new separate entity, usually a Science Park management company, but it may also be in the form of loose/flexible cooperation such as joint ventures where partners maintain separate responsibility for the different functions (Grayson, 1993) or other hybrid versions (Broadhurst et al., 1993). The presence of multiple partners can have an important impact on the Parks' operation and development and objectives, even if the promoters and main investors tend to maintain their controlling role (Bigliardi et al., 2006).

From the positive side, the participation of more than one partner can bring necessary additional resources and increase the projects' legitimacy and support from the wider community (Luger and Goldstein, 1991). However, it may also bring competing or diverging interests and priorities. Public sector investors/governments usually have broader economic and technological development objectives, while private developers/investors may be interested only in the property development. Central governments are likely to focus on activities supporting national competitiveness and avoid duplicate efforts inside the country, while regional/local governments may put priority on the regional development level (Nijkamp et al., 1994; Kang, 2004). University/research centres tend to give priority to increasing income for the university (Nijkamp et al., 1994) and do not show interest in supporting activities with no direct benefit. Phan *et al.* (2005) suggest a possible "principal-principal" agency problem where opportunistic behaviors of participant stakeholders and parochial interests impede or nullify the more general development goals and objectives. Furthermore, even when the Parks are created from a single entity, local stakeholders such as the business community or other research organisations may attempt to take an interest. It is thus important that harmonious working relationships, agreement and commitment to specific set objectives are present. An appropriate governance structure should be able to accommodate potential conflicts (Nijkamp et al., 1994).

2.5.2 **STPs management and implementation capacity**

The management needs to be professional and effectively organised (Broadhurst et al., 1993). Irrespective of the specific structure selected by its promoters, the management team needs to have the resources and competencies to implement defined strategies, to effectively organise and coordinate the Park's operation and to develop the relevant mechanisms (Souitaris and Daskalopoulos, 2000). Ineffective non-professional management structures can undermine the interest or willingness of tenants and other firms to use the Park mechanisms and reduce the capacity to organise and coordinate the Park's operation. Cabral (1998) makes reference to the Park manager/director, the so called "Mr/Ms Science Park", as a person with a high level of recognition, perceived as embodying the interface of academia and industry and with linkages inside and outside the region. Pierre Laffite in Sophia-Antipolis or Frederick Terman in Stanford Science park are examples (Castells and Hall, 1994) illustrating the positive role that such individuals can play in the Parks' success.

2.5.3 **Property and infrastructure**

Whether referring to large plots or to smaller incubator spaces, the property element is always a critical part of the Parks' operation. The quality of the infrastructure, the high-tech design and the location advantages inside the region are all relevant for the attraction of new tenants (Monck et al., 1988; Massey et al., 1992; Grayson, 1993; Komninos, 1993; Nijkamp et al., 1994; Westhead et al., 1994). Depending on the target group and level of demand, the balance between plots for large firms and office spaces for small units is important in determining the occupancy and activity growth rates. It also defines the capacity to create a minimum critical mass and, thus, the opportunities/probabilities for the formation of linkages and synergies (Komninos, 1993). Parks' location in central, semiurban or more distant greenfield spaces balance the flexibility in terms of building density and size of investment with the proximity to other firms and services.

The extensive focus on high-quality infrastructure and facilities can, however, operate against the Parks' success. The need to fill the Park space absorbs the managers' focus to the detriment of the coordination and organisation activities (Komninos, 2002). High maintenance costs or a location with a high land price can create pressure to relax the admission criteria if initial demand for space from high-tech activities is not as expected. Parks' managers and promoters should be able to support the initial infrastructure investment with the necessary additional resources and maintain a long-term approach (Nijkamp et al., 1994).

2.5.4 **Finance**

Finance refers here to both the STPs' construction and operation as well as to the presence of the necessary financial resources for the Parks' tenants. For the STP general operation, the high cost of the Parks' facilities, construction and maintenance, the possible long gestation periods and the high costs for the development of some of the intangible services require financial instruments of a patient and on-going character. In the long term, successful Parks may count on the expected cross-financing of these intangible services from rents, income from the sale of plots and an increase in land value (Komninos, 2002). However, this cannot take place in the initial stages of the STPs' operation. Securing the viability of these operations through the necessary financial schemes is important and public/government funding allows for a longer term perspective and support for their development (Nijkamp et al., 1994).

From the firms' perspective, the presence of appropriate financial support schemes is necessary. In their absence, the Park loses part of its attractive capacity and an important tool for facilitating knowledge flows and innovation creation. Equity support schemes with participation of the STPs in the tenants' capital are suggested as the most appropriate form when it comes to the creation of new firms (Kelessidis et al., 1999). Nevertheless, the presence of other internal mechanisms or direct access to public and private financial sources that support R&D activity or partnerships development can prove equally important (Komninos, 1993). The role of the Parks' management is then to support the access to such mechanisms.

2.5.5 **Anchor-tenant(s) and their role**

While not a design element of the Parks' operation, the presence of large players with a strong knowledge base and R&D activity, so called anchor or flagship tenants, can serve as an attraction mechanism for other firms and may contribute in building the Parks' innovative environment through various forms of linkages with firms or the creation of spin-offs (Markusen,1999: p.278). The examples of IBM in Research Triangle Park (Goldstein and Luger, 1991) and Sophia-Antipolis (Longhi, 1999), Nokia in Oulu Technopolis in Finland (Ylinenpaa, 2001) and Eriksson in Linköping Technopolis have already been mentioned. A similar role/function is in some cases assumed by the universities or research centres with increased R&D capacity and entrepreneurial character such as the case of Daeduck Science Park in South Korea (Shin, 1999).

However, not all flagship tenants can play such a supportive role. High profile multinational firms may maintain closed-doors policies in order to protect their intellectual property (Longhi and Quere, 1997), while some universities and research organisations may be constrained by rigid government bureaucracies not allowing much interaction, may focus exclusively on blue-sky research or may simply be teaching universities with very limited R&D activity (Castells and Hall, 1994). The selection of the flagship tenants should thus not only be a matter of image or size of initial investment, but should also examine the activities brought into the Park and their potential to develop longer-term linkages and externalities.

2.5.6 Conclusion

The above parameters can assume positive or negative and a lesser or greater role in each STP and, in most cases, they are strongly inter-related. Promoters' objectives and organisation structures can affect both the type of Park design and strategy as well as the management team operation. The same applies to the Park property and the attraction capacity of the Park and the pressure of investment costs. Access to finance, especially of a long term character, plays a determinant role in all the above, but this depends again on the commitment of promoters and their effective use by the Park management. When all are properly coordinated, they can form a supportive base for the Parks' operation and success.

2.6 The role of the regional context : implications for STPs in lagging regions

Besides the internal elements/parameters of the Parks, the broader context of where the STPs are created and operate has also been made evident. It is linked to the definition of the STPs priorities, a supportive institutional framework in relation to technology transfer, cooperation and entrepreneurship, the availability of local resources to attract into the Park and a home market to support the NTBFs growth. Nijkamp et al. (1994) provide a list of economic, social and environmental factors (Table 2-2) that are seen as important to support the Parks' viability and Souitaris and Daskalopoulos(2000) use a PEST (Political, Economic, Social, Technological) analysis of the macro-environment to examine the impact on the operation of STPs.

Table 2-2 - External success factors of Science and Technology Parks

Economic factors	Social factors	Environmental factors
Risk capital	Local support groups	Desirable living environment
Skilled labour force	Entrepreneurial spirit	
Related industries		
Infrastructure		

Source : Nijkamp (1994,p.242)

Luger and Goldstein's (1991) analysis of STPs in the U.S. reveals that Parks have greater possibilities of success in large urban centres with significant market demand, labour supply, business services and high concentrations of manufacturing activity. Small metropolitan areas may prove to be successful locations for STPs provided there is a major research university or public research centre located in the area that can attract companies in the region. They propose a number of regional environment parameters as fundamental for any STP operation:

- presence of a significant market for the NTBFs product and availability of customers and suppliers
- presence of a university with related research activity to the Park tenants that is also the source of qualified local labour
- supportive broader business community that integrates the Parks' firms' operation in the regional network rather than considering them as competitors
- competent state/local governments in the region that, besides the provision of finance for the park infrastructure, develop other complementary measures and, more generally, a supportive innovation framework

2.6.1 **The lagging regions of Southern Europe as a context for STPs creation**

Against the above identified parameters of STPs' success, lagging regions of Southern Europe (regions under Objective 1 status[6] in Greece, Italy, Spain and Portugal) represent important obstacles and constraints for STPs. Despite variations, they share common elements in relation to their broader socio-economic model and the limited role that innovation activity and creation have played in their development history. They face increased pressures as a result of both the European integration and broader globalisation forces and find themselves in a rather ambiguous position. On the one hand, the low-cost strategies in traditional industries that characterised their development model in earlier periods are no longer viable due to competition from countries with much lower labour costs (e.g. Central and Eastern Europe countries, China, India). On the other hand, they cannot compete in high technology sectors and activities with the more advanced regions with a strong and accumulated technological and innovative capacity. Boosting the innovative capability of existing industries and restructuring their economies towards more knowledge-intensive activities is considered to be the only way forwards (Komninos, 2002).

Examining in more detail some of the characteristics of the Southern Europe lagging regions, low GDP levels per capita (<75% of EU average) represent only one, and not the most striking, difference from the core, more advanced regions of Europe. Their weaknesses as compared with the more advanced regions are much more stark in relation to critical elements of their innovation systems (see also Figure 2-2):

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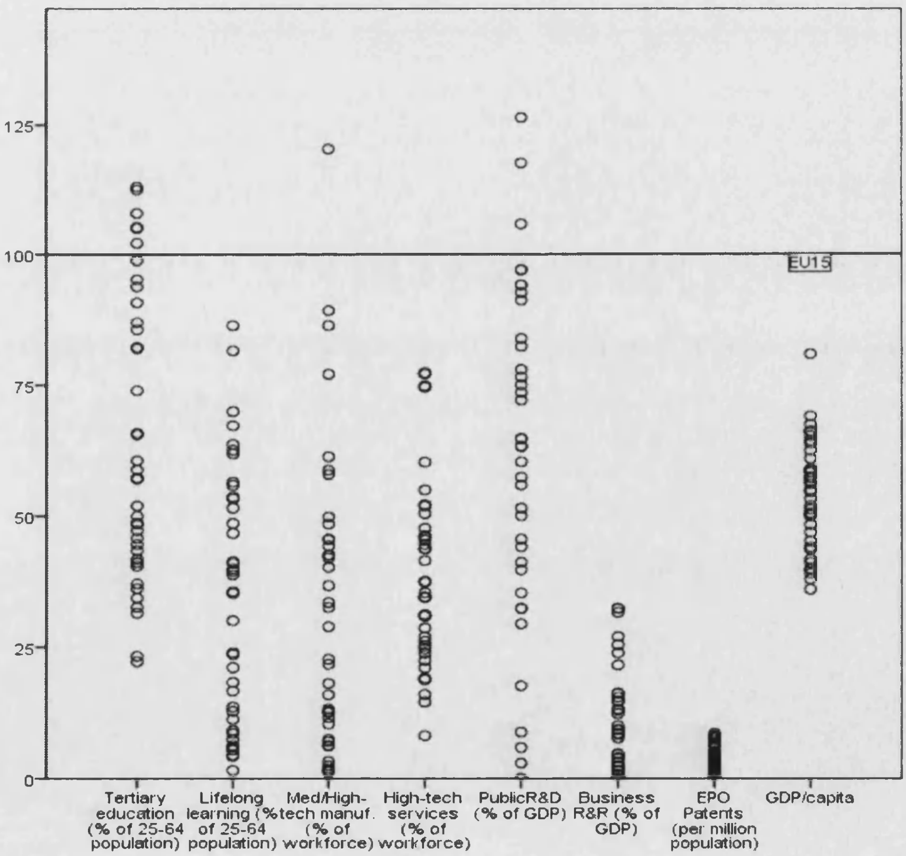
[6] Regions with GDP/capita levels below 75% of EU average.

- Total R&D expenditure in all cases is less than 1% of the regional GDP (average of EU15 countries in 2005 was 1.89%)
- Private sector share of R&D activity is, with few exceptions, below 40% of the total (EU15 average in 2005 64%)
- Shares of R&D personnel from the total active population are less than 0.78%, much below the EU15 average of 1.46% in 2005
- With few exceptions, the percentage of active population with tertiary education is less than 15% (EU15 average in 2002: 22%)
- Patent application levels are, with only a few exceptions, not more than 15 per million inhabitants, in comparison to 135.6/million inhabitants of EU15 in 2003



Source : EC(2003) and Eurostat(2005b)

Figure 2-2: Southern Europe 40 lagging regions' innovation indicators - comparison with EU15 average (EU15=100)

Similarly, the economic structure of the great majority of lagging regions is not supportive of development of innovation, since:

- manufacturing activities are limited in size – small agglomerations – and are concentrated in traditional, low-technology sectors that invest limited resources in R&D and innovation creation. High and medium-high technology sectors have limited shares (employment in those sectors in 2002 ranged from 0% to 6% while the EU average was 7.41%)
- services sectors are dominated by commercial activities and other non-knowledge intensive activities. The share of high-tech services in 2002 was below 1.5% in almost all cases in comparison to 3.57% in EU15
- there is a predominance of small and medium size enterprises with very few large local companies with the internal capacity/resources to invest in innovative activities and a very large number of very small firms (Oughton et al., 2002)

The above elements are connected with rather problematic institutional settings, ill-equipped to generate and disseminate new practices and to promote innovative activity and networking (Morgan and Nauwelaers, 1994). Uncertain markets and regulative environments for a long period lead to a dominance of short-term strategies with low propensity for investment in innovation and knowledge creation and for the development of long-term cooperation and partnerships. Tsipouri and Gaudenzi (1998) point to an inherent anti-agglomeration and anti-cooperation attitude that is the result of negative local conventions and working environments (no competent partners, distorted markets and no appropriate market regulation) and firms' organisational limitations. Instead of addressing the uncertainties of volatile markets and of innovative processes, as is the case in advanced economies, local cooperation is seen as increasing the level of uncertainty. Similarly or more problematic is the connection and interaction between the science system (to the extent that this exists) and the private sector. In most cases, public R&D appears to be unrelated to the needs of local and traditional industry. As a result, investments in public R&D activity tend to become residual from the point of view of innovation creation and development having a much smaller impact in the creation of innovation and economic growth than is seen in the core regions (Landabaso, 1997). Lagging regions are characterised as innovation averse societies (Rodríguez-Pose, 1999) with limited capacity to transform R&D activity and knowledge creation into innovation outputs and to achieve higher levels of economic growth.

In the policy sphere, lagging regions are characterised by inappropriate frameworks and policy delivery systems and a lack of understanding of the innovation process in order to design effective policies (Landabaso, 1997). The inflow of financial support from the EU structural funds, in many cases, remains under-exploited or is ultimately directed to more traditional measures (Tsipouri and Gaudenzi, 1998). Limited credibility and competence of the regional authorities and the opportunistic behaviours and short-term views of the private sector affect the ability to build consensus and to formulate common long-term development strategies.

It is clear that lagging regions pose important obstacles to most parts of the STPs' operation (see Table 2-3). The weak R&D and innovative activity of local firms and PRTOs and a limited/weak labour market are not supportive for the attraction of multinational firms' R&D and other knowledge intensive activities. As a result, integration of non-local activities and the development of the backward and forward linkages is much more difficult. Similarly, in relation to the NTBFs creation, there is no significant pool of new ideas (due to a low level of R&D and activity and skilled personnel) for the development of entrepreneurship, nor a supportive home market for the firms' growth.

Limited internal R&D activity and focus on the embodied technology of the traditional sector firms also means low absorptive and relational capacity and limited genuine demand for the Parks' technology and innovation services. The possibility of STPs forming local cooperation and collective learning processes is seen as problematic; the necessary effort is harder and longer and the results even more unclear (Capello and Morrison, 2005).

Table 2-3: Lagging regions' obstacles to STPs' operation and success

STPs' operations/functions	Potential obstacles from lagging regions' environment
Concentration/attraction of high-tech activities	Limited home market, peripheral location not attractive to foreign firms Absence of necessary business services No/few firms and PRTOs with strong innovative capacity to create agglomeration benefits Relatively weak capacity of local public research organisations Absence of skilled labour
Promote R-I cooperation	Limited number of firms with own R&D activity – absorptive capacity Low relevance of public R&D with market No experience of cooperation – no relational capacity Focus of firms on codified knowledge and embodied technology – latent demand for innovation
Promote inter-firm cooperation and networks	Limited number of firms with own R&D activity – absorptive capacity Priority on import of embodied technology No experience of cooperation – no relational capacity Opportunistic behaviours and limited trust – dominance of arms-length relationships
Support NTBFs creation and growth	Limited knowledge base for the development of a pool of ideas Risk-averse and short-term opportunistic attitudes – focus on commerce Absence of entrepreneurial skills Limited and not sophisticated market – no demand
Develop advanced support services	Latent and/or limited demand for technology services No local expertise for the provision of technology transfer services No priority or experience from state/authorities and other local institutions
Create economic and employment impacts	No competent/relevant local firms to develop backward and forward linkages – leakages expected outside Absence of business services and small market size limit agglomeration forces
Diffuse knowledge and innovation in region	No competent/relevant local firms to develop backward and forward linkages Dominance of arm's length relationships with no knowledge and technology exchange Limited demand for technology
Support partnerships/association among regional players	Competitive and individualistic attitudes Public-private dissension No capacity to formulate and support development strategies

Source: Own elaboration

Based on the above, a number of scholars conclude that STPs should simply be avoided in the lagging regions' context. Tsipouri (1998) and Hilpert (1991) suggest that the development of both large scale STPs (Technopoles) or even smaller STPs in less favoured regions are not viable projects, require much more public support that elsewhere and have unclear expected results. The transferability of the STPs model, proposed as a possible success in few high-profile cases and regions even though not working in many others, is regarded as limited. Even if the parks do develop some form of innovative activity, based on the attraction of few high tech firms or the location of a high quality research centre, they are expected to remain disconnected from the regional environment, becoming cathedrals in the desert(Tsipouri, 1998b). External linkages based on broader business and technology networks are expected to dominate (Storper, 1998; Benko, 2000) against the local connections and processes of collective learning. Such negative conclusions are supported by the studies of Luger and Goldstein(1991) and Massey et al.(1992) that compared STPs in more and less advanced/dynamic regions in the US and UK and found a low level of technological sophistication in the latter and increased probability of closure or slow activity growth. Some scholars criticise the focus on endogenous policies, the promotion of local networking (Isaksen, 2001) and the cluster creation logic behind STPs (Kim and Woo Yoo, 2007) in regions with limited own technological resources and thin institutions. It is suggested that the priority should be to strengthen access to external sources of technology and innovation and integrate local firms to national and sectoral innovation systems.

More moderate/positive approaches view STPs as projects expected to support the change of existing backward conditions. Priority is given to addressing the specific interaction/networking weaknesses that are dominant in more lagging regions. What is to be avoided, though, is the connection of the creation of STPs with expectations of new "Silicon Valleys" (Landabaso and Mouton, 2005). It is proposed that STP structures and objectives should be fine-tuned to the particularities and characteristics of these regions. In his analysis of three STP development strategies in the lagging contexts of Malaga (Andalusia), Hania (Crete) and Belice (Sicily), Komninos (2003) identifies important differences in the local technological supply and the relative capacity of the local markets to attract foreign-origin investment. Only Malaga could support a large property-led Park with the aim to develop a high-tech cluster. The environments in Hania and Belice meant that a Park project was not-sustainable and should focus only on the provision of intangible services and cooperation promotion. Capello and Morisson (2005) suggest that STPs in lagging contexts have an innovation transfer/diffusion function and should leave aside innovation creation or the development of a seedbed environment. The Parks in these cases deviated from the original model as a result of regional limitations.

Other positive approaches see the creation and operation of STPs as an evolving and learning framework (Landabaso, 2005). The presence of different stages in their development should allow for corrections and improvements, especially in relation to the development of the more intangible mechanisms and networking promotion. In a similar way, at a policy level, STPs can represent a stage in the formulation and implementation of more coherent innovation policies as regional policymakers acquire experience and a more associative culture develops. This may, in turn, support the operation of the Park or lead to the development of new, more effective mechanisms.

2.6.2 **Revisiting the research hypothesis**

The review of the literature and empirical evidence does not contradict the claim for a paradox of the creation of successful STPs in lagging regions. The restrictions posed by the local environment are expected to negatively affect the STPs' operation and functions. However, the previous discussion suggests that, against a dichotomy of complete success or failure (closure or the transformation to a high-tech labelled industrial/business park) there can be varying levels of "partial success" or "partial failure".

STPs in lagging regions may end-up serving fewer objectives than STPs in more advanced contexts, may deviate in their technological intensity, suiting the local backward environment or may promote much less innovation creation and focus on the diffusion of innovation and technology. Alternatively, they may operate as connection points/nodes for external linkages for the few dynamic firms of the Parks, even if local connections and collective learning processes remain underdeveloped. There are thus alternative pathways in relation to the Parks' internal operations and functions and their impact on the local environment. They are determined by the combination and the interaction of the internal design parameters and the external regional context and the capacity of the first to address the limitations posed by the second. Furthermore, there is an element of time and evolution of STPs along the different stages influenced by either internal or external parameters. Improvement over time from less to more successful structures may take place, although the presence of trajectories means that the change from a failed Park with few technology activities and undeveloped structures inside a lagging region to an innovative milieu is unlikely.

2.7 Conclusion

This chapter brought together a broad theoretical basis and existing empirical evidence in order to create a framework for the analysis and evaluation of Science and Technology Parks. As has been shown, STPs are policy tools that are aimed at supporting a range of functions in relation to knowledge and technology creation and diffusion, modeled around the success of specific regions and environments which they attempt to replicate. The theoretical work related to the innovation creation and diffusion process, firms' location decisions, entrepreneurship and regional development/growth explain the STPs' expected operation and point towards a wide range of objectives that are proposed by their promoters. Bringing them together, an analysis framework has been developed that is based on the physical concentration of knowledge creation and exploitation activities and the development of the mechanisms and processes that promote synergies, entrepreneurship, innovation creation and diffusion in a self reinforcing manner. The innovation intensive environment is expected to spearhead regional economic growth through the development of linkages and interactions. In comparison to the model, however, the empirical evidence reveals that Parks usually display weak performance in many of the expected internal functions. Similarly, there are only few, albeit high profile, examples in the literature that are linked to a strong role of STPs in supporting regional economic and technological development.

Against this theoretical and empirical base, STPs in Southern Europe's lagging regions face particular challenges. The regional context is deprived of most of the necessary inputs, is weak in demand for technology and is low in the mechanisms and institutions that serve as the necessary supportive background to the Parks' operation. It is thus expected that STPs will be a failure in such contexts or, as a result of a more realistic adoption to the specific regional context, deviate or downgrade in order to fit to their lagging context.

The objective of the following chapters is to examine in greater depth the development and operation of STP-labelled structures in such non-supportive contexts, evaluate their success and shed light on the ways through which the specific context interacts with the STPs leading to alternative (more or less positive) pathways. An initial analysis of the population of the STPs leads to the selection of four cases to be examined in-depth using the developed framework.

3 Chapter 3 - Research design and case selection

3.1 Introduction

This chapter has three main objectives. The first is to explain the choice of a multiple case study research design as the most appropriate method for the purposes of this study and explain the criteria used for the selection of the cases among a broader population of STPs. The second objective is to present the Science and Technology Parks phenomenon and its evolution in the Objective 1 regions of Southern Europe. Based on secondary sources and responses received from the STPs managers, the information is used to describe the main features of their operation, classify them among the different typologies and assess their performance in terms of activity growth and technological/innovation content. The analysis leads to the selection of the cases for the in-depth comparative case study analysis. The third objective is to provide a detailed account of the field work and the methods used for the collection of necessary data. This section assesses the capacity to provide valid and reliable answers concerning the examined phenomena, identifies possible limitations and weaknesses of the field work and explains how these were fully or partly addressed.

3.2 Justification of the multiple case research design and selection criteria used

The research methodology selected for the examination of the proposed research question was that of multiple/comparative case-studies. It is based on the recognition of the contemporary character of the examined phenomenon and the complex nature of the central unit of analysis (the Science and Technology park and its multiple parameters of operation), as well as the expected strong connection and interaction with the broader regional context that is at the centre of this thesis. Following Yin (1994, p.14), the case study approach is the most appropriate for the "examination of a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". For the examination of the STPs operation, it allows the researcher to address the large number of interrelated variables and to use multiple sources of evidence, based on the triangulation principle, combining various research methods and data forms, of both qualitative and quantitative nature. At the same time, though, a selection of multiple STPs and their examination in parallel addresses their variation, as illustrated from a range of existing labels and typologies, and the absence of a single representative case.

The typology and classification of STPs represents a whole group of literature by itself. It is either based on the Parks' labels, as presented in Chapter 2, or focuses on the Parks' critical characteristics including physical characteristics, the type of services provided, the management structure, the promoters/stakeholders and their objectives and the role of PRTOs – see EC (1996) and Geenhuizen (2008) for a review. In this study, the dichotomy model of property-led versus technology-led STPs described by Kelesidis et al.(1999) and Komninos (1993; 2002) is used (see Table 3-1). It provides a clear and visible distinction between Parks that place greater weight on the role of the property element against those that focus mainly on the intangible parameters. The former 'look' primarily inside the Park space, while the latter 'look' more outside it (Komninos,1993). While the two types abide to the Parks' general definition, their difference is not only related to the scale. They represent different starting points and strategies with different weights given to important design parameters.

Table 3-1: STP typology used and main characteristics

Type I – Property led	Type II – Technology led
High priority placed on property element	Decreased role of property/infrastructure
Focus/priority on attraction of high-tech firms and organisations	Focus/priority on new technology based firms and the incubation function
The park space as a market – focus on proximity	Focus on the development of services and mechanisms
"The parks look inside"	"The parks look outside"

Source: own elaboration based on Kelessidis (1999), Komninos (2002)

With that in mind, for each of the two types the maximum deviation of performance was targeted, based on activity growth and knowledge intensity data. The objective was to increase the level of variation in the dependent variable (the Park's performance) so that through their comparison the differences in internal (of the Park) and external (of the region) parameters can be illustrated. The definition used at this stage to assess performance is only part of the actual definition of success as provided by the STPs' model. Activity growth and high-tech intensity have been suggested as important preconditions for the development of interactions and synergies, the third most important STP function, but do not guarantee their presence. This decision was due to very limited available secondary evidence of the development of synergies and linkages among the parks of Southern Europe.

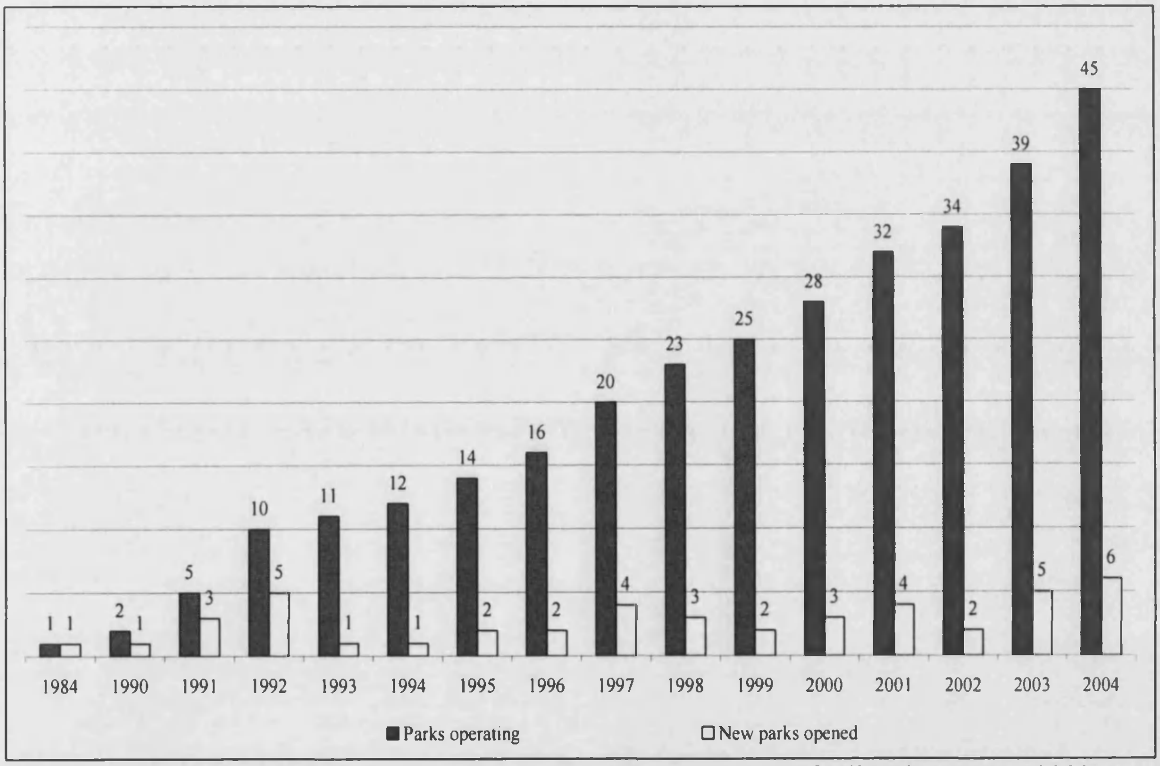
Alongside these two main criteria, additional considerations were integrated in the case selection. The first concerned the time element and a minimum cut-off point of ten years of operation was applied. The application of a time criterion is linked to the wide recognition of its role in the development and evolution of STPs from the institutional phases towards the maturity stage already stressed in the literature (Castells and Hall, 1994; Bakouros et al., 2002; Harper, 2003). The general conclusion in the literature is that 15 or even 20 years may sometimes not be sufficient for a Park to reach maturity (referring to successful cases such as Sophia-Antipolis or the Research Triangle Park) although the smaller technology-led Parks may require less time (Komninos, 2002). The choice of a ten year cut off point is rather arbitrary. Given that the first STPs in lagging regions were created in the mid 1980s and the way the STP phenomenon evolved thereafter, which is to be presented in detail in the following section, it was considered as being appropriate in order to balance the time requirement with the need to have a sizeable and representative sample of the total Parks' population from which to select the case studies.

The final criterion was linked to the feasibility of implementing and replicating the research design in each of the selected cases. Time and resource limitations, language and communication constraints and accessibility to primary and secondary data sources were all taken into consideration as they could affect the quality of the field work research and the ability to provide a valid analysis of the phenomena examined in each of the selected cases. This, in turn, could have a negative impact on the validity of the cross-case comparisons and the capacity to reach broader conclusions.

The following section provides a description of the population of STPs in lagging regions, an analysis of their characteristics and classifies them among different typologies. This classification is combined with an analysis of the Parks' performance based on existing secondary sources, leading to the selection of the appropriate cases for more in-depth analysis.

3.3 Analysis of the STP population in Southern Europe

The creation of STPs in the less developed countries of Southern Europe represents the so called third wave of the STP phenomenon (Komninos, 2002). It was initiated in the mid-1980s with the Tecnopolis Novus Ortus project in Bari (1984), took shape during the 1990s, reaching a total of 30 operating parks by 2000, and was still in evolution until 2005 (see Figure 3-1:). While in many cases the idea of the STPs' creation was already in place, the real impetus in the development of STPs came with the initiation of the European Union regional support programmes and a number of other EU wide initiatives (e.g. SPRINT, STRIDE) from 1989 on represented the main source of financing. STPs were promoted by central/ regional authorities and other players (universities, research centres) as projects eligible for EU support, connected with a gradual uptake of policies aiming at strengthening the lagging regions' innovative capacity (Landabaso, 1997). They were also connected to an increasing level of regionalisation of research and technological development policies, either in a top-down or a bottom-up manner (Charles and Howells, 1992).



Sources : Own elaboration based on APTE(2005), APSTI(2007), Sofouli and Vonortas(2007), Maltez(2004)

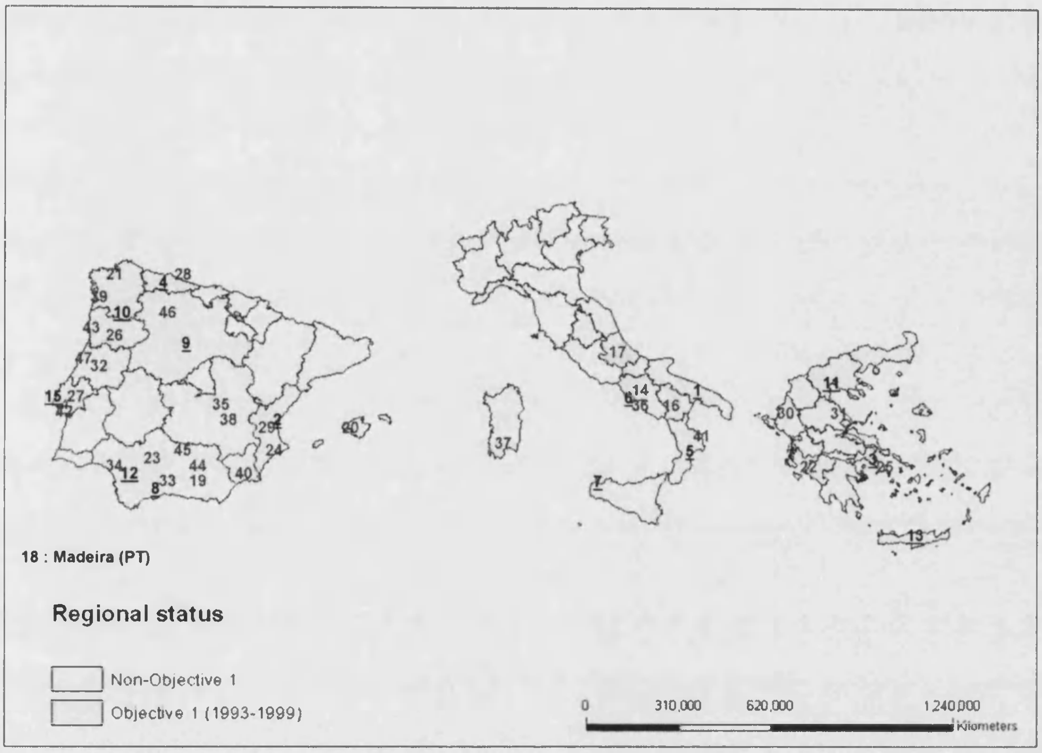
Figure 3-1: STP projects' evolution in objective 1 regions (projects in operation)

From 1989 onwards there was more than one Park opening every year (see Figure 3-1:) and the trend increased after 2000. In 2004 there were 45 STPs already operating and more in the planning stage (see also Appendix 2 – List of STPs in Objective 1 regions of South Europe). The phenomenon has reached such a level that there are currently few

Objective 1 regions in Southern Europe that do not host at least one STP-labelled structure (see also Figure 3-2). STPs in four Southern European countries represent more than 20% of the total number in Europe.[7]

Among the four Southern European countries, it is Spain where the STP phenomenon has been particularly widespread, driven primarily by the regional autonomous governments (Lubias, 2003). Nowadays, more than half of its 50 provinces host a STP-labelled structure or are planning the creation of one. After the first STP structures were created in the late 1980s in the more developed regions of Madrid, Catalonia and the Basque Country, most of the lagging regions followed. In Andalusia, two Parks were created in the early 1990s and nowadays there are nine STP-labelled projects operating or at different stages of development (APTE, 2005). Valencia has three Park structures, while more than one can also be found in the regions of Asturias and Galicia. According to Ondategui (2001) and Rubiralta (2004), the Spanish Parks have followed a two wave evolution that reflects not only differences in the period of their establishment, but also a different weight to the role of science and R&D activity. It has been suggested that the first projects place a greater focus on the companies/business side and are connected primarily with regional industrial policies. A second wave, starting after, 1992 appears to have a greater, more direct, connection with science with a more active presence of universities and many of them were labelled as Science Parks or Science and Technology Parks to reflect this difference. Cartuja93 is seen as part of this trend (Rubiralta and Vendrell, 2004).

[7] This is only an estimate based on the number of European IASP members. Not all IASP members are Science Parks and not all Science Parks are members of IASP (2007)



2 Technology Park of Valencia (1991)
3 Attika Technology Park – Leukippos (1991)
4 Technology Park of Asturias (1991)
5 Science and Technology Park of Calabria (1991)
6 Technapoli (1992)
7 Science and Technology park of Sicily (1992)
8 Technology Park of Andalucia- Malaga (1992)
9 Technology Park of Boecillo – Castilla Leon (1992)
10 Parque Tecnologico de Galicia (1992)
11 Thessaloniki technology park (1993)
12 Cartuja93 – Seville (1993)
13 Science and Technology Park of Crete (1993)
14 Science and Technology Park of Salerno (1995)
15 Taguspark – Lisbon (1995)
16 BasenTech – Basilicata (1996)
17 Science and Technology Park of Abruzzo (1996)
18 Madeira Tecnopolo (1997)
19 Campus of Health Sciences of Granada (1997)
20 Park of Technological Innovacion of Balearic Islands (1997)
21 Ferrol Metropoli - Galicia (1997)
22 Patras Science Park (1998)
23 Rabanales, STP of Cordoba (1998)
24 Mediterranean Science Park – Alicante (1998)
26 Tecmaia – Norte (1999)
27 Lispolis-Technological Pole of Lisbon (2000)
28 Science and Technology Park of Gijón (2000)
29 Paterna – Science Park of Burjassot – Valencia (2000)
30 Science and Technology Park of Epirus (2001)
31 Thessaly Technology Park (2001)
32 Parkurbis – Centro (2001)
33 Agroparque de Meditteraneo - Malaga (2001)
34 AERÓPOLIS de Andalucía (2002)
35 Parque Tecnologico de Castilla la Mancha (2002)
36 Citta della Scienzia – Napoli (2003)
37 Polaris – Sardinia(2003)
38 Science and Technology Park of Albacete – Murcia (2003)
39 Tecnological and Logistical Park of Vigo – Galicia (2003)
40 Technology Park of Fuente Alamo – Murcia (2003)
41 Science and Technology Park of Crotone – Calabria (2004)
42 Madan Park – Lisbon (2004)
43 Science and Technology Park of Porto (2004)
44 Metropolitanan, Industrial and Tecnology park of Granada – Andalusia (2004)
45 Geolit Science and Technology park – Andalusia (2004)
46 Science park of Leon (2004)
47 Biocantpark – Centro (2008)

Sources: own elaboration based on APTE(2005), APSTI(2007), Sofouli and Vonortas(2007), Maltez (2004)

Figure 3-2 - STPs operating by 2008 in Objective 1regions of Southern Europe (underlined = Parks created before 1995)

The development of STPs in the other three countries was less extended. In Portugal, out of the six projects promoted by the national and local authorities during the early 1990s, it was only Taguspark of Lisbon that started operating before 1995 (Maltez 2004). Most other projects remained in the planning/proposal phase for a long period and opened only after 2000. Nowadays, the capital region of Lisbon hosts four such schemes, with all other regions, including the island region of Madeira, already hosting or planning a new STP-labelled structure.

In the case of Greece, the first phase of STP development took place in the early 1990s with the initiation of four such projects in Thessaloniki, Crete, Athens and Patras[8]. Besides the Park of Athens, the location of the Parks followed the location of the new government research centres that were created by the central government during the 1980s. Three additional projects – in Thessaly, Ipeiros and Attika (in the township of Lavrion outside the metropolitan area of Athens) – were initiated at that time, but were officially inaugurated after 2000 (Sofouli and Vonortas, 2007). Following this first wave, the central government decided to "take stock" of the STPs' operation (EC, 1996) and some additional proposals (e.g. the Technology Park of Chania in Crete) have not materialised. More recently the government promoted the creation and management of STPs and technology incubators from the private sector (ELEFTHO program) and the provision of subsidies for the infrastructure and services. Two such initiatives, in Athens and Thessaloniki, are at different stages of the planning process. Finally, in Italy, the majority of the 30 STPs that are members of the Italian Science Park Association (APSTI) are concentrated in the more developed regions of the North. In the lagging regions of the South, a ministerial decree financed the development of 13 STP projects, some of which had already been initiated in

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[8] While initiated in the same period, the STP of Patras opened as late as 1998, while the Athens based STP (TESPA -Lefkippos) was limited to a 320m2 incubator with a sizeable extension (a new 1760m2 large building) planned since 2000, but still not operational even in 2008 (TESPA, 2008) .

previous periods (Rubini, 2002). Tecnopolis of Bari was the only exception, developed as early as 1984. Of the thirteen projects, seven STPs are currently in operation.

Altogether, the total number of Parks in Southern Europe represents an important part of a constantly increasing number of STP-labelled structures in Europe that are now gradually moving to the Eastern Europe countries, supported by a similar type of EU regional support policy measures. Nowadays, an important number of STPs (15) have been in operation for over ten years, good candidates for an analysis of the processes and mechanisms that affect their evolution and their role in broader innovation systems. They include two Parks in Greece, five Parks in Italy, one in Portugal and six in Spain (see Table 3-2).

Table 3-2: List of STPs in operation for more than ten years (2005)

	COUNTRY	REGION	STP NAME	OPENED
1	Greece	C.MACEDONIA	TTP- Thessaloniki Technology Park	1993
2	Greece	CRETE	STEP-C Science and technology Park of Crete	1994
3	Greece	ATTIKA	TESPA - Leykippus Science Park	1991
4	Italy	APULIA	Tecnopolis CSATA Novus Ortus	1984
5	Italy	CALABRIA	TPC- Technology Park of Calabria	1992
6	Italy	CAMPANIA	STPC- Science and Technological Park of Salerno and the Internal Area of Campania	1995
7	Italy	CAMPANIA	STPN- Science and Technological Park of the metropolitan area of Napoli	1992
8	Italy	SICILY	STPS- Science and Technology Park of Sicily	1991
9	Portugal	LISBOA	Taguspark	1995
10	Spain	ANDALUCIA	TPA - Technology Park of Andalucia - Malaga	1992
11	Spain	ANDALUCIA	Cartuja 93 - Seville	1993
12	Spain	ASTURIAS	PTA- Technology Park of Asturias	1991
13	Spain	CASTILLA LEON	BTP- Technology Park of Boecillo	1992
14	Spain	GALICIA	PTG- Technology Park of Galicia	1992
15	Spain	VALENCIA	VPT- Valencia Park Tecnologic	1991

Sources: TTP (2004b), STEP-C (2004c), Sofouli (2007), Tecnopolis (2004), CALPARK (2004), PSTSA(2004a), Technapoli (2004b), PSTSicilia(2004), Freire(2003), PTA(2004), IAT(2004), IDEPA(2004), BTP(2003), PTG(2003)

3.4 STP characteristics – towards a classification of STPs

The analysis of the Parks' main characteristics intended to classify them following Kelessidis et al.'s (1999) dichotomy of the property-led versus technology-led models. Secondary sources, primarily the Parks' websites, were used to identify a number of parameters that are supportive of this direction. The size of the two types of Park and the types of infrastructures developed represent the most visible, easily distinguishable element that separates the two models. At the same time, though, other parameters that may separate the Parks are noted, including the STPs' ownerships and management structure, and the support services developed.

3.4.1 The tangible element: property, infrastructures and facilities

Based on the property size, infrastructure and facilities, the STPs are clearly separated into two groups (see Table 3-3). The first includes the sizeable Spanish STPs and Taguspark that cover large areas ranging from 51 hectares in the Technology Park of Galicia (PTG) to 182 hectares in the Technology Park of Andalusia in Malaga (TPA). In all these cases, the common element is the presence of important numbers of large and small sized plots that are expected to be sold or leased to firms to construct their own facilities. Along with the plots for larger firms, in some STPs office buildings are constructed by the Parks' promoters or by other public or private entities and organisations to accommodate the needs of small and medium enterprisies (SMEs). Their size varies from 447,000m^2 in Cartuja93 to no more than 7,000m^2 in Asturias. Incubator-labelled buildings/spaces are the third type of facilities present in almost all cases. Brought together, the Spanish Parks and Taguspark provide the full range of infrastructure created to cover the needs and requirements of large, small and newly created firms.

In comparison, the Greek STPs and the Tecnopolis in Bari follow a technology incubator model based on a restricted approach of small-sized Parks with no plots for sale or lease to individual firms/tenants, limited office space and priority given to the incubation facilities. The larger share of their total built space was covered in all three cases by their prime promoters: the research centres. Attica Park (TESPA) is by far the smallest, with no more than 320m^2 available for the new Park firms, compared to the 35,000m^2 of Democritus NCSR institutes that already pre-existed before the creation of the Park incubator. In comparison to the French model followed by the Spanish Parks and Taguspark, these establishments are closer to the British Science Park model, focusing on research and technology organisations and incubation facilities.

Table 3-3: STPs' property and infrastructures [9]

Region	PARK	Park area (hectares)	Total office space	Incubator spaces	Plots area (number)
C.Macedonia	TTP	2,5	1200m2	1200m2	NO
Crete	STEP-C	25[10]	4000m2	600m2	NO
Attiki	TESPA	60[10]	320m2	320m2	NO
Puglia	Tecnopolis	5,7	n.a.	2660m2	NO
Calabria	CalPark	Dispersed offices	n.a.	NO	NO
Campania	STP Salerno	Dispersed offices	n.a.	NO	NO
Campania	Technapoli	250m^2 office	250	NO	NO
Sicily	STP Sicilia	Dispersed offices	1600m2	NO	No plots
Lisbon	Taguspark	111 + 89[11]	145.000m2	2 incubators	99 hectares (nd)
Andalucía	TPA	186	10 buildings	7500m2[12]	37 has (50)
Andalucía	Cartuja 93	82	447.000m2	NO	35.6has (64)
Asturias	PTA	61 - 17 [13]	7.000	1300m2	29 has (53)
Castilla Leon	BTP	61 + 57[12]		7900m2	38 has (61)
Galicia	PTG	51		6000m2	28 has (74)
Valencia	VPT	103	5 centres	4375m2	68.7 has (262)

Sources : own elaboration from APTE (2003); CALPARK (2004); IAT (2004); Gonzalez (1995),; Guillermo (2002),; Ondategui (2001); Pessoa (2003); PTA (2004); PTG (2004); STEP-C (2004c); STEP-C (2004b); Technapoli (2004b); Tecnopolis (2004); TTP(2004b); TTP(2004a).

Finally, a third group comprises the four Italian STPs of the South. The Parks of Calabria, Sicily, Salerno and Napoli have a much less tangible character. In their limited facilities,

[9] Empty cells are left in the case of no available data.
[10] Refers to the total space. The greater part is dedicated to the research centres.
[11] 2nd phase extension
[12] In three incubators
[13] De-characterisation of the industrial Park space

they host only the Park management and other supporting services; in some cases, dispersed among various locations inside the region. They use ICT networks to link partners and participants in a virtual STP scheme that covers the whole local or regional space (Technapoli, 2004; CALPARK, 2004; PTSiciliy, 2004).

3.4.2 Promoters and ownership and management structure – dominance of the public sector

An examination of the Parks' promotion and ownership structure reveals the common dominant role of the public sector in all examined projects. The Parks' have been initiated by public authorities, even at different spatial levels, and the infrastructure investments came from the public purse; private investors have been largely absent. At the same time, there is important variation in terms of the type of public entities behind the Park structures, with each country following a rather different model.

In Spain, the promoters of all STPs have been almost exclusively regional authorities. Either directly or through various regional development agencies, the regional governments have been the prime actors in the initial stages of the STPs' creation, including the promotion of the Park idea, the identification and purchase of land and the securing of necessary financial sources utilising regional, national and European programmes (Ondategui, 2002). Their dominance is usually expressed through the controlling shares they have in the management teams (see **Table 3-4**), which are the main entities responsible for the Parks' operation. In the Asturias and Valencia Parks, where separate management entities were not created, the Parks are directly controlled by the respective regional development agencies (IFR/IDEPA in Asturias or IMPIVA in Valencia).

Other local players have performed only secondary roles. Central government only played a role in Cartuja93, again due to ownership of part of the land, but its role is secondary. Municipal authorities to which the land belonged were present in some cases (Malaga, Galicia, Sevilla), but in no instance did they assume a prime/controlling role and even less common was the presence of universities, research organisations or the private sector, either in the form of individual investors or through industry associations[14].

In the Italian STPs, regional authorities have also played a prime initiator role, but this time in cooperation with other local players, regional universities, business associations and private firms, through the formation of partnerships or consortia that were responsible for the Parks' creation, their operation and their subsequent development (Rubini, 2002). In the management teams, usually a private entity with small share capital, the regional authorities tend to maintain the majority. Puglia Tecnopolis was an exception, as the promoter role was assumed initially by the local university of Bari and its partnership with the private sector for the formation of the CSATA Novus Ortus technology centre (1969 - fifteen years before the Park's creation) even though, later on, the regional government assumed the greater share in the Park's management company (Tecnopolis Novus Ortus S.L).

In comparison with the active role of the regional authorities of the Spanish and Italian models, in Greece and Portugal they have been almost completely absent as a consequence of being centralised or partially centralised countries. In both nations, the central governments assumed the key role in the promotion of STPs, even though they reduced their involvement in later stages. In Greece, the central government promoted and financed

[14] A minor role in the operation of the Parks is usually played by the "maintenance or urbanisation entity", a situation where all public or private land owners have shares and have the responsibility for the maintenance of the infrastructure and other basic services (security, transportation).

the creation of STPs by some of the most dynamic government research organisations: the FORTH research centre in Crete, the CPERI research institute (also part of FORTH) in Thessaloniki and the Democritus research centre in Attica. However, it did not actively participate in the subsequent stages of the STPs' development. The research centres were the owners of the Park land and were the entities with the main responsibility for subsequent development (STEP-C, 2004c; TTP, 2004b; TESPA, 2005). The participation of other partners, mainly from the private sector, came through the management teams, private entities expected to develop the various support services in the Park. Individual investors/firms and the industry association were attracted to the project, but universities and the regional or local authorities did not engage with the STPs' projects.

The Portuguese national Government was the initiator of the Taguspark project[15], but in this case a partnership scheme was created that included the local university, a non-profit foundation (FLAD Luso American Foundation) and the municipalities where the Park was to be created (Maltez 2004). Taguspark S.A., the entity created to manage the Park, is the owner of the Park space, responsible for both the basic and advanced services, the development strategy and admission decisions. By transferring its stake in the management team to the university and the research centres, central government financed their participation in the project and secured space for the creation of their new facilities in the Park.

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[15] At that time, the government promoted the creation of two Parks, one in Lisbon and one in the other main urban centre, Oporto.

Table 3-4: STPs' promoters and management structure

PARK	Promoters	Management structure	Management entity shareholders	%
TTP – Thessaloniki	National government + CPERI research institute	TTP Management and Development company S.A	CPERI Industry Federation Others	43 20.7 36
STEP-Crete	National government + FORTH research centre	STEP-C Management and Development company S.A.	FORTH, Bank of Pireaus Others	30.9 30.5 38.6
TESPA - Attica	National government + NCSR research centre	Public sector company	Central government	100
Tecnopolis Puglia	Regional government + University	Tecnopolis S.A	Regional government University of Bari Others (business)	57 42 1
CalPark Calabria	Regional government leading public and private consortium	CalPark S.A.	More than 40 entities (HEIs, public administration and private firms)	100
STP Salerno	Regional government leading public and private consortium	STP Salerno S.A.	More than 100 entities (HEIs, public administration, private firms)	100
Technapoli Campania	Regional government leading public and private consortium	Technapoli S.A.	More than 20 entities (HEIs, public administration, private firms)	100
STP Sicilia Sicily	Regional government leading public and private consortium	STP Sicilia S.A.	More than 25 entities (HEIs, public administration, private firms)	100
Taguspark Lisbon	Central government	Taguspark S.A.	Public sector (R&D centres + HEIs) Private (banks, companies)	56 44
TPA Malaga	Regional and local authorities	PTA S.A. + Conservation entity	Regional gov't Municipality of Malaga	67 33
Cartuja 93 Seville	Regional and national authorities	Cartuja S.A. + Conservation entity	Regional gov Central government Municipality of Seville Province of Seville	51 34 10 5
PTA Asturias	Regional authority	Regional development agency + Conservation entity	Regional government	100
BTP Castilla Leon	Regional authority	PTB S.A. + Conservation entity	Regional gov't	100
PTG Galicia	Regional authority	PTG S.A. + Conservation entity	Regional gov't Province of Ourense Municipal authorities Industry associations 2 HEIs	47 21 14 12 4
VPT Valencia	Regional authority	Regional development agency + Conservation entity	Regional government	100

Sources: own elaboration based on APTE (2003); CALPARK (2004); IAT (2004); Gonzalez (1995); Guillermo (2002); Ondategui (2001); Pessoa (2003); PTA (2004); PTG (2003); STEP-C (2004c); STEP-C (2004b); Technapoli (2004b); Tecnopolis (2004); TTP (2004b); TTP (2004a)

3.4.3 The intangible support mechanisms

Alongside quality infrastructures, the STPs were expected to develop more advanced services related to technology transfer and innovation diffusion objectives. The differences are mainly related to the role that the STPs' management teams have in their development, the presence of other relevant support organisations, the intensity of their provision and the reference/priority area of these activities: internal dedicated to the Park's tenants or external with reference to the broader region.

In the Greek and Italian STPs, the Park management teams are the entities primarily responsible for the provision of business and technology services (Table 3-5). The advertised services range from information concerning R&D programmes to business and management support, training, technology transfer and networking services. They are also responsible for the incubation support function, even if the infrastructure is managed by the PRTOs. Critically, their reference is to both the internal environment (the researchers and incubator firms) and also the broader local industry to which they are expected to provide services ranging from information diffusion to more advanced technology transfer and business/management support and the implementation of regional development projects. The research centres' technology transfer in the Greek STPs or the other members of the Italian STP consortia is also expected to complement the support developed by the Park managers while, in some cases such as financing, cooperation with external partners is the chosen approach.

In the larger Spanish STPs and Taguspark, the management companies/teams have an explicit Park-space focus. Their participation in regional development programs is limited to those cases that have direct reference to the Parks' operation. At the same time, while in Malaga (ES), Taguspark (PT) and Galicia (ES) the management team functions include the direct provision of technology and business services, in the parks of Cartuja93 and Castilla y Leon they are limited to information diffusion and general coordination while more advanced activities are developed from other organisations. In the Valencia Park, the management team limits itself to basic services, excluding even the networking function, with other activities are developed solely by other organisations (Garcia, 2001).

Table 3-5: STPs' services – role of management and other entities (M: management, O:other entities) and regional development focus

Park	Type of service provided							Regional development
	Basic services	Business support	Training	Finance	Incubat.	Networks	Tech. Transfer	
TTP	M	M+O	M+O	O	M	M	M+O	High
STEP-C	M	M+O	M+O	O	M	M	M+O	High
TESPA	M	M+O	M+O	O	M	M	M+O	High
Tecnopolis	M	M+O	M+O	O	M	M	M+O	High
CalPark	-	O	O	O	-	M	M+O	High
STP Salerno	-	O	O	O	-	M	M+O	High
Technapoli	-	O	O	O	-	M	M+O	High
STP Sicilia	-	O	O	O	-	M	M+O	High
Taguspark	M	M+O	M+O	M+O	M+O	M+O	M+O	Low
TPA	M[16]	M+O	M+O	O	O	M+O	M+O	Low
Cartuja 93	M[16]	O	O	O	- [17]	M+O	O	Low
PTA	M[16]	O	O	O	O	M+O	O	Low
BTP	M[16]	O	O	O	O	M+O	M+O	Medium
PTG	M[16]	M+O	O	O	M+O	M+O	M+O	Low
VPT	M[16]	O	O	O	O	O	O	Medium

Source: own elaboration from APTE (2003), CALPARK (2004), IAT (2004), Gonzalez (1995), Guillermo (2002), Ondategui (2001), Pessoa (2003), PTA (2004), PTG (2004), STEP-C (2004c), STEP-C (2004b); Technapoli (2004b), Tecnopolis (2004), TTP (2004b), TTP (2004a)

Concerning the financing parameter, most of the examined STPs have so far attracted firms by supporting their establishment in their premises through the provision of subsidies or, in the case of new firms, reduced rent schemes. More direct support for innovation related activities or venture capital schemes for new projects were rarely internally developed, the only exception until 2005 being Taguspark (Freire, 2003). The focus in all cases has been on the provision of information concerning external resources and funds developed from the regional, national or EU authorities.

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[16] Includes also conservation entity

[17] Expected after 2008.

Brought together, business support, technology transfer and networking services are functions that the Parks' promoters and managers have attempted to integrate into the Park operation at varying levels. In most cases, the support mechanisms are a combination of internal management team development and the operation of other dedicated organisations. The Greek and Italian Parks and management team have a broader regional reference in terms of the provision of their services; they are clearly the cases that look outside. The Spanish Parks and Taguspark management teams, in contrast, have given a greater weight and priority to the internal space of the Park. In all cases, the intensity of their development and the capacity and effectiveness of the providers appears to be important, but a proper assessment of that requires a more in depth analysis.

3.4.4 Classifying the STPs following the typology

The property and facilities element and the amount of investment made represent the most visible differences between the examined cases, but they are also a reflection of the different priority objectives and functions of the Parks. Following the typology established by Kelesidis et al. (1999) we can classify them in three different groups (see Table 3-6). The Greek STP and Bari Tecnopolis fit clearly into the technology-led model of small spaces that focus on technology transfer and the incubation function, they have increased their reference to the external environment and the founding PRTOs have a determining/important role in their management and operation. By contrast, the Spanish and Portuguese cases follow a property-led development model where priority is given to the attraction of firms and other high-tech activities inside the Parks' infrastructure. Here, all types of Park spaces are made available, even if they are different sizes and carry a different weight among the Park's total. Furthermore, the internal development of STP functions assumes a greater weight.

The four remaining Italian cases, two STPs of Campania, one in Sicily and one in Calabria, do not fit into any of the above groups. While they do share common characteristics with the technology-led model, a focus on mechanisms and services, they are not property-based initiatives, thus missing a critical element of the STPs model. They follow more what is called the network approach, similar to that of the German STPs (Ondategui, 1997), the virtual Park model (Komninos, 2002) or the cluster model (Kelessidis et al., 1999). Despite their STP label, they are in practice technology transfer/support centres or intermediary organisations that focus on services provision and the promotion of cooperation and are not based on physical proximity elements for the development of innovation intensive environments.

Organisations of this latter type share many of the intangible elements of the STP operation. However, as they do not share the critical property element, with the advantages and constraints that this entails, they do not fit the STP model. Hence, they cannot be assessed based on the same type of metrics and indicators and cannot be compared with the other property-based initiatives. Since the purpose of this study was not to assess the effectiveness of different types of interventions but to examine the feasibility of developing successful STPs, with the exception of Technopolis of Bari, the Italian STPs were considered inappropriate for the objectives of the study and were excluded from the subsequent stages of the selection.

Table 3-6: Classification of examined STPs

Technology-led model	Property- led model	Virtual model
TTP – Central Macedonia	BTP – Castilla Leon	CalPark - Calabria
STEP-Crete	Taguspark - Lisbon	PST Sicily
Tecnopolis – Puglia	Cartuja93 - Seville	Technapoli
Leykippus - Attiki	PT Andalusia - Malaga	PST Salerno
	PT Asturias	
	PT Galicia	
	VPT - Valencia	

Source : own elaboration

3.5 STPs' performance

The assessment of the STPs' performance at this stage was constrained by the limited availability of data from secondary sources and the fact the only some of STPs responded to a questionnaire (see Appendix 3 - Information request form sent to STPs management entities during the first stage). The picture illustrated and the assessment made is thus based on a combination of STPs' managers' responses, the data available on the Parks' websites and studies available at that time.

The Spanish Association of Technology Parks had commissioned two studies that provide a range of data (COTEC, 2000; APTE, 2003). In addition, analyses of the STPs' development for the period up to 2000 were found in Ondategui (1997; 2001; 2003) and Gonzalez (1995). Some of the Spanish STPs were also analysed by Vazquez-Barquero and Carillo(2004) (for Cartuja93), Guillermo (2003) (for BTP), Romera (1995) (TPA - Malaga) and Benito del Pozo(1997; 2001) (for BTP, PTG Galicia, and PTA Asturias). In the cases of Bari Tecnopolis and Lisbon Taguspark, the study of Rubini (2002) was the main source used, along with presentations available on the Parks' websites (Tecnopolis, 2004; Freire, 2005). Additional information for Taguspark was also found in Freire (2003) and Pessoa (2003). Finally, for the two Greek STPs, the main sources were Kelessidis (1998) and Kelessidis,Vasalos et al.(1993), Souitaris and Daskalopoulos (2000) and Bakouros et al.(2002).

Some provided information concerning interaction and connections among the Parks' tenants or assessed the Parks' mechanisms. However, the majority of the information available was limited to quantitative data concerning the activity growth and the type of tenants operating in the Parks. The researcher chose to focus only on the measurable and quantifiable aspects that concerned the Parks' activities and knowledge intensity. In this respect, Benko's (2000) two main axes/elements were followed to identify "real" from "false" Technopoles. The first is a quantitative assessment of the Parks' activity evolution measured in terms of the occupation levels of the Parks' facilities, the number of tenants attracted and the creation of new firms. The second concerns the knowledge and technological intensity, which is usually measured in terms of R&D inputs and their shares in the total Park activity. Sectoral and functional specialisation and R&D activity intensity were the parameters examined in this respect. Bringing them together, the combination of the two parameters was used to place the Parks in different cells in the performance matrix presented in Table 3-7.

Table 3-7: Relative classification of STPs' performance by activity and knowledge intensity

		Knowledge creation intensity (relative performance)		
		Low	**Medium**	**High**
Occupancy and activity growth	**High**			
	Medium			
	Low			

3.5.1 STPs' activity growth and occupation levels

The analysis of the Parks' activities and evolution reveals various patterns of growth (see Table 3-9). In the small technology-led Parks of Thessaloniki, Crete and Puglia that focus on technology transfer and incubation functions, the research centres that represent the main drivers of activity and employment growth range from over 95% of the total in TESPA in Attica with only six small firms (Souitaris and Daskalopoulos, 2000) to around 65% in Tecnopolis (Tecnopolis, 2004). In STEP-C and TTP, the research centres constituted more than 80% of the Parks' employment and around 85% of the total activity turnover (STEP-C, 2004c; TTP, 2004a).

The critical element, however, is the private sector activity and the creation of new firms. For the STPs' incubation functions, high occupation levels are positive only to the extent that they coincide with positive/high firm turnover and graduation rates. In the examined cases there are clear trade-offs. Among the Greek STPs, high occupancy rates (above 80%) reported in Thessaloniki and Crete were reached early on and maintained since then, especially in STEP-C. Similarly high levels of occupation were reported for Tecnopolis in 2002 and 2004, although data were not available for earlier periods. However, these high occupancy levels should again be seen against low firm turnover rates and a tendency of established firms to stay inside the Parks for periods longer than five or even up to ten years, when the average recorded in the EU incubator benchmarking study (EC, 2002) was 35 months (2.9 years). In the case of the very small TESPA, the data from a number of years show that at no point did the Park host more than six firms in total (although there is no data on total space occupied) of which, according to Souitaris and Daskolopoulos (2000), the majority were not actually operating in the Park, but used the premises only periodically.

Low turnover rates also reflect low rates of firm creation (see Table 3-8). In the case of the TTP, no more than 21 tenants had operated in the Park in a ten year period (1994-2004), and some of them were not new firms. This leads to a creation rate that is, at best, 2.1 firms/year in comparison to the average of 6.6 firms/year for the EU. In the Attica Park, according to Sofouli, between 1991 and 2003, eleven firms (not all of them new) had operated in the Park, an average rate of less than one firm per year. STEP-C reports a more positive performance, with around 50 firms graduating in the period 1995-2005 according to the Park's management (five firms per year), even if this is still below the respective EU average. Being somewhere in the middle, the firm creation rate in Tecnopolis in Puglia was around 60 firms in a period of around 20 years (1984-2004), which equals three firms per year, with 50 of them successfully graduating from the Park (Rubini, 2002). Without examining the quality and knowledge intensity of the Parks' tenants, all four STPs seem to have underachieved in terms of new firm creation activity, with the Parks of Thessaloniki and Attica having the poorest performance and STEP-C the best.

Table 3-8: Activity, employment and occupation level evolution in the technology-led STPs

Park	Indicator	1994	1997	2000	2003	2005
TTP (1993)	PRTOs employees	n.d.	125	135 [1999]	384 [2004]	390
	PRTOs budget (M€)	n.d.	4.4	9.9	14.6	17.9
	Firms	n.d.	10	11	8	7
	Employees (in firms)	n.d.	42	47	55	31
	Occupancy	0%	≈100%	≈100%	≈80 %	≈80 %
STEP-C (1994)	PRTOs employees	920	700	650		800
	PRTOs budget (M€)	n.d.	28.0 [1996]	35.6	31.5	37.4
	Firms	4 [1995]	16	22	22 [2004]	23
	Employees (in firms)	n.d.	n.d.	≈150	≈150	164
	Occupancy	n.d.	≈70%	≈90%	≈90%	≈90%
TESPA Attica (1992)	PRTOs employees	n.d.	n.d.	635	847	
	PRTOs budget (M€)	n.d.	26.5 [1998]	34.8	29.8	34.7
	Firms	n.d.		6	6	5
	Employees (in firms)	n.d.	n.d.	n.d.	n.d.	n.d.
	Occupancy	n.d.	n.d.	n.d.	n.d.	n.d.
Tecno-polis – Bari (1984)	PRTOs employees	n.d.	n.d.	n.d.	190 [2004]	220
	PRTOs budget (M€)	n.d.	n.d.	n.d.		
	Firms	n.d.	n.d.	n.d.	25 [2004]	28
	Employees (in firms)	n.d.	n.d.	n.d.	100 [2004]	108
	Occupancy	n.d.	n.d.	n.d.	> 90%	> 90%

Sources: own elaboration based on: TTP (2004b), STEP-C (2004c), Rubini (2002), CERTH (2004)

Turning to the property-led Spanish STPs and the Portuguese Taguspark, there is a clearer deviation of performance between the different cases. The Asturias and Galicia Parks faced great difficulty in attracting companies and organisations. Despite the provision of strong subsidies, in 2003 (after more than ten years of operation) there were still low occupancy levels below 60% of the provided space with no more than a total of 1,000 employees. Large parts of the Parks' space were left unoccupied. The great majority (over 70%) of firms in the Parks were very small firms located in incubator spaces (Ondategui, 2001). Moreover, in Asturias Park the promoters formally decided to reduce $1/3^{rd}$ of the initial Park space[18] in order to accommodate the location of a manufacturing unit that did not fit with the environmental and other building requirements of the Park's space (Ondategui,

[18] 17 of the total initial 61 hectares were de-characterised

1999). The incubator of CEEI in Asturias Park achieved on its own a more positive performance, reaching high occupancy rates (>85%) in less than five years, showing rates of firm turnover above the EU average (IDEPA, 1995-2004). Rather similarly, in Galicia, while a large part of the Park is still unoccupied, the main building has attracted a large number of small firms and subsidiary units; although, in this case, there are no data on firm creation rates.

In comparison to these two cases, the remaining five Parks (PTA, Cartuja93, Taguspark, VTP and Boecillo), in a period of between eight to twelve years, had achieved occupancy levels close to 90% by the end of 2003. The 88 tenants in the Boecillo Park in 2003 employed 3,700 members of staff and covered 90% of the Park's space. In 2004, the Park extended its space by 57 hectares, almost doubling its size. Taguspark had 140 firms with more than 6,000 employees and a similar extension is taking place (Freire, 2005), while more than 230 entities were operating in the Parks of Andalusia, Cartuja93 and Valencia (Ondategui, 2001; Rubini, 2002; Guillermo, 2003; Vazquez-Barquero and Carrillo, 2004). Overall, and at different paces, they managed to reach significant levels of economic activity.

Table 3-9: Spanish STPs and Taguspark activity evolution [19] [20]

Park (opening year)	Category	1994	1997	2000	2003	2005
Taguspark	Companies	20 [1995]	80	146 [2001]	144 [2002]	160
(1995)	Employees	n.d.	2200	5000	6000	7000
	Occupancy	n.d.	n.d.	n.d.	n.d.	-
	Turnover (M€)	n.d.	n.d.	n.d.	n.d.	950
TPA – Malaga	Companies	35	75	184	286	375
(1992)	Employees	459	1501	3071	5718	8539
	Occupancy		48%	80%	90%	
	Turnover (M€)	14	159	440 [2001]	658	1022
Cartuja93	Companies	86	111	180	232 [2002]	311
(1993)	Employees	2300	4288	6794	8608 [2002]	11455
	Occupancy	34%	46%	75%	90% [2002]	
	Turnover (M€)	n.d.	n.d.	704	1200 [2002]	1676
TP Asturias	Companies	14	23	37	n.d.	102 [2006]
(1991)	Employees	n.d.	342	420	n.d.	2300
	Occupancy	n.d.	15%	25%	60%	n.d.
	Turnover (M€)	n.d.	n.d.	n.d.	n.d.	n.d.
Boecillo TP	Companies	29	43	77	93	113
(1992)	Employees	298	993	3515	3986	5037
	Occupancy	n.d.	45%	60%	90%	n.d.
	Turnover (M€)	n.d.	36.3	282 [2001]	n.d.	384
PTG – Galicia	Companies	10	23	28	55	62
(1992)	Employees	n.d.	130	200	700	763
	Occupancy	n.d.	35%	45%	53%	60% [2004]
	Turnover (M€)	n.d.	n.d.	46	90	82
VTP–Valencia	Companies	21 [1993]	36	38 [1999]	n.d.	>300
(1990)	Employees	625	904	1200	n.d.	n.d.
	Occupancy	32.5%	45%	50%	n.d.	>80% [21]
	Turnover (M€)	n.d.	n.d.	n.d.	n.d.	n.d.

Sources: own elaboration from: PTG (2004), Ondategui (2001), Cartuja93 (2002), APTE (2003), Hermosa (1998), IDEPA (2004); Rubini (2002), PTA (2004), Pessoa (2003), APTE (2003)

Concerning the creation of new firms, the data available for the above five parks reveals an even greater range of performances. In Taguspark and PTA of Malaga, significant and positive rates of new firms' creation were continued with the operation of an advanced incubation support structure (see Table 3-10). In the first, around 60 of the 146 firms operating in 2001 were new firms created inside the Park's space (Rubini, 2002), an average annual rate of ten firms/year. In the Malaga Park, more than 190 firms were created in the Park's main incubator (BIC-Euronova) in a period of twelve years (1992-2004)(PTA,

[19] The employees' number includes all employees in the Park –administration and research centres- and not only of the companies established in the Park.
[20] Occupancy rates provided refer to the percentage of available space in the Park occupied or sold to any type of tenant.
[21] Based on map view

2004), with more than ten graduating/year. In Cartuja93, despite the absence of a dedicated incubation support structure, around 25% of the total Park tenants (around 70) were new firms in 2005(IAT, 2005). The absence of a dedicated incubation structure, however, means that a direct connection between the STP operation and their creation is not possible. Close to the EU average firm creation rates were recorded in the incubator of the Park of Castilla y Leon (BRP) (6.2 firms/year) for the period 1993-2000, with 23 firms graduating in that period (3.3/year) (Guillermo, 2002). Finally, in Valencia, the CEEI incubator reported the operation of 16 firms in 2005, but there were no data available on new firm creation.

Table 3-10: New firms' creation in STPs

PARK	Space for new firms (m^2)	Firms in incubator (last year available)	Number of new firms created (years of operation)	Annual firm creation rate
TTP	1200	8	21 (10)	2.1
STEP-C	4000	23	40-50 (10)	4-5
TESPA	320	6	11 (12)	0.9
Tecnopolis	2500	28	50 (20)	2.0
Taguspark	3 incubators		60 (6)	10
TPA	4100 [22]	38	>190 (12)	16
Cartuja 93	-	-	>70 (11)	>6.3
PTA	1300	20	100 (11)	9.1
BTP	5500	24	50 (8)	6.3
PTG	6000	35	n.d.	n.d.
VTP	2587	16	n.d.	n.d.
EU aver.	*3000*	*27*	*66 (10)*	*6.6* [23]

Sources: Guillermo (2003), Guillermo (2002), Freire (2003), Rubini (2002), Ondategui (2001), STEP-C (2004c), TTP (2004b), Pessoa (2003), EC (2002)

Overall, the secondary sources and the data available on the Parks' evolution reveal a broad range of performances. Asturias and Galicia have, so far, displayed very low performance levels, at least in relation to their priority function for the attraction of firms. The other Spanish cases and Taguspark of Portugal reveal more positive performance levels, reaching occupancy rates close to 100% by the end of ten years, with important activity and employment growth rates and further expansion in size in the case of some (BTP, Taguspark). Among the small and incubation-focused Greek STPs and Bari Tecnopolis,

[22] Refers only to the Bic-Euronova incubator
[23] For the specific size of incubator and number of tenants

either moderate (in the case of STEP-C and Tecnopolis) or poor performance levels (TTP and Attica) were found. The high space occupancy of over 80% o was achieved in these cases only by sacrificing expected turnover and creation rates, thus jeopardising or not being able to sustain their incubation function.

3.5.2 The STPs' innovation intensity

While the growth of the Parks' activities and high occupancy levels is an important precondition for their viability, it is only to the extent that these activities are knowledge-intensive and have the real high-tech character needed by STPs in order to be considered as achieving real success. The establishment of low-tech, low innovation intensive firms and their transformation to simple business incubators or industrial parks is, on the contrary, an indication of failure. An assessment of the Parks' knowledge intensity is made by examining the characteristics of the public research organisations (PRTOs) operating inside the Parks, as well as the sector of activity of the firms, the functions brought inside the Parks and the resulting R&D intensity of the Parks' operations.

3.5.2.1 The STPs' public research and technology organisations

In all STPs, the PRTOs, university departments and government research institutes, provide an important input to the Parks' R&D base. In the technology-led and small Greek and Italian Parks, the research centres and institutes have a dominant role, reaching levels as high as 90% of the total activity and space (see Table 3-11). The Greek PRTOs, FORTH, CERTH and NCSR Democritus, focus on basic and (mainly) applied R&D and less so on technological development. They are centres with significant weight and important roles in the national public R&D activity, characterised by dynamism not present in the Greek HEI sector (Tsipouri, 1991; EC, 1996). In Tecnopolis, the Park there has some applied R&D activity from the University of Bari veterinary medicine labs, but the greater weight is on technology development and services provision from CSATA NOVUS ORTUS and CENTRO LASER technology centres. What is critical in the three cases, and not possible to assess based on secondary data, is the extent to which these knowledge inputs are transformed into innovation activity.

Table 3-11: STPs' public research organisations

Park	PRTOs in park	Type of R&D activity (listed according to priority)	PRTOs' employ-ees[24]	PRTOs' Turn-over (mil.€)[24]	% of STP employ-ees
TTP – Thessaloniki	4 R&D institutes	Applied research Tech. development/services	390	18.3 [2004]	90%
STEP-Crete	4 R&D institutes	Applied research Tech. development/services	800	35 [2004]	80%
TESPA – Attica	8 R&D institutes	Basic and applied research Tech. development/services	847	29.8[2003]	>95%
Tecnopolis - Puglia	2 R&D institutes 1 university dep't	Tech. development/services Applied research	220		70%
Taguspark - Lisbon	5 R&D institute 3 university dep'ts	Applied research Tech. development/services	600	41	10%
TPA – Malaga	27 tech. centres 1 university dep't	Applied research Tech. development/services	650	40	12%
Cartuja 93 - Seville	31 R&D and tech.centres 2 university dep'ts	Basic research Applied research Tech. development/services	1500	79	15-20%
PTA – Asturias	1 regional tech. centre	Tech. development/services	70	4	3.5%
BTP – Castilla y Leon	5 regional tech. Centres	Tech. development/services Applied research	500	40	10%
PTG – Galicia	2 tech.centres	Tech. development/services			
VTP - Valencia	6 regional + 3 national technology centres	Tech. development/services Applied research	>750	>50	

Source: own elaboration based on: APTE (2003), Ondategui (2001), STEP-C (2004c), Tecnopolis (2005),TTP (2004b),GSRT (2004),Pessoa (2003) and own survey

[24] Last year available

In the Spanish and Portuguese Parks, the presence and weight of the public research organisations represent a clear differentiating element (Table 3-11). Taguspark in Portugal nowadays represents a rather strong base of more than 600 employees in applied R&D and technology development activities, representing around 10% of the total Park employment. Even stronger, in 2003 Cartuja93 concentrated over 30 research and technology organisations that employed around 1,500 employees, more than 15% of the total Park employment. The four CSIC[25] institutes, the University of Seville Engineering School, as well as more than 20 regional technology centres, cover a wide range of sectors and range from pure/basic research to the provision of specialised technology services. A strong concentration of PRTOs, with greater focus on applied research and technology development, is also apparent in the cases of PTA-Malaga, Valencia and Castilla y Leon. It is the result of the transfer of the R&D units of the local universities and/or the creation of an important number of technology centres in the three regions that coincided more or less with the STPs' creation.

In comparison, public research and technology activity in the Parks of Galicia and Asturias is much more limited. Until 2005, the regional universities had not located any R&D unit inside the Parks' space, despite initial reported plans (Ondategui, 2001) and despite formal partnerships with the Universities of Salamanca and Santiago de Compostella, in the case of Galicia Park. Inside the Parks, only small regional technology centres' R&D activity (wood and meat-processing in Galicia and materials processing in Asturias) that represent only minor shares of the total employment can be found. In comparison to the other STPs, there has been limited priority or capacity by the promoters to attract significant levels of public R&D and knowledge creation activities.

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[25] CSIC (Spanish National Research Council) is the largest public R&D body in Spain, with institutes operating in almost all regions.

3.5.2.2 Private sector activities' knowledge and technology intensity

Even more critical for the STPs are, however, the presence and characteristics of the activities of the private sector brought or created inside the Parks' space. The sectoral and functional distribution and the total share of R&D activities are indicators that can provide part of the picture of the knowledge intensity of the Parks' activities.

ICT and engineering and technical business services firms are the most dominant types (Table 3-12). ICT sector firms have shares between 15% and as much as 85% of the existing number of tenants (Tecnopolis), with informatics and software development holding the dominant share and telecommunications and electronic manufacturing activities less common. In the Cartuja93 and Asturias cases, engineering and technical services firms have similar or even greater weight (APTE, 2003) (Ondategui, 2001). Other high-tech sectors such as biotechnology, medical technologies, robotics and automatics, aeronautics, environment or energy related technologies are present in most of the Parks at smaller rates. Altogether, all STPs host important shares of firms in the so called new or high-tech sectors, ranging from 50% up to 90% of their total tenants.

However, the above rates also show the weight of non-high tech or knowledge intensive sector firms. The Parks' lists include low-tech manufacturing or services in low-knowledge intensity areas such as retailing or other traditional business services; they have particularly high weights in some of the STPs. In the Taguspark, the PTA and Cartuja93, more than 20% of tenants could be considered as belonging to activities with no apparent high-tech character[26]. They include public administration activities or basic business services (travel agents or banks) (IAT, 2004). In other STPs, these numbers are even higher. Around 50%

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[26] The data available in Cartuja93 reveal, however, lower shares in terms of employment or economic activity. Similar data are not available in other Parks (IAT, 2004).

of the tenants of the Valencia Park in 2005 belonged to sectors with limited knowledge content, while in 2005 in Asturias this was close to 30%. More importantly, both of these two Parks formally or informally lowered their admission criteria before 2000 (Garcia, 2001; Maldonado, 2001) in terms of expected knowledge intensity. This appears to have attracted a high number of activities of a questionable character. In the Galicia and Boecillo Parks, low-tech sectors firms have shares among the total tenants in the range of 15-20%. The presence of low-tech firms is evident, however, even in the small Tecnopolis park of Puglia or the Greek STPs. STEP-C and TTP tenants include travel agents or local associations occupying part of the Parks' space. While limited in numbers, they still occupy part of the equally limited incubator-space.

Table 3-12: Share of high tech sectors in STPs

PARK	Sectors present in the Park (% of total number of tenants)	% of firms in less-knowledge intensive sectors
TTP[27]	ICT (40%), Engineering services (14%)	30-35%
STEP-C	ICT + electronics(45%), Biotech (13%)	30-35%
TESPA[28]	ICT, Biotechnology, Engineering services	n.d.
Tecnopolis	ICT (85%), Environment	15%
Taguspark	ICT(80%), Energy, Environment, Materials	5-10%
TPA	ICT and electronics (50%), Advanced business services (10%), Biotech, Aeronautics, Environment, Materials,	20%
Cartuja 93	ICT (20%), Advanced business services (27%), Environment, Biotechnology	15-30%[29]
PTA	ICT (25%), Engineering and technical services (35%), Chemicals/plastics, Electronics, Textiles	20%
BTP	ICT (52%), Advanced business services (13%), Automatics/Robotics (10%)	13%
PTG	IT (25%), Agro-industrial (18%), Manufacturing (11%), Environment	5-%
VTP	ICT (10%), Advanced business services (14%), Biotech (2%), Various high-tech manufacturing (6%)	25-55%

Sources : own elaboration based on : Guillermo (2003), Pessoa (2003), Rubini (2002), APTE (2005), Souitaris (2000)

[27] Based on data for the whole period of operation
[28] Based on the data available for 2000 (Souitaris and Daskalopoulos, 2000).
[29] There is important variation between the data provided from the study of IAT(2004) and the data available from APTE (2004). The first indicate that firms in basic services comprise around 18% while the APTE data suggest around 33% of tenants belonging to "others". The two lists classify firms under different sectors on many occasions.

The sectoral distribution of the Parks' tenants provides, however, only part of the picture and does not say much about the actual activities/functions developed inside the Park and the new knowledge and innovation creation. The data available in this direction from each Park are rather limited and the use of different sources reduces their comparability. Nevertheless, they still reveal important variations among the examined cases.

The presence of dedicated R&D units of either large national or of multinational firms is limited in all STPs. The R&D units of FORTHnet in STEP-C and FIAT technology centre in Tecnopolis of Bari are the only examples in the examined technology-led Parks. Not more than two or three such tenants can be found among some of the larger Parks. The R&D units of the local origin of rather large firms such as MacPuarsa and Tecnologica in Cartuja93 are such examples. The Taguspark hosts the R&D unit of Portugal Telecom, Telefonica[30] has an R&D unit in Boecillo Park and in Malaga Park one could find the R&D units of Alcatel[31] and Hughes Microelectronics in the past (Romera, 1995) or Cetecom/AT4Wireless and Vodafone recently. PT of Galicia hosts the R&D units of the local origin food-processing firm Corren.

The presence of some R&D activity in parallel to the production, services provision or administration functions of firms is more common, however. The examined STPs differ in the shares of aggregate R&D employment and expenditure, indicators of different knowledge intensity and potential innovative capacity (see Table 3-13). In the Cartuja93 Park, around 10% of the firms' turnover is invested in R&D activities, with 76% of companies stating participation in one or more R&D projects and more than 20% of the total employment dedicated to R&D activities (Ondategui, 2001; Cartuja93, 2004). Similar

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[30] The main Spanish telecommunications company

[31] They were present in the past through some local partnerships.

levels of knowledge intensity were found in the Malaga park (APTE, 2003), while a study of Taguspark that focused on the smaller sized firms referred to even higher R&D expenditure shares of 23% of their total turnover (Pessoa and Lopes, 2003).

The data available for the other STPs are limited and do not allow for clear conclusions. Boecillo Park has an important concentration of R&D employment, but with much greater focus on technological development (Ondategui, 2001). In Galicia, the high shares of R&D employment (65%) recorded in 1997 were due to the limited employment (200) at that time and the dominance of the Corren research unit. Based on Ondategui (2001), Asturias had the smaller levels of R&D employment , all coming from the public sector (COTEC, 2000), and the same applied to Valencia Park which had, until 2000, maintained the high-tech criteria. Since then there has been a sudden inflow of tenants into the Park (from 38 to more than 300), but a large part of them are non-innovation/technology oriented firms.

The overall picture is that of coexistence at different levels in all STPs of both knowledge-intensive activities and sectors largely absent from the respective regional economies in parallel with more traditional firms, that contribute little in building a high-tech space. The Parks of Malaga, Taguspark and Cartuja93 STPs reveal a more positive picture based on the important share of total R&D activity, the strong presence of public R&D and few private R&D labs. On the contrary, Asturias, Galicia and, after 2000, Valencia Park provide much less positive results, both in relation to the role of the public sector as well as that of the private.

Table 3-13: R&D intensity of STPs

PARK	R&D empl. (% of total)	R&D exp. (% of turnover)	% firms stating R&D activity	% of employees with tertiary education
TTP[32]	n.d.	n.d.	65%	>80%
STEP-C[32]	n.d.	n.d.	>80%	>80%
TESPA[32]	n.d.	n.d.	>60%	n.d.
Tecnopolis[32]	50%	n.d.	n.d.	66%
Taguspark[33]	24%	23%	n.d.	68%
TPA[33]	25%	8%	n.d.	
Cartuja 93[33]	20%	10%	76%	56%
PTA[33]	10%	n.d.	n.d.	n.d.
BTP [33]	24%	n.d.	n.d.	n.d.
PTG[33]	65%	n.d.	n.d.	n.d.
VTP[33]	40%	n.d.	n.d.	n.d.

Sources: own elaboration based on Ondategui (2001), Pessoa (2003), Tecnopolis (2005), Souitaris (2000), TTP (2004b)

Among the small technology led STPs, the absence of aggregate data make the assessment of the tenants' R&D intensity difficult. According to Souitaris and Daskalopoulos (2000), more than 75% of the firms in the two Greek Parks stated the presence of some form of R&D activity. However, TTP Park managers themselves suggest that 45% of the tenants have a real-estate character with no real R&D activity, even if they belong to knowledge intensive sectors (TTP/MDC, 2004). Souitaris and Daskalopoulos (2000) questioned the R&D intensity and the appropriateness of a number of some of the firms in the Greek Parks. In the Tecnopolis Park, the management reported around 280 R&D related employees, 60 of them in the private sector (50% of total private sector employment). Brought together, the above limited data suggest a small variation in relation to the high-tech content of the three technology-led STPs. Both the Greek STPs as well as the Italian cases host innovation-oriented firms which add to the research centres' activity and support the Parks' base in parallel with firms which appear to have limited knowledge-intensity.

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[32] Refers only to firms

[33] Refers to the total Park employment

3.6 Parks' classification based on performance levels

Based on the analysis provided, the examined Parks can be placed at different positions along the success - failure matrix (see Table 3-14). Among the technology-led Parks group, the TTP and Attica Park provided the weakest results when assessed in comparison to their own objectives and against the performance of the remaining STPs. Besides the strength of the public research centres, the presence and dynamism of the private sector element remained limited, with poor results in the incubation function. In comparative terms, STEP-C and Tecnopolis have shown more positive performance levels in terms of the creation of firms, even if again at below average rates, although not very different knowledge intensity levels.

Among the large scale property-led Parks, PTA of Malaga, Taguspark and Cartuja93 STPs have followed a parallel and overall positive pattern of activity growth, reaching comparatively higher levels of knowledge intensity. This applies even though there are questions concerning the innovative intensity of an important part of the established companies and the level of space occupied. In comparison, Boecillo Park in Castilla y Leon (PTB) had a more moderate performance. The positive activity growth and occupancy rates have secured the viability of the Park and the expected future expansions represent positive indications. However, there is still lower R&D presence and intensity, both public and private, in comparison to the previous examined cases. Less positive is the performance documented in the Valencia Technology Park, where the apparent high activity growth rates of the years since 2000 coincided with high shares of non-knowledge intensive activities hosted in the Park, eroding the presence of an important public R&D base of regional technology centres and providing an example of a Park that only partially fits with its high-tech label. Finally, the overall performance of Galicia and Asturias Parks is worse, as they both have serious problems in filling their space, as well as maintaining their high-tech character. Attraction of firms has been so far problematic, with only the business offices and incubation building achieving positive performance rates. The knowledge intensity of the activities hosted is in both cases questionable, with weak presence of public sector R&D, rising levels of non-high tech sectors and knowledge-intensive activities. The formal decision to relax the admission criteria in the case of Asturias (Ondategui, 2001) is probably the clearest indication of failure to adhere to the character of a STP.

Table 3-14: Relative classification of STPs performance by activity and knowledge intensity (property led type STPs underlined)

		Knowledge intensity (relative performance for each type)		
		Low	**Medium**	**High**
Occupancy +activity growth	**High**	VTP - Valencia	BTP Boecillo	TPA - Malaga Cartuja93 Taguspark
	Medium		STEP-Crete Tecnopolis - Bari	
	Low	PTA Asturias PTG Galicia	Thessaloniki Park Tespa - Attika	

Source: own elaboration

3.7 Selection of cases

Based on the analysis, the selection framework described leads to a number of alternative choices for further study. Among the property-led STPs, based on the increasing variation of performance, this leads to a choice between Taguspark, PTA and Cartuja93, as the most positive cases, and Galicia and Asturias as the most negative. From the technology-led group, Tecnopolis in Bari and STEP-C in Crete provide a more positive outlook, while TTP and TESPA represent the most negative examples. Among the latter, Thessaloniki Park was considered as more appropriate due to the very small size of Attica Park, the extremely small number of firms and, thus, the clear possibility that synergies and inter-firm linkages would a-priori be absent. Language constraints in the case of Bari Tecnopolis led to the selection of STEP-C as the 2nd technology-led Park case.

The selection of two Greek Parks also guided the choice of two Spanish STPs among the property-led cases. The comparison of the Spanish and Greek cases provides additional benefits due to the common institutional framework and relevant national technology policy tools applicable to the parks in each country. The choices of Cartuja93 and PT Asturias, and again the cases of Malaga and Galicia, were a result of the researcher being able to establish contacts with key persons in each region (but not directly linked with the Parks) before the initiation of the field work; this supported the arrangement of interviews with important/key players.

The four cases selected (see Table 3-15), Thessaloniki Technology Park in Central Macedonia, STEP-C of Crete, Cartuja93 of Andalusia and PTA of Asturias, serve the criteria set for the selection of cases for a comparative analysis. They represent the two main types of STP development strategies and, at the same time, they reflect different evolution and performance patterns. They provide the necessary variation in order to identify the role that different internal and external parameters can play in the Parks' development, evolution and performance.

Table 3-15:STP cases selected and main selection criteria

Park name	Country	Region	Typology	Activity growth	STP technological intensity
TTP	Greece	C.Macedonia	Technology led	Low	Medium
STEP-C	Greece	Crete	Technology led	Medium	Medium
PT Asturias	Spain	Asturias	Property led	Low	Medium-Low
Cartuja93	Spain	Andalusia	Property led	High	Medium-High

Source: Own elaboration

3.8 Data collection in the field

Turning to the fieldwork and the data collection, the approach followed in each case was a combination of qualitative and quantitative research methods. Methodological and data triangulation (Yin, 1994) was employed based on the combination of tenants' surveys, semi-structured and open-ended interviews with important players' representatives and local experts, as well as other secondary sources (newspapers/journal, internet sources, existing studies, administrative documents).

The fieldwork in each case was completed in two periods/trips. During the first trip, interviews with the Park managers, main promoters and STP shareholders were conducted. The objective at that time was to establish in greater detail the Parks' history and evolution with the collection of primary data, understand their structure and operation and identify the critical players and their objectives and priorities. Furthermore, aggregate qualitative and quantitative types of data were collected concerning their tenants' activities and the developed services. The information collected in the first round was used as feedback for the second stage that included a questionnaire-based survey for the Park tenants: firms and research organisations. The analysis also served for the formulation of additional questions for a second round of interviews with other regional players beyond the STPs' space.

3.8.1 Interviews with stakeholders and experts

A total of 41 semi-structured interviews with mostly open-ended questions and few closed-end questions were performed in the four cases, including actors inside and outside the Parks. The internal actors involved the management teams' directors, as well as representatives of the STPs' promoters and the management team shareholders.

For the non-park actors, the objective was to interview representatives of the most relevant players of the regional innovation system. This group included policy makers and government officials, university and research organisations' directors or other persons with responsibility in the area of R&D and technology transfer, local industry association representatives, directors/managers of other organisations operating in the areas of knowledge and technology transfer or the businesses' innovation support. This group was complemented by local individuals/experts identified based on their academic/research work or recommended during the interviews with any of the previously mentioned actors (see Table 3-16). The omission of regional authorities in the case of Asturias, despite consistent efforts[34], is partly counterbalanced by the fact that the regional development agency and the organisation that is responsible for the Park management (IDEPA) is directly controlled by the regional government and is the entity that implements the regional government policies. Overall, the interviews cover a wide range of viewpoints concerning both the activities inside the Parks' space as well as the important interactions with the external environment.

Table 3-16: Interviews conducted according to type of organisations represented

	TTP	STEP-C	Cartuja93	PT Asturias
Park management entity representative	2	1	2	2[35]
Shareholders (% of management entity capital represented)	3 (80.33%)	2 (60.24%)[36]	3 (95%)	1 (100%)
STPs tenants association	Not exist	Not exist	1	Not exist
Regional gov't representative	1	1	2	-
Regional HEI representative	1	1	1	2
Regional industry representative	1	1	-	2
Intermediary organizations/agencies representative	1	1	1	3
Local experts	2+1[37]	1+1[38]	1	-
Total	**12**	**8**	**11**	**10**

Source: own elaboration from fieldwork

[34] The heads of both the regional ministry of industry and employment and of education and science declined repeated requests for an interview.
[35] Includes a representative of the regional development agency (IDEPA) and one of CEEI, the entity responsible for the development of the Park incubator.
[36] Remaining percent is dispersed among many small firms and investors.
[37] Includes a former policy maker at the national level that referred to both Greek STPs.

In the case of the STPs' management teams, the questionnaires (see Appendix 5 - STP management entity interview questionnaire) included quantitative and qualitative information covering the following areas:

- objectives of the Park and the management team
- the Park facilities and infrastructures
- management team structure, organisation and operation
- basic and advanced services developed inside the Parks' space
- the Parks' tenancy and activity levels and the characteristics of the Parks' tenants
- cooperation and linkages with other regional actors and their role in the Park operation
- perceived added-value of the different elements/services of the STPs for their tenants
- strengths and weaknesses of the regional innovation systems

While in each case the questions varied depending on the type of organisation/actor represented, for the remaining regional organisations/actors, the interviews covered the following areas/topics:

- Background information of each organisation/expert and description of their role in the innovation activity and policy making of the region.
- Reasons for participation in the STP project and their objectives from the STPs (for Park shareholders).
- Role/relation and the linkages and interactions developed (or not) with the STPs' management team and the STPs' tenants and their evolution over time.
- Assessment of the Parks' operation in relation to their activity growth, the high-tech character, their role in attracting firms and creating new firms, their supportive role in innovation cooperation and technology transfer.

- Strengths and weaknesses of the regional innovation systems.

3.8.2 Survey of STP firms and PRTOs

The interviews with the above internal and external players were complemented by a questionnaire-based survey that targeted the Parks' firms and public research organisations (PRTOs). (see questionnaire in Appendix 6 - PRTOs questionnaire and Appendix 7 - Firms questionnaire),

3.8.2.1 PRTOs survey

The research organisations' survey was based on a questionnaire completed in person by the director of each organisation or by another person appointed by the director. The questionnaire included 33 questions developed in five sections, covering the following areas/topics:

1. General information on PRTOs: date of creation and location in the Park, form of the organisations, shareholders and supervising authority (if applicable).
2. PRTOs research activities: areas/sectors of R&D activity, characterisation of R&D activity and priority given to each type, role of external sources in the development of the organisations R&D capacity, evolution of researchers and research budget over time, sources of financing and income creation, research activity results, training activities.
3. PRTOs cooperation patterns and contacts with industry: incentives/reasons for cooperation, importance of different public and private partners and their geographical location (in Parks, region, national, international), evolution of cooperative activity at different special levels, types of linkages developed with other research organisations and firms, mechanisms for partners identification, obstacles in cooperation development.

4. STPs role for the PRTOs: reasons for location of the PRO in the Park, perceived added-value from infrastructures, services, proximity to other tenants and environment, services use and added-value.
5. PRTOs broader local/regional environment: assessment of the regions' environment in relation to the PRTOs' operation in terms of infrastructure, demand for technology services, relevant support mechanisms in technology transfer, quality of human capital, financing support mechanisms.

The identification of the research organisations was based on each Park's directory. In the case of research centres that operate as umbrella organisations(FORTH, CERTH, CSIC), the individual institutes were used as separate entities as they operate in different sectors and have a significant level of autonomy. The response rates achieved (see Table 3-17) can be considered as satisfactory. In the case of Cartuja93, the total of nine responses represented 26% of the existing R&D units, but covered more than 50% (801/1530) of the total employment in this sector. Moreover, the engineering school (AICIA), CSIC 4 research institutes, the Institute of Technology of Andalusia (IAT) and two more technology centres (CITAGRO, CENTRE) represent more than 95% of the total 1629 ISI scientific publications produced in the park during the period 1994-2005 (ISI, 2006). The survey does not include R&D units in the areas of social sciences or statistics or public agencies and business support organisations (e.g. Citandalucia or Sevilla Global) that were classified as R&D units in the Park directory and were part of the interview group.

Table 3-17:PRTOs' responses

	TTP	STEP-C	Cartuja93	PTA
Number of PRO units in the STPs (2005)	4	4	34	1
Responses	3	4	9	1
Share of PRTOs' employment covered	94%	100%	53%	100%

Source: survey results

3.8.2.2 Firms' survey

The tenant firms' survey was conducted based on a questionnaire that covered the following areas/topics:

1 Tenants basic characteristics: name of the firm, status of park unit (independent or subsidiary, existing or new), sector of activity, size of the firm, type of location occupied inside the Park (plot, offices, incubator), date of entrance in the Park, origin (local vs. not local), type of functions developed inside the Park space.

2 Economic activity of the tenant: employment and turnover size and evolution, shares/weight of different markets in the sales, supply of materials and equipment and workforce skills.

3 Innovative activity and capacity of each tenant: R&D intensity (share of R&D in employment and turnover), type of R&D activity developed, innovative results (new products/processes, patents), share of innovative products in total activity, importance of different activities in the development of firms' technological capacity, participation in publicly funded R&D programs.

4 Partnerships and linkages: presence and importance of various types of public and partners at different geographical scales (STP, regional, national, international), types of linkages developed with those partners (formal, informal), reasons/incentives for developing R&D cooperation, obstacles in cooperation.

5 Assessment of the STPs' role: reasons for locating in the STP, level of use and satisfaction with different elements linked to the Park location (infrastructure, basic and advanced support services, linkages with other tenants).

6 Tenants' broader Park environment: assessment of the regions' environment in relation to the firms' operation in terms of infrastructure, market size, support mechanisms, human capital, education and technology levels, access to finance.

The majority of the questions were formulated using a closed-end format with the opportunity for alternative answers. An important number involved assessment/evaluation concerning the presence, weight or importance of specific parameters (e.g. the presence of a specific activity, the importance of a specific partnership, the added-value of the provided services). A 5 – point Likert scale was used, with the additional option of a "no opinion" or "no use" (in the case of services) response. The questionnaires were developed in English and subsequently translated into the local language.

In the Greek Parks, due to the small number of tenants, the survey was performed during the fieldwork through appointments arranged with the tenant firms' managers or other persons appointed by them. Non-technology related firms such as tourist agents or a local association were not included. While some firms refused to participate in the survey, the final results represent over 50% of the total population and should be considered as representative of the situation at the time of the survey (see Table 3-18 below).

A similar approach was not possible in the case of the Spanish Parks which, at the time of the survey, hosted 103 tenants in the STP of Asturias and 278 in the case of Cartuja93, according to the Parks' directories. From those, a decision was taken to exclude from the target population firms/tenants that were listed in the Park directories under the basic services sectors such as travel agents, catering, public administration and wholesale/retail sectors and others. This was considered appropriate, given that the focus of the survey was towards firms with some form of technological activity/content which could provide insight into the role of the Park environment and not simply produce mainly "no-use" or "no-relevance" answers. The final target population was reduced to 74 tenants in Asturias and 155 in Cartuja93.

The initial objective of the survey was to receive responses from, if possible, all the firms/tenants. A three-stage approach was followed. Firstly, an electronic mail was sent to all firms explaining the objectives of the research and inviting the respondents to access a web-based version of the survey. Two reminder emails were sent ten days and 30 days later. The e-mail addresses for each firm were gathered from the Parks' online directory (Cartuja93, 2004; PT Asturias, 2007). A limitation found here was that the email addresses available referred, in some cases, to marketing or customer relations departments, while the nature of the study required that the survey was completed by a person with a thorough knowledge of the firms' activities – especially in the area of innovation. In some cases, this was rectified through research on the firms' web site to identify the appropriate email addresses. In addition, the e-mail sent and the survey introduction page asked that the questionnaire be completed by a person with the relevant position. Despite these efforts, response rates during this first step were limited. From a total of 76 and 212 valid email addresses in the Asturias and Seville Parks respectively, there were only four responses from the former and six from the latter, while 1/3rd of the questionnaires were only partially completed.

For the second stage, the survey was organised via direct communication with firms by phone, during which a more appropriate person was identified and an electronic version of the survey was sent or, in the majority of the cases, an appointment was arranged for the in-person completion of the questionnaire during the period of the field trip. Given the time limitations of the fieldwork, however, the focus was to create a representative random sample following the classification of the tenants' population in strata. The criteria considered as relevant for the classification of the Parks' tenants in strata included:

- tenants' ownership structure (independent firm or subsidiary)
- origin (local or non-local)

- newness: new or existing firm
- size of firm
- activity sector
- type of space where firm was located (incubator, office space, plot)

All the above are parameters that the literature identifies as having potential to determine a role for the firms' relationships/linkages with their broader environment. From the above criteria, only the last two, the sector of activity and the firm's location, were available for all firms in the Parks' directory and were thus used for the grouping of the tenants' population.

As can be seen in Table 3-18, the response rates achieved in both Spanish Parks were relatively low, which means that the expected confidence intervals in most of the questions can be expected to be very wide. Statistical significance tests are thus not applicable. The small numbers also limit the capacity for the use of more advanced types of statistical analysis such as the grouping of tenants in larger clusters, as performed in other studies, or the examination of correlations between firms' characteristics and their responses to different questions. As a result, the analysis was limited to the use of descriptive statistics for each Park case and the conclusions reached from the picture provided did not include claims made about statistical significance.

Table 3-18: Survey population and response rates

	CARTUJA93	PT ASTURIAS	TTP	STEPC
Firms operating at time of survey	278	103	7	21
Firms contacted	155	74	7	21
Responses	27	28	5	11
% of responses	16.7%	37.3%	71%	52%

Source: survey

Given these limitations, it can still be argued that the results provide a good picture of the processes and mechanisms developed inside the Parks. The sectoral distribution in the sample of all four parks (Table 3-19 and Table 3-20) shows a good match with that of the target population. The only sector from which no responses were received, due to negative responses from all firms contacted, were the media and communication sector in Cartuja93 Park. It is unclear whether the activity area actually involves knowledge intensive activities, as it included both a couple of television broadcasting firms as well as film and advertisement producers. While clearly an omission, it is not considered critical in our understanding of the phenomena taking place in the Park.

Table 3-19: Spanish STPs' firm population and sample distribution by activity sector

PTA					Cartuja93				
Sector	**Firm Population**		**Sample**		**Sector**	**Firm Population**		**Sample**	
	N	%	n	%		N	%	n	%
ICT	25	33	10	36	ICT	57	36.7	10	37
Engineering and technical services	35	47	14	50	Engineering and technical services	36	23.2	8	30
High + medium-high tech manufacturing	6[38]	8	2	7	Medical/pharmaceutical	6	3.9	2	7
Low and medium-low tech manufacturing	8[39]	11	2	7	Biotech/agro-food	6	3.9	2	7
					Energy + Environment	17	10.9	2	7
					Management consulting	19	12.2	3	11
					Media/communication	14	9.1	-	-
Total in survey	**74**	**100**	**28**	**100**	**Total in survey**	**155**	**100**	**27**	**100**
Firms not in survey					**Firms not in survey**				
Education/training	1				Education/training	14			
Wholesale/retail	8				Wholesale/retail	10			
Public administration	2				Public administration	18			
Other services	18				Other services	81			
Total Park tenants	**103**				**Total Park tenants**	**278**			

Source: Survey

[38] Pharmaceuticals (1), chemicals(1), medical equipment (1), electrical(1), transport(1), other machinery equipment(1)

[39] Textiles (2), plastic(2), printing/publishing (2),recycling(1),metal processing(1)

Table 3-20: Greek STPs' population and sample distribution by activity sector

TTP			STEP-C		
Sector	**Population**	**Sample**	**Sector**	**Population**	**Sample**
ICT	4	3	ICT	10	6
Automation	1	-	Engineering/business services	2	2
Medical/biomedical	1	1	Medical/biomedical	2	1
Agro-bio	1	1	Biotechnology	3	2
Total in survey	**7**	**5**	**Total in survey**	**17**	**11**
			Tourism services	4	
			Bank	1	
			Local association	1	
Total tenants	**7**	**5**	**Total tenants**	**23**	

Source: survey

Furthermore, in relation to the distribution of respondents by location, the sample reflects closely that of the survey population in both examined cases (Table 3-21). In the case of the Greek Parks, TTP included only firms in incubation status. In STEP-C, the sample included eight of the fourteen firms considered to be in an incubation function at that time and the three firms operating on a more permanent basis.

Table 3-21: Distribution of Spanish STP firms' sample by location

	Cartuja93				PT Asturias			
	Population	%	Sample	%	Population	%	Sample	%
Plots	34	22	7	26	31	41	12	43
Offices	97	63	17	62	23	31	8	28.5
Incubator[40]	24	15	3	11	21	28	8	28.5
Total	**155**	**100**	**27**	**100**	**75**	**100**	**28**	**100**

Source: survey

In relation to the remaining parameters, for which no data of the total population were available, it is not possible to assess whether the results are representative. Table 3-22 shows, however, that the dominant profile of local origin and independent firms fits with the picture provided in other studies in Spanish Parks (Hermosa and Barroeta, 1998) (Ondategui, 2001). There is a balanced presence of new firms created inside the Park and firms with pre-existing activity transferred inside the Park or establishing a new subsidiary unit. As for the firms' size, the dominant type is that of a very small firm with less than 25

[40] In Cartuja93, the central Park building (Pabellon de Italia) has a reduced rent scheme directed towards new high-tech firms, although other special incubation support is not provided.

employees, although in the case of Cartuja93 there was also a significant presence of firms with over 50 employees at the time of the survey.

Table 3-22: Distribution of STPs firms' sample by size, newness, origin and dependence and time of location in the Park

Parameter	CARTUJA93	PT ASTURIAS	TTP	STEPC
Size (number of employees)				
<5	3	9	2	7
5-25	10	10	3	3
26-50	3	7	0	1
51-250	6	2	0	0
>250	3	0	0	0
No answer	2	-	-	-
Newness				
Firm created in Park	11	10	3	5
Existing firm	16	18	2	6
Origin				
Local	22	25	4	10
Non-local	5	3	1	1
Ownership				
Independent firm	18	22	4	8
Subsidiary unit	9	6	1	3
Time of location in Park				
<1997	2	4	2	2
1997-2001	12	6	3	4
>2001	13	18	-	4
N	**27**	**28**	**5**	**11**

Source: survey

Another potential target population was that of firms that have graduated or are have committed themselves to moving inside the Parks, especially in the case of new firms leaving the Parks' incubator facilities/spaces (Dahlstrand and Klofsten, 2002). However, none of the Parks were able to provide lists of former or future tenants. Among those firms for which contact information was identified, only one in the case of TTP and one in Cartuja93 Park participated in the survey and responded to a questionnaire designed specifically to assess their experience in the STP and their reasons for departing from the Park space. In relation to incoming firms, four expected new entrants identified in Cartuja93 were contacted, but declined to participate in the survey. One of the three incoming tenants in PTA participated and two more from the TTP[41]. The questions

[41] In Cartuja93 Isotrol, Sando, Vorsevi, GDO that were according to the local press were contacted but did not respond. In the PTA I contacted Treelogic, Orto Iberica and Jesus Martin Alvarez Contrucciones from which only the first responded. In TTP I received answers from Biomatrix and Pharmathen.

addressed the type of activities they expected to bring to the Park; the reasons for their location and their expectations were used in a complementary manner.

This study did not include a control off-park sample. Although a control population is suggested as necessary to provide a counterbalance in the evaluation of policy measures (Weiss, 1998) and researchers have used it in some STP studies (Westhead and Backstone, 1999; Colombo and Delmastro, 2002; Löfsten and Lindelöf, 2002), in this study such a control sample was not considered necessary. The unit of analysis is not the individual firm, but the Park as a whole. The objective was not to assess the added-value of the Park location in the firms' performance, but to examine whether the expected functions of the general STP model actually develop and to identify the reasons/mechanisms that support or hamper their development. The comparison with firms outside the Park space could thus not support the examination of this research question.

3.8.3 Secondary sources

Finally, along with the primary data collected during the period of the fieldwork through interviews and the firms' survey, additional and complementary data were collected in all four cases from secondary sources. They concerned the STPs' creation and operation, the promoters' activities and priorities, tenants' activities and characteristics, the regional innovation systems' structure and operation, the role of important players and relevant decisions by the national and regional governments. The sources used included:

- National and regional government official newspapers
- EU, national and regional socio-economic and innovation related statistics' datasets (Eurostat, INA, IEA, SADEI, ESYE, GSRT)

- Public and private Spanish and Greek firms' databases (IDEPA, CBA, ICAP)[42]

- Publications and articles in academic journals

- Studies/ reports produced by regional authorities and other regional organisations in the framework of European and national programmes, as well as other studies of the local economy

- Firms and organisations' web sites providing firm data and annual reports

- Local business/commercial journals and newspapers' articles referring to Park-based and local firms' and organisations' activities

All the above sources, of varying degrees of reliability, were used as supportive or complementary evidence in order to "triangulate" information provided from interviews and surveys. The objective was to increase the validity of the conclusions concerning the Parks' operation, processes and role of different parameters.

3.9 Conclusion

Summing up, a multiple case study approach was selected to examine a complex and contemporary phenomenon where multiple parameters and the broader context have an important role in the way the related STP processes are designed and implemented. Following an analysis of the main parameters of STPs with a minimum of ten years of operation, three criteria for the selection of the cases were applied: representation of the two main STPs' development models, variation in terms of general performance and feasibility of conducting the necessary research work. This led to four cases being selected: the Greek Thessaloniki Technology Park in Central Macedonia and the Science and Technology Park of Crete (STEP-C), the Spanish Technology Park of Asturias and the

[42] IDEPA firm directory available at www.idepa.es provides information on Asturias firms. In Andalusia the Central de Balances de Andalucia (http://www.centraldebalancesdeandalucia.es/default.asp) provides information for 28.000 firms in Andalusia. In the case of Greece, the most extended is the ICAP database (www.icap.gr) that has local directories for Northern Greece and Crete.

Cartuja93 Technopolis in Andalusia. They are cases that reflect different development/focus strategies and which, according to secondary sources, have achieved different levels of performance.

In the following two chapters (4 and 5), the selected cases are examined in pairs. In each chapter, the researcher analyses the Parks' creation history and their operation and evolution, while studying the role of the STPs' internal parameters and that of the broader context and evaluating the development of the Parks' expected functions based on the STP model. The analysis in pairs allows the researcher to illustrate the differences in the role that variables and players, internal and external to the Parks, have played in the Parks' operation.

4 Chapter 4 - The Greek STP experiment: the Parks of Thessaloniki and Crete

4.1 Introduction

The Thessaloniki Technology Park (TTP) and the Science and Technology Park of Crete (STEP-C) are two of the older STPs operating in Greece. Both are typical technology-led STPs of small size that give priority to the promotion of technology transfer and entrepreneurship. Both reflect a strategy based primarily on the development of the mechanisms with a tendency to extend beyond their limited physical space and relate to the broader economy.

In the sections that follow, the main elements of the Parks' structure and operation are examined in parallel and their performance is evaluated. Following a presentation of the regions' socioeconomic structure and an analysis of the main features of the local innovation systems, a historical review of the Parks' creation and evolution is provided and the tangible and intangible features of their operation are examined. The fieldwork data from the firms' and PRTOs' surveys and the interview of key stakeholders are presented in order to assess the Parks' innovation intensity, the linkages and synergies created, the entrepreneurship support and NTBF creation record and to identify the impact of their operation in the broader region.

4.2 STPs' regional context

The first section examines the respective broader regional contexts, the structure of the economies, the characteristics of their regional innovation systems at the time of their creation and their subsequent evolution. Both are lagging regions in the EU context, have very similar scores in most innovation indicators and share a similar legal framework. However, there are important differences in the structure and the size of the respective economies, largely as a result of the island character of Crete, and also in the institutional capacity of the two regions, primarily as a consequence of the different roles of the local industry. The following paragraphs focus on the elements of the two systems that are relevant to the operation of the STPs, as well as on the broader national context.

4.2.1 The regions' socioeconomic base

4.2.1.1 Central Macedonia – metropolitan centre with traditional industry base

The region of Central Macedonia in northern Greece (see Figure 4-1) is the second most populated region in Greece, with a total of 1.7 million inhabitants in 1991which increased to 1.9 by 2001. The city of Thessaloniki is the largest metropolitan centre in the north part of the country, with around 1 million inhabitants living in the metropolitan area. After Athens, it represents the second most important economic and administrative centre in the country.

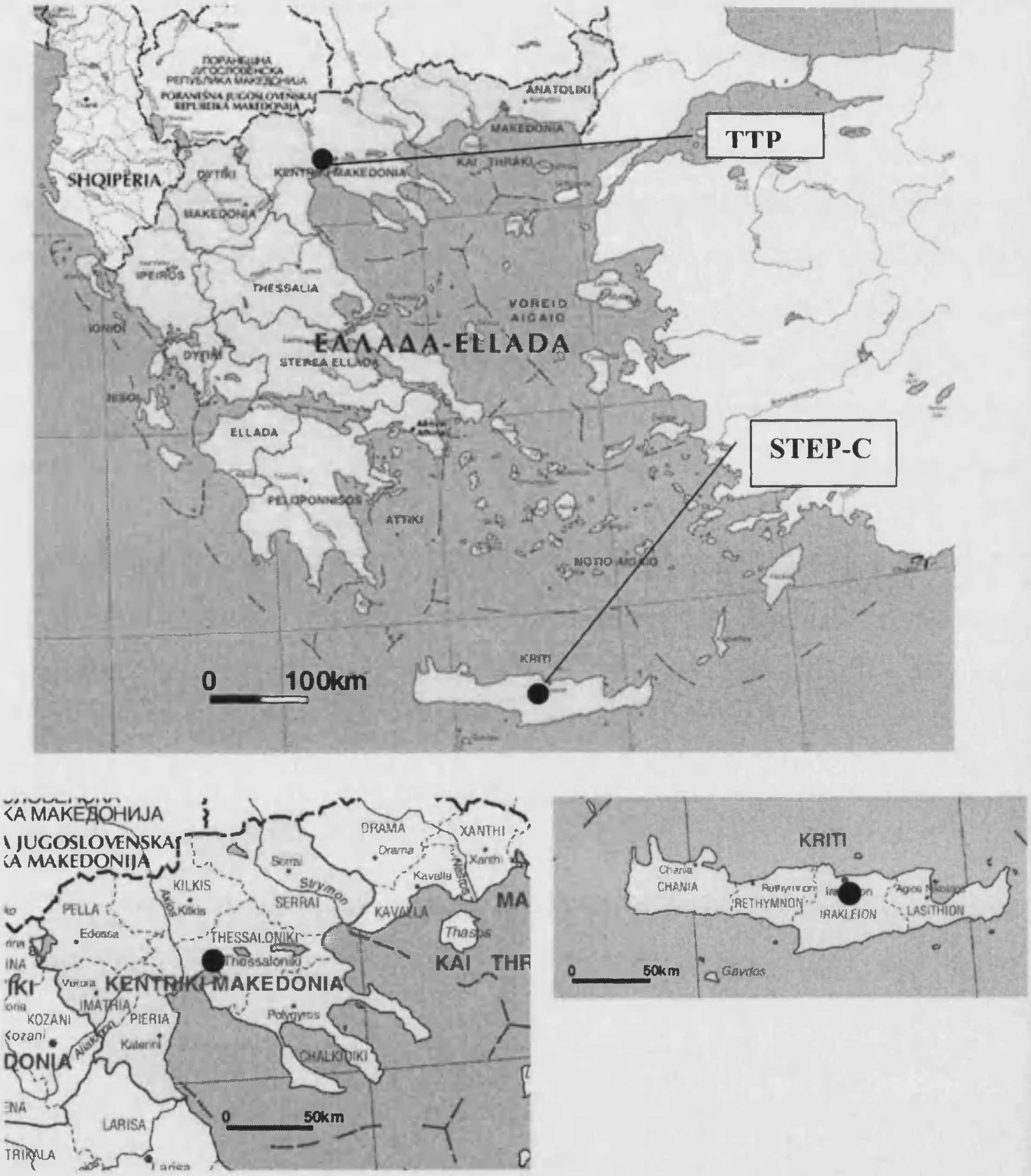
Around the time of the Park's creation (1991), the region accounted for 16.6% of the total GDP of Greece with an important presence in the manufacturing sector (see Table 4-1) that employed 28% of the regional workforce. Industrial activity was concentrated in the prefecture of Thessaloniki (over 70% of total secondary sector employment), while the other six prefectures of the region[43] were, and still are, characterised by high levels of activity in the primary sector (>30% of employment), with more limited industrial activity. The industrial base of the region was dominated by low and medium-low technology sectors (food and beverages, textiles and clothing, furniture, metals processing, chemicals

[43] Prefectures (nomoi) represent the NUTS3 administration level in Greece. The seven prefectures of Central Macedonia are Thessaloniki, Serres, Imathia, Pieria, Halkidiki, Kilkis, Pella

and plastics and electrical appliances) (Komninos, 1993). The limited higher technology manufacturing and services firms (less than 2.5% of total employment in 1994) were concentrated around the metropolitan area of Thessaloniki and involved primarily knowledge intensive market services (transportation, real-estate, financial and business services) (see Table 4-2). A gradual emergence of the ICT sector after 1995, including around 200 small sized firms (<50 employees) in 2004, concerned primarily retail activities (around 50% of total), less ICT services and software development (33%) and a only a very small number of hardware development and manufacturing firms (Komninos, 1993; Innovatia, 2004).

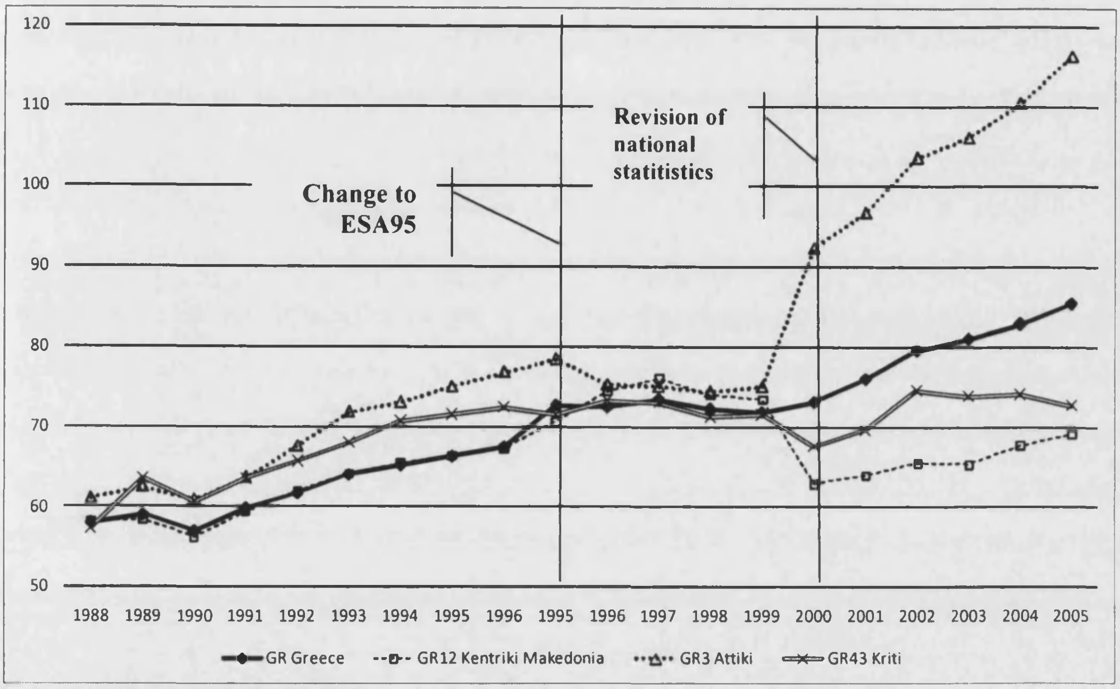
During the 1980s, Northern Greece experienced an important industrialisation wave in traditional low-tech sectors through the creation/relocation of new firms. This increased industrial employment by over 8% (Sefertzi, 1998) and supported above national average growth rates for most parts of the 1980s (Komninos, 1998)[44]. At the time of the Park's creation, however, Central Macedonia was back to a period of low growth rates. This was linked with the out-migration of many of the low-tech production units to Balkan countries in search of cheap labour (Labrianidis, 1996), which led to increase in industrial unemployment (from 6% in 1991 to 11% in 2001). The period after 2000 has experienced growth rates lower than the national average and well below that of the capital region of Attiki (see) (EUROSTAT, 2005a).

[44] Central Macedonia had an average growth rate of 2.3% in comparison to 1.8% for Greece.



Source: Europa(2004)

Figure 4-1: The location of TTP and STEP-C in Greece and in the regions



Source: EUROSTAT (2005a)

Figure 4-2: Greek regions GDP per capita in the period 1988-2005 (PPS) (EU15=100)

Table 4-1: Main socio-economic indicators of the two regions

	C. Macedonia		**Crete**		**Greece**	
	1991	**2005**	**1991**	**2005**	**1991**	**2005**
Surface (km2)	18811		8430		131.940	
Population (000s)	1707	1911	540	601	10300	10900
Employment (000s)	618	731	194	257	3632	4386
GDP (million Euros PPS)	15728	33372	5304	11043	94777	
% of national GDP	16.6	17.2	5.6	5.2	-	-
Unemployment rate	6.0	11.1	4.0	7.1	7.7	9.8
% of popul (25-64) with tertiary education		21.4		19.6		20.5
Workforce structure						
Agriculture	25.1	12.6	43.9	21.3	22.2	12.4
Industry + Construction	28.4	24.9	15.6	17.3	25.7	22.4
Services	46.5	62.5	38.3	61.6	52.1	65.2
GVA composition						
Agriculture	17	6.0	31	9.3	14	4.3
Industry + Construction	28	29.2	13	13.8	26	22.2
Services	55	64.8	56	76.9	60	73.5

Source : ESYE(2004), EUROSTAT (2005a) , EUROSTAT (2008)

4.2.1.2 Crete – island region with no industrial base

Situated in the southern part of Greece, the island of Crete had a total population of around 540,000 in 1991 (601,000 in 2005). Herakleion, where the STP is located, is the largest city and capital of the region with a population of 264,000[45]. Among the four prefectures (NUTS 3 classification) of the region, Herakleion contains more than 50% of employment and economic activity, with the other three (Chania, Lasithi and Rethymnon) representing less than 20% each.

The economy of Crete is based on the primary and tertiary sectors (together over 85% of regional GVA) (see Table 4-1) and industry has a very small share in the total employment and gross added value. While agriculture has lost an important share in the total activity, it is still much higher than the national average. Representing 80% of total employment, commerce, tourism and transportation services dominate the market services sector. The limited industrial base of the island includes construction (37% of total manufacturing) and the processing of agricultural products (25%). Other activities present include glass and ceramic products, building materials, pulp and paper and a small number of plastics firms. With very few exceptions, firms in all sectors are very small in size (only 1% has more than 50 employees). Higher technology manufacturing sectors are almost completely absent (Table 4-2), while knowledge intensive services are also limited (16% of total employment in comparison to over 20% of the national average in 1994). According to the IOBE (2006) study, by 2006 the number of ICT firms in the region were only 39.

By the time of the creation of the Park, Crete's GDP/capita was at 70% of the EU average, above the national levels. After 1995, however, it started to lose pace against the national

[45] By 2001 this was raised to 291 (EC,2006)

and the EU average and only after 2000 (see) did the economy of the island start to recover, albeit at rates below the national average. Concerning unemployment, Crete has consistently maintained unemployment rates at 3-5% less than the national average, but this is largely due to the seasonal employment in agriculture and tourism (Logotech, 2006).

Table 4-2: Technological intensity in Crete and Central Macedonia[46] (% of total workforce)

	Central Macedonia		Crete		Greece		EU15	
	1994	2003	1994	2003	1994	2003	1994	2003
High and medium-high tech manufacturing	1.57	2.28	-	0.57	2.31	1.99	7.73	7.11
Low and medium-low tech manufacturing	18.51	16.48	6.42	7.22	12.35	10.81	13.21	11.45
Knowledge intensive business services	18.15	22.50	16.13	16.48	20.13	23.08	27	33.8
Knowledge intensive high-tech services	1.00	1.43	1.28	1.25	1.44	1.75	2.63	3.49
Knowledge intensive market services	3.72	5.63	2.92	3.23	4.85	6.00	6.27	8.01
Knowledge intensive financial services	1.84	1.85	1.92	1.12	2.37	2.53	3.50	3.35
Non-knowledge intensive services	34.1	35.5	34.9	39.9	35.5	39.9	30.8	34.5

Source: (EUROSTAT, 2005b)

4.2.2 Technology supply and demand in the two regions

As in almost all lagging regions, the main characteristic of both regions' innovation systems is the dominance of public sector R&D activity, the limited participation of the private sector, and the low levels of innovation outputs. Among the two regions, Crete shows a particular imbalance between public and private sector R&D activity.

Concerning knowledge creation, in Central Macedonia the total R&D expenditure was below 0.4% of the regional GDP in 1993, with less than 25% of it coming from the private sector. Still, at the national level, the region represented the second greatest concentration of total R&D activity and research personnel (Table 4-3).

[46] The classification of sectors follows the definition of OECD based on R&D intensity

Table 4-3: Main innovation input indicators in Central Macedonia and Crete

	Year	Central Macedonia	Crete	Greece
R&D expenditure (in million PPS)	1993	70	32	374
	2005	192	106	1389
R&D expenditure as % of GDP	1993	0.35	0.72	0.36
	2005	0.58	0.96	0.58
Business sector % of total R&D exp.	1993	23	3	26
	2005	22	8	31
Total R&D employment – headcount	1995	7907	2916	36385
	2005	12097	4204	61454
R&D employment. (% of active population)	1995	1.1	1.3	0.95
	2005	1.47	1.52	1.27
Business sector R&D employment % of total	1995	10.3	2	17.7
	2005	16.7	8.4	21.0
Population with tertiary education	2002	18.65	16.11	17.62
Tertiary level students/1000 population	2002	88	72	51.8
Human resources in S&T - % of labour force	1994	25.2	17.5	25.1
	2003	30.2	22.9	30.2

Source: EUROSTAT (2005b); EUROSTAT (2008)

Most parts of total R&D activity are performed by the Higher Education sector; primarily by the Aristotle University of Thessaloniki (AUTH)[47]. Being one of the oldest and largest universities in the country, AUTH had 139 research units/labs and 2,800 researchers/academics that cover a very wide range of disciplines including engineering, natural, life and medical sciences along with social sciences and humanities (Table 4-4). In addition to AUTH, there was a number of government research institutes/units operating in the region, including CPERI chemical processes institute, the research units of the National Foundation of Agricultural Research (19 units) and the Hellenic Institute of Metrology. Altogether, there were more than 270 research units (URENIO, 1999). An evaluation of their operation before the creation of the Park (Komninos, 1993) revealed that a large part of them did not match the needs of the industry due to inefficient organisation structures, their small size and the limited interest or even negative attitude towards cooperation with the private sector. Even among the most dynamic, priority was towards scientific

[47] Other HEI units include the Technical Educational Institute in Thessaloniki and Serres specialized in technical education and with rather limited research and the University of Macedonia specializing in social sciences.

publications with a negative attitude or disinterest towards exploitation of research results through patenting/licensing or (even more so) through entrepreneurial activity.

In Crete, R&D activity levels have been the highest in the country since the early 1990s (0.72% in 1993 and 1.02% in 1999) due to the presence of two dynamic and research oriented universities (the University of Crete and the Polytechnic School of Chania), the five research institutes of FORTH, the Institute of Marine Biology, the Mediterranean Agronomic Institute and the units of the National Foundation of Agricultural research. Despite, or possibly due to, its relative youth, the University of Crete has developed a strong research base in medical, life and natural sciences and informatics, while the Polytechnic School in Chania is known for electrical engineering, computer sciences, energy and environment. The activity of FORTH research centres has a particularly high share (20%) in the total national government R&D expenditure (see Table 4-5). The evaluation reports of both the University and FORTH suggest that, in terms of quality, the research activity of some departments/units stands out at an international level (CIRCA et al., 1999; EUA, 2001)

Table 4-4: Characteristics and research capacity of main universities in the two regions

	Aristotle University (C.Macedonia)	University of Crete	Chania Technical University - Crete
Students registered (2001)	63000	8100	1800
% students in engineering, natural and life sciences	60%	50%	100%
Professors/Researchers (2001)	2800	573	145
Research budget (2001)	45,000K€	24,950K€	
Publications in SCI (1995-2006)	8.834	5.158	743
Citations per article (1995-2006)	5.29	9.25	4.07
% of national SCI publications	14.7%	6.8%	1.15%
Main research areas (based on number of ISI publications)	Medical/pharmac., Electrical/Chemical/ Civil + environ. eng., Materials, Plant/veterinary sciences	Computer sciences, Biology, Medical/biomedic al	Electrical engineering and computer sciences, environment, energy

Sources: (ESYE, 2004 ;ISI, 2006)

The increased presence of universities and research centres in both regions is linked also with an increased share of the level of student population in the region. With more than 88 students per thousand inhabitants in Crete and 72 in Central Macedonia (2002 data), the two regions are clearly above the national average of 51.8. In Crete, however, only a very small share of the higher education population stays on the island after graduation (Galanakis et al., 2005) and, as a result, the share of the labour force with tertiary level education remains below the national average.

Table 4-5: Regional participation in national R&D expenditure by sector (1995)

	Crete	Central Macedonia	Attica
Share in national GDP	*5.3*	*16.5*	*38*
Total R&D exp.	8.17	17.56	51.59
University R&D exp.	6.44	25.30	45.54
Government R&D exp.	19.95	10.57	56.99
Business R&D exp.	0.8	11.6	62.9

Source: (EUROSTAT, 2005b)

Relative to the public sector R&D activity, private sector participation, either conducted by the firms themselves or outsourced, remains limited. Despite the relatively strong industrial base of Central Macedonia, it has fluctuated between 15% and 25% of the total and the share in the total national is well below the region's total economic activity (Table 4-5). In Crete it has been very close to zero: 3% of total R&D expenditure in the region and less than 1% of national. The very limited size of industrial activity, the dominance of less-knowledge intensive services sectors and the small size of firms all contribute to this picture (Logotech, 2006).

The limited investment in R&D by the private sector and the basic (non-applied) character of public R&D activity is also reflected in the limited innovation results of firms in both regions. It is illustrated by the low number of patents and the poot shares of innovative companies: 23% for C. Macedonia and 23.1% for Crete (Logotech, 2004) according to the

3rd Community Innovation Survey[48] for 2000-2002 (see also Table 4-6). Studies in both regions (RTP, 1996; Sefertzi and Skiadas, 1996; Zoumpoulaki et al., 1996; RITTS, 2000; Kyrgiafini and Sefertzi, 2003), before and in the initial years of the Park's operation, found that the dominant technology upgrade strategy has been based on equipment and machinery purchase from foreign suppliers with limited demand for other sources, including research and technology organisations. Innovation is mainly focused on marketing and branding and does not often have a technological content (Deniozos, 1993). In Central Macedonia, Komninos (1993) referred to the latent character of technology supply and demand where firms do not have a clear idea/picture of the role of innovation and do not recognise the opportunities that new technologies offer to increase their productivity and competitiveness. The dominant strategy of the low-tech sector firms was based on lowering costs and the de-skilling of human capital. Even more so in Crete, the technology demand analysis for the RITTS project (2000) pointed to an extremely limited demand for technology services and cooperation with the public research organisations.

Table 4-6: Innovation performance/results of firms C.Macedonia and Crete

	Central Macedonia	Crete	Greece	EU15
Share of innovative companies (1998-2000)[49]	23%	23.1%	27.3%	44%
EPO Patents/million popul. (aver.1990-1992)	2.75	3.60	3.47	81.1
EPO Patents/million popul. (aver.1999-2001)	8.30	7.40	7.3	153.6

Source: (Logotech, 2004 ;EUROSTAT, 2005b)

The cost-based, short-term and low-risk strategy of the private sector in relation to innovation creation has been also linked with the negative macroeconomic conditions that prevailed in previous periods. Low growth rates, high levels of inflation and economic instability increased uncertainty and created disincentives for long-term investment in new activities and technology development and in risk-taking (Tsipouri and Gaudenzi, 1998).

[48] The earlier CIS surveys (1994-1996 and 1996-1998) revealed similar (32% for 94-96 and 23% for 96-98 C.Macedonia) or even worse scores (20% for 94-96 and only 5% for 96-98) in Crete (Logotech, 1998).
[49] Firms that introduced a new product or production process during the period 1998-2000.

4.2.3 Innovation policies, mechanisms and the legal and institutional framework

In Greece, most parts of the research and technology governance structures and responsibilities remain strongly centralised[50]. As a result, the general policy framework and the respective measures and mechanisms most relevant in relation to the STPs' operation are defined at a national level. During the period prior to the Parks' creation, the central government attempted some form of decentralisation through the creation of new organisations and mechanisms related to technology transfer and innovation support (e.g. Intellectual Property Organization (OBI), Standardisation Organisation (ELOT), sectoral technology companies). Their location in different regions reflected an infrastructure-focused regional technology policy. Most of them, however, were still in their infancy or underperforming and had not managed to effectively serve their purpose (Deniozos, 1993). After 1989, the focus shifted towards the strengthening of the systemic character at a national level. The new research infrastructures was matched with programmes for R&D (EPET I&II) and technological cooperation (EKBAN), technology transfer and entrepreneurship support measures (public seed or guarantee funds), as well as liaison offices in universities and research centres, specialised technology consultants and technology transfer units (Appendix 8 - Research and technology support programs, measures and actions in Crete and Central Macedonia during the period 1994-2006). The EU Research Framework and Eureka programmes also offered alternatives to the national government sources for R&D activity and technology transfer. Participation shares in both regions were high, but predominantly concerned the public sector and only a handful of firms (CIRCA et al., 1999).

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[50] The main bodies responsible are the General Secretary of research and technology (Ministry of Development) (that designs and implements the national policy and manages most innovation-related funds) and the Ministry of Education (responsible for university funding). The ministry of Agriculture also has responsibility over the National Agriculture research institute units and a small budget.

More sophisticated and relevant measures were introduced after 2000, targeting the creation of academic spin-offs (PRAXE A and B), venture/seed capital creation (TANEO), and the creation of technology incubators from the private sector (ELEFTHO program). ELEFTHO led to the creation of two new technology incubators in Central Macedonia, while in the case of Crete, a local bank (Pancretia) created the first regional venture capital scheme (Technopolis, 2006). At the time of the survey, the regions were also in the initial stages of the regional innovation pole programmes, probably the first region-specific support measure developed by the central government.

At the regional level, some technology and innovation policy measures were developed after 2000 (Logotech, 2006). The implementation of innovation related EU community initiatives (RTPs, RIS, RIS+, RITTS)[51] also helped. Central Macedonia was one of the first/pilot regions in EU to develop their own Regional Technology Plan and has been considered a success in framing a more coherent development strategy (Benneworth, 2007). The Regional Technology Plan project brought together for the first time the important/relevant regional players and helped the formulation of innovation strategies (URENIO, 1999; 2003) that were integrated in the subsequent RIS+ and Excellence initiative programs and the structural funds regional operation programme of the period 2000-2006 (CIRCA et al., 1999). In Crete, the implementation of the RITTS programme (1997-2000) also provided inputs for the formulation of a regional innovation and technology policy, but it was not successful in forming a regional coalition and few of the proposed measures were implemented (STEP-C, 2004a; Logotech, 2006).

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[51] In Central Macedonia, the Regional Technology Plan (1995-1997) was followed by Regional Innovation Strategy+ (1999-2000)[51]and Excellence (2002-2003) programmes. In Crete, the Regional Innovation and Technology Transfer Strategies (1999-2001) was followed from the Crete Innovative region program (2003-2004).

Even so, the above programmes and measures have not led to significant changes. Public expenditure for R&D remains less than 0.6% of total government expenditure; the lowest among the EU15 countries (EUROSTAT, 2005b). Furthermore, the support measures have had very limited capacity to induce firms towards future R&D and innovative activity or cooperation with public PRTOs (Tsipouri and Gaudenzi, 1998). Access to public programmes is limited to only a few firms and is linked with access to cash, with the results most often not used in the production process. At the regional scale, innovation related measures have minor shares in the total regional operational programme budget. Central Macedonia allocated to R&D and innovation only 2.9% of the 2007-2013 regional operation programme , the highest in relative and absolute terms among all regions, while Crete assigned only 1.1% (Technopolis, 2006). The measures tend to copy the respective national ones while, due to the limited capacity of the regional administrations, many actions were not properly implemented.

In parallel to that, the legal framework posed significant constraints on the Parks' operation in the important period after the Parks' creation. It was, and remains, restrictive in relation to the exploitation of public R&D, the capacity for researchers to participate in spin-offs and (critically) did not provide even a definition of a Science or Technology Park. Some improvements such as giving more space to private sector participation in public R&D and exploitation of public research through patenting or licensing the entrepreneurial activity of researchers (OECD, 2005) came after 1999. A new definition of STPs was also provided and gave them a status similar to those of industrial areas, but with no particular/additional incentives related to the characteristics and needs of high-tech firms.

Along with these specific elements comes the wider negative institutional framework. A complicated legal structure means very long and costly procedures for the creation of new firms and the approval of investments (IOBE, 2007). Public administration remains heavily bureaucratic, clientelistic, prone to corruption and often ineffective. Both are connected with important distortions in the operation of markets, disincentives for innovation and the hampering of entrepreneurial activity. They are also considered to be some of the main reasons for Greece's extremely poor FDI attraction record (UNCTAD, 2007; Pantelidis and Nikolopoulos, 2008).

4.2.4 Conclusion

The description of the two regional contexts depicts a common "hostile" environment with important obstacles posed to the two STPs' operation for most of the period following their creation. The most critical weakness is the limited participation of the private sector in R&D activity and innovation, the dominant role of the public sector and the absence of connections among the two. Local firms not only had low own absorptive and relational capacity, but also a low awareness of the opportunities related to the use of innovation and low interest in exploiting them. As intermediation structures, the STPs had to bridge two worlds that were far apart. They could count on relatively limited, albeit gradually increasing, supportive policies and measures (mainly at national and European level), but also had to operate in an environment where most players had no experience in the use, and consequently the demand, of their services. Both cases also faced a similarly unsupportive national environment in relation to the legal framework and the national R&D and innovation effort.

Having said that, there are also some important differences between the two Parks. TTP was created in a region that represented an important economic and, to a lesser extent, administrative centre for the country, with a wide range of business and financial functions and an industrial base that could provide significant demand for high technology services.

The dominance of traditional sectors, on the other hand, created at the same time path dependencies and rigidities regarding the investment and use of knowledge that had to be overcome. A pro-active industry association with an agenda for the technological development of the regional economy could be seen as an additional asset. In comparison, STEP-C could count only on strong and dynamic HEIs and research centres and skilled human capital as a source of new business ideas, but it had to overcome the absence of significant local demand (further accentuated by the island's character) and limited entrepreneurial capital. In relative terms, the TTP regional context appeared as a more positive starting base for the operation and success of a STP in comparison to that of STEP-C.

4.3 Historical review: from the initial idea for the STPs to the current status

4.3.1 The initial idea for the STPs

The historical traces of the development of the two STPs go back to the mid-1980s and the creation of a number of new research institutes in the periphery of the country. Created next to the existing universities of the cities of Thessaloniki, Herakleion and Patras, they were an attempt to enhance the weak research activity and occupy the underutilised research personnel of the universities, but also repatriate a number of Greek researchers. The creation of STPs (infrastructures already developed in most other EU countries) was seen as part of a broader set of initiatives aiming to "...promote and strengthen mechanisms for exploiting research outputs coming from universities and public research laboratories" (Kasteli, 2000:11). In parallel, their creation in the periphery was part of an implicit effort to decentralise the national R&D activity, heavily concentrated until that time in Athens (Deniozos, 1993).

While central government support has been clearly instrumental in the STPs' creation, it is less clear where the idea for their creation initiated. According to a FORTH representative:

> "...the park idea came from FORTH directors[52]and the central government provided the necessary support (political and financing) for its implementation. FORTH institutes has already created the first spin-off firm and the parks' were expected to support the spin-off firms and attract private firms to research" (Stratigis, interview, 2006).

The former General Secretary of Research and Technology (Mr Deniozos)[53] asserted, however, that:

> "...the park idea was developed inside the General Secretariat [of Research and Technology] and it was in a sense 'imposed' to the directors of FORTH which at that time were looking for mechanisms to finance the development of new infrastructures for the research institutes. The institutes were operating in the initial period inside the respective universities and the sharing of resources and equipments created problematic conditions. We [the central government] suggested that funds for the development of new infrastructures from the Structural Funds could be allocated only in the framework of a science/technology park project. The objective was to create technology transfer mechanisms that did not exist in Greece until that point and the parks were seen as an experiment in this direction." [54](Deniozos, interview, 2005).

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[52] No single/particular person was identified.

[53] Dr Dimitris Deniozos was General Secretary of GSRT in the period 2000-2004. In the period 1989-1993, he was responsible for the Operational Program of Research and Technology that was used to finance the two Parks.

[54] At that time, the institutes were operating inside the local university premises with significant problems created in terms space availability and use of laboratory equipment and resources (Deniozos, interview, 03/06/2005)

The second version appears to be the most plausible, at least in the case of the Thessaloniki Park. The Park manager and main person responsible for its promotion suggested "...at that time our first priority was to provide the necessary infrastructure for the institute" [i.e. CPERI] (Vasalos, interview, 18/06/2005).

For the objectives of this study, the actual initiator of the STP idea is not that important in itself. More important is the presence of implicit priorities, objectives and expectations related to the Parks' creation by the Park promoters. The experimental approach of the central government, as stated from Mr Deniozos, should also be noted here as reflecting the limited or moderate commitment to the STP project before their viability and success was proven. This is particularly important, given the strong role the the Greek central government has in innovation policy and the weakness of the regional mechanisms and institutions.

4.3.2 STPs' establishment and evolution

Both FORTH and CPERI institute directors separately pushed the STPs projects for financing through the national programme for research and technology. Feasibility studies were also conducted through the Science Park Consultancy Scheme of the EU SPRINT programme (Komninos, 2002). These studies suggested the adoption of a technology-led development strategy, with focus on the provision of technology transfer services and the promotion of contract research and incubation related functions (Vasalos and Bakouros, 1993). The construction of the two STPs was initiated in 1992. At the same time, following the proposal of the studies, the Parks' promoters created the management and development entities of the two STPs, targeting the participation of a number of local players. In TTP, the first phase of the construction plan was completed in 1994 and in 1995 the incubator already hosted the first firms. In STEP-C, FORTH institutes buildings were ready in 1994, while the incubator opened officially at the end of 1995.

4.3.2.1 TTP – dynamic start but loss of momentum and role

In Thessaloniki, the Park was established in the township of Thermi in the eastern outskirts of the city (see Figure 4-3 and 4-4) at a plot of a 2.5 hectares. In comparison to other locations, including one close to the larger industrial area (Sindos), it was selected due to its proximity to the city airport, access to a well developed road network, relative low cost of land, attractive clean environment and the ability (according to zoning regulations) to accept low-polluting industrial activities (Tramantzas, interview, 2005)[55]. The area around the selected site provided land for possible future expansion.

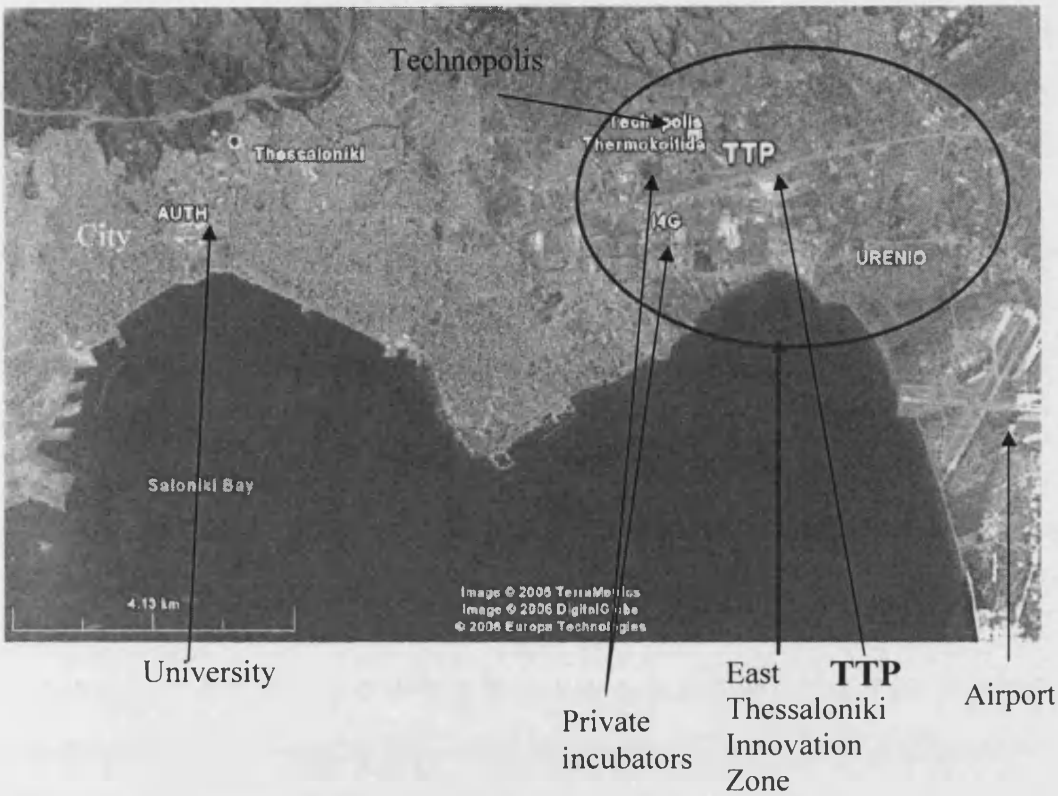
CPERI held the ownership of the Park space and the responsibility for maintenance and other services, while a private entity with the participation of CPERI, the local industry federation (FING), the American Farm School and other minor private investors (TTP/MDC S.A.) was to be responsible for the management of the incubator and the provision of the business and technology support services. The CPERI institute and the first company in the incubator were established in TTP in 1995, although additional research facilities were completed as late as 2000. In the initial period, the Park's incubator had a slow growth rate of 2-3 firms annually, reaching full capacity only in 2000 with a total of eleven firms and 50 employees (see Table 4-7). CPERI activities grew at a greater pace and reached 135 employees. The small Park management team implemented the first support projects and created, through a government fund, a technology transfer unit. The development of the STP's operation during this period was characterised as quite dynamic

[55] CPERI directors looked also for a location close to the industrial area west of the city. However, high levels of pollution, poor accessibility and the idea that such spatial proximity to industry was not necessary to facilitate contacts led to the site east of the city (Vasalos, interview, 18/06/2005).

(Deniozos, interview, 2005) with increasing levels of activity from the STP management team and a gradual increase in the number of tenants.

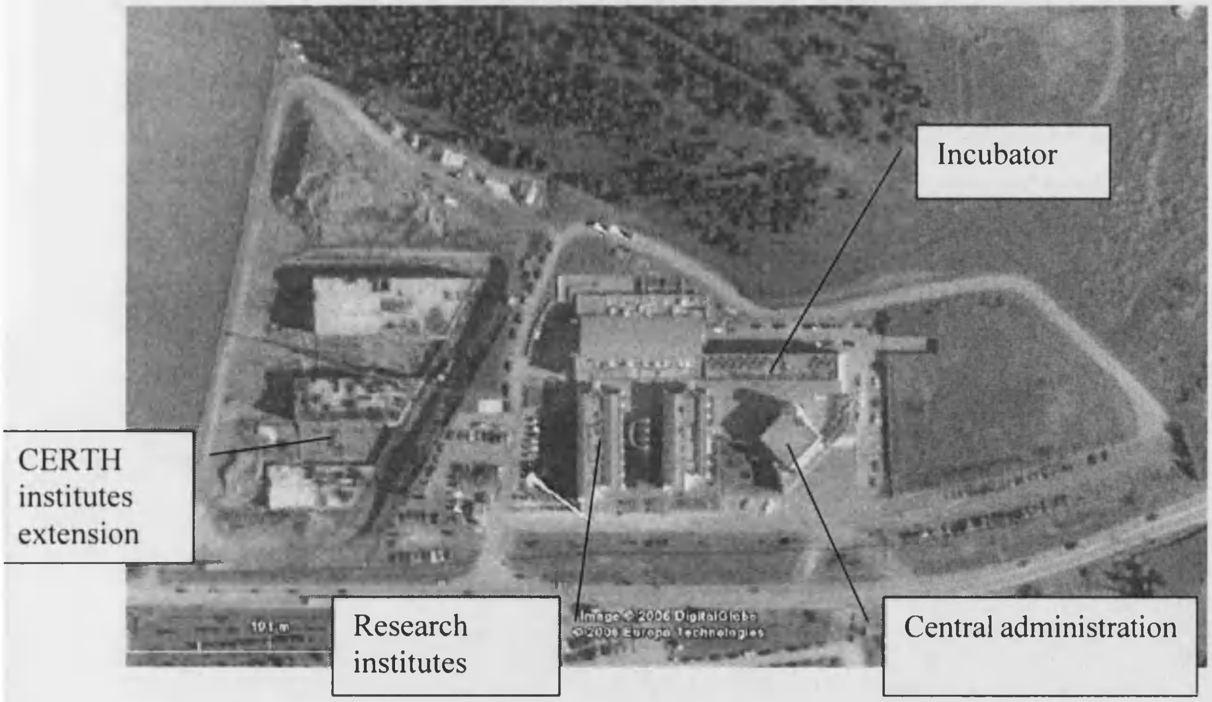
An important milestone in TTP development was the separation of the CPERI institute from FORTH in 2000 and the formation, together with three new research institutes, of a new organisation, the Centre of Research and Technology Hellas (CERTH). This decision served the purpose of creating a more flexible and autonomous research organisation (Souitaris and Daskalopoulos, 2000). However, it also had some negative implications. In the short-term, it caused animosity from the FORTH side and a "freezing" of linkages that precluded TTP from access to the country's most established and effective research network (Souitaris and Daskalopoulos, 2000)[56]. The Park also had to undergo additional institution and mechanism-building processes for the new research centre (CERTH), especially since the other three research institutes were new and very small. While FORTH had already formulated a general strategy in relation to the exploitation of research results, CERTH was still missing one even as late as 2005 (Oikonomidou, 2005). These changes and the need to secure the viability and recognition of the new research centre absorbed the attention of CERTH directors for a significant period.

[56] This included access to the PRAXIS network, a national technology transfer organisation that FORTH had created in cooperation with the National Industry Federation (SVE) and the Federation of Industries of Northern Greece (FING).



Source: own elaboration from GoogleMaps

Figure 4-3: TTP and other technology related projects/entities in the Thessaloniki area



Source: own elaboration from GoogleMaps

Figure 4-4: Thessaloniki Technology Park facilities (2005)

In the following years, CERTH experienced fast growth[57] and by 2002 it employed more than 300 employees: researchers and support staff. In 2004, a new construction phase was initiated to further extend the research facilities in a plot next to the Park and new plans for two new research institutes under the CERTH umbrella were put forward (Vasalos, interview, 2005)[58]. On the contrary, however, the private sector activities evolved at a much slower pace, showing a loss of dynamism and decline. After 2001 the incubator had low levels of activity, some offices being rented but not constantly occupied, and low firm turnover rates. At the time of the survey (06/2005), only seven firms with 31 employees were operating in the Park's incubator and all of them had already been in the Park for more than six years (see Table 4-7). The first couple of spin-off firms were created at that time by CERTH institutes and were expected to occupy Park space. There was also a decision to end the contract of some of the firms and replace them with new tenants, with the expectation of revitalising the Park (most entered in 2006, one year after the survey). Critically, while all were in high tech sectors, pharmaceuticals, biotech and ICT, none of the new entrants was a start-up firm, while in one case the Park provided only office/administration space. The STP management team has maintained its level of activity in relation to the implementation of regional, national and European innovation programmes, but has almost abandoned the incubation support or the provision of services to CERTH. The picture is one of a gradual abandoning of the incubation and spin-offs support function of the Park.

[57] In 2002, a fifth institute (Institute of Solid Fuels) in the region of Western Macedonia came under its umbrella.

[58] The creation of a new institute in the biomedical and bio-molecular research area (Vasalos,interview, 21/06/2005).

This decline should also be seen in connection to the creation of new structures in Thessaloniki and in close proximity to TTP. A number of public, semi-public and private units offering similar services have been created, competing for the same national and regional government funds. There has thus been a necessary sharing of the given funding sources (Kelesidis, interview, 2005). More important, however, is the creation of two private technology business incubators (Thermi and i4G) in 2004 through the Eleftho programme. They are larger[59] and are managed by specialised business consulting firms providing seed/VC capital to their tenants. The association of ICT firms of Northern Greece is also creating a property-led Park (Thessaloniki Technopolis) of 12.5 hectares adjacent to the Park plot. The concentration of most of these activities in the broader area east of Thessaloniki, also adding a small number of high tech firms[60], is nowadays seen as the foundation for the "Innovation Zone of Thessaloniki" (Komninos and Manos, 2005) (see also Figure 4-3). It is suggested (Kelesidis, interview, 2005) that the Park was, in some respects, the initiator of this process. Clearly, these developments could be seen as positive for the region. For the TTP, however, rather than playing a strengthening/reinforcing role, they are linked to the gradual loss of most of its initial activities, limited to the R&D activity of CERTH institutes.

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[59] I4G has a total size of 1800m2 that can host 13-15 firms. Thermi incubator has a total size of 6000m2 that can host around 30 firms.

[60] The examples provided by the park management (Tramantzas, int.) include Euroconsultants (management consulting firm), Infoquest (ICT services), Compucon (ICT manufacturing).

Table 4-7:Evolution of activity (number of tenants and employment) in the two STPs

	1995	1996	1997	1998	1999	2000	2001	2004	2005
STEP-C									
Employees	920	n.d.	n.d.	n.d.	n.d.	800	n.d.	950	964
In FORTH	920	n.d.	700	n.d.	n.d.	650	n.d.	800	800
In Firms	-	n.d.	n.d.	n.d.	n.d.	150	n.d.	150	164[61]
Tenants	4	14	20	n.d.	24	26	27	26	27
Institutes	4	4	4	4	4	4	4	4	4
Firms	-	10	16		20	22	23	22	23
TTP									
Employees (no)	120	146	167	172	175	>214	>301	439	421
In CERTH	108	124	125	126	135	n.d.	n.d.	384	390
In Firms	12	22	42	46	40	47	n.d.	55	31
Tenants	6	8	11	11	11	15	14	12	11
Institutes	1	1	1	1	1	4	4	4	4
Firms	5	7	10	10	10	11	10	8	7

Sources: (GSRT, 2004; STEP-C, 2004b; TTP/MDC, 2004, Survey, own elaboration; CERTH, 2005)

4.3.2.2 STEP-C – maintaining pace?

Established in the outskirts of the city of Herakleion[62] and close to the new campus of the University of Crete (see Figure 4-5 and 4-6), the Science and Technology Park of Crete was developed in a total area of 25 hectares with a built space of 34,000m^2 spread across six buildings. Four of them were dedicated to FORTH institutes, while the remaining two (total 4,000m^2) hold firm tenants and the management and technology transfer unit (STEP-C, 2004c). The incubator facilities were ready in 1995 when the first companies were established in the Park's space. The Management and Development Cooperation S.A. (STEP-C MDC S.A.), with a small amount of capital (and the participation of FORTH, a private bank (PIRAEUS bank) and a large number of minor investor), was given responsibility for the Park's operation and services. A regional office of the PRAXI

[61] Including 44 employees of ENISA that established in the park in September 2005.

[62] Municipality of Voutes around 8 km from Herakleion centre

technology transfer agency[63] was later established, expected to offer services complementary to the MDC team.

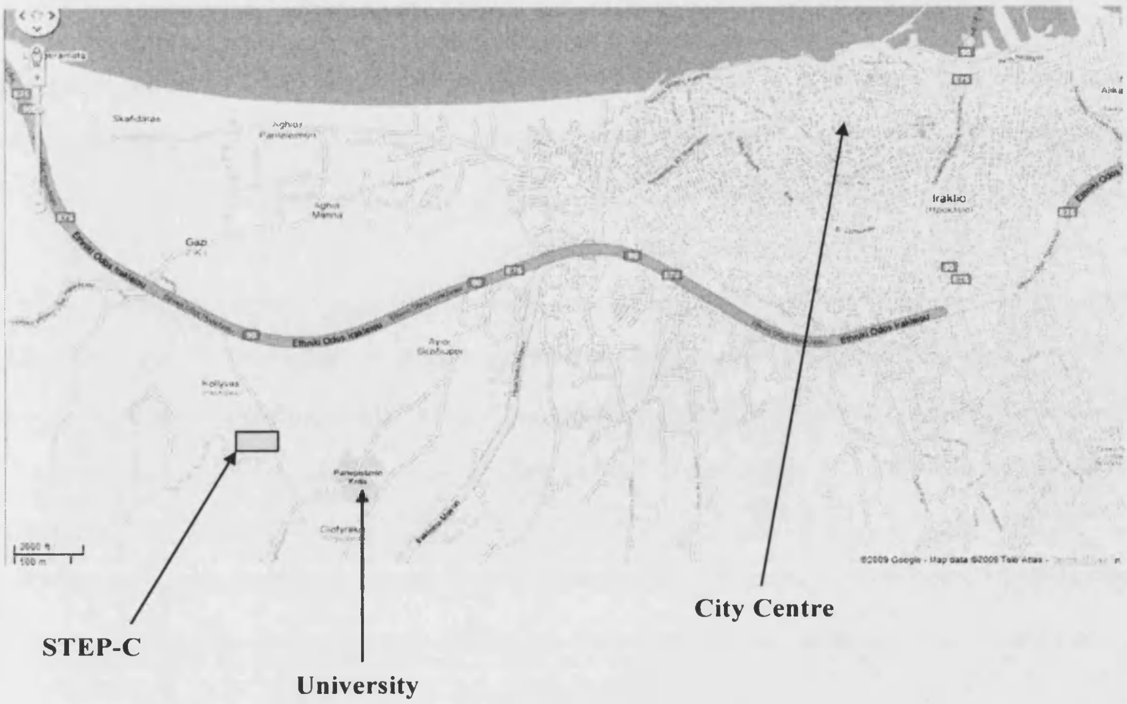
At its opening, the incubator attracted ten small companies and increased at an annual rate of 2-3 firms (see Table 4-7). Initially, the Park managers and promoters (FORTH) attempted to attract R&D units of national and international companies and a Greek telecoms manufacturing firm (Intracom S.A.)[64] opened a small unit inside the Park; however, Intracom stayed only for two years and left the Park at the end of 1996. According to a FORTH representative "...their sole expectation from the presence in the Park was to secure access to public R&D programmes. When they realised that this was not the case they left the Park" (Stratigis, interview, 2006). Since then, the Park's promoters decided to focus exclusively on the support of small and new innovative start-ups and spin-offs (Stratigis, interview, 2006) through the provision of subsidised rent schemes and support services. The creation in 1997 of one of the most successful spin-offs in Greece (FORTHnet) was critical for the profile of FORTH and of the Park. FORTHnet experienced very high growth rates and was listed on the Greek stock market three years later. In 2000, the Park hosted a total of 22 tenants with around 120 employees, a number which has been maintained with small fluctuations thereafter (Table 4-7). According to its manager, 45-60 new companies had operated in the Park's space during the period 1996-2006 (Saitakis, interview, 05/05/2006).

Despite this positive picture, at the time of the survey there was again a feeling of a gradual loss of momentum. There were no employees working in some of the occupied

[63] PRAXI is a technology transfer support organisation with national reference created from FORTH, the National Industry Federation and the Federation of Industries of Northern Greece.
[64] Intracom is one the biggest Greek manufacturers of telecommunication equipment and IT services with over 3,000 employees (Intracom, 2003)

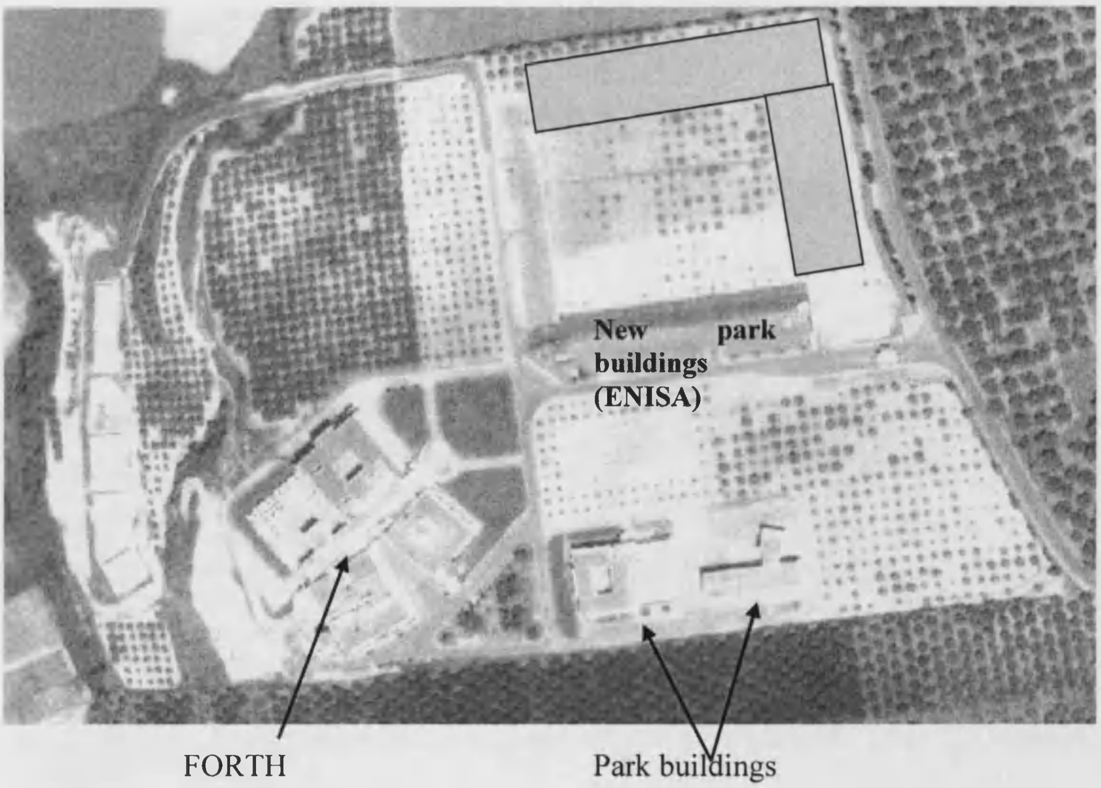
spaces/offices during the two weeks of the survey, while parts of the Park's space were occupied by FORTH researchers. FORTH representatives also expressed disappointment concerning the Park's performance (Stratigis, interview, 2006) in relation to the total spin-offs' creation rates, as well as to STP's management team and the services provided. An internal study of FORTH (not published) after the end of the survey suggested a decline in total activity during the subsequent period (18 firms in 2007). While not in the same position as TTP and with no real competition from other local players[65], STEP-C appeared at the time of the fieldwork to be losing part of its initial momentum.

[65] The only other incubator structure was created in 2000 in the city of Chania and focuses on more traditional sectors. The chamber of commerce and industry only recently created a centre of business and technology support.



Source: own elaboration from GoogleMaps

Figure 4-5: STEP-C, University of Crete and Herakleion city centre



Source: own elaboration from GoogleMaps

Figure 4-6: Science and Technology Park of Crete's buildings (2006)

Table 4-8: The Parks' evolution - important milestones

STEP-C	Year	TTP
First idea for Park creation from FORTH	1988	First idea for Park creation from CPERI.
Initiation of Park construction	1992	Initiation of Park construction
Creation of STEP-C MDC S.A	1993	
Opening of STEP-C with operation of FORTH 4 research institutes	1994	Creation of management company TTP/MDC First phase of construction completed
	1995	Establishment of CPERI and first company in incubator
Opening of incubator building - ten tenants	1996	
FORTHnet spin-off creation	1997	
Second firms' building completed - Intracom R&D unit leaves the Park	1998	Second phase of construction completed
FORTHnet moves outside Crete leaving in the Park an R&D unit with 32 employees	1999	
Park reaches almost full capacity with 22 tenants	2000	Creation of CERTH and establishment of three new research institutes in Park. Change of Park ownership structure 3rd phase of construction completed.
	2001	Park incubator reaches full capacity
	2003	Two new private technology incubators established next to the Park
7th building in the Park area completed	2004	Initiation of works for extension of research centres infrastructure
23 firms operate in the Park ENISA established in the Park	2005	Number of Park tenants fall to seven

Source: own elaboration

4.4 Stated objectives and implicit priorities

The previous section already referred to the motivations for the STPs' creation and indicated the presence of specific interests of the main partners/stakeholders. Using the Parks' official statements in the projects' proposal documents or the STPs' websites, the interviews with the Park directors and the management entities' shareholders, the researcher attempted to codify and prioritise these objectives, but also to identify deviations or conflicts between stated objectives and the interests of the promoters and other important players.

In the case of the Thessaloniki park, the proposal submitted to the EU Support Programme Consultancy Scheme stated that "...the principal objective for the establishment of the Technology Park of Thessaloniki is to respond to the public authorities' appeal for a better and more effective exchange of ideas and scientists between universities and Industry. Such an initiative would render the Park a centre for research, development and technological excellence, thereby bringing along regional development. Controlling factors for regional development are:

- Creation of high tech companies and encouragement for the establishment of new firms, balancing the income and employment loss caused by industrial decline in the region.
- Technology transfer, understanding scientific reasoning of advanced technology, assisting the industry in addressing problems regarding the proper application of new technologies, production and new product distribution.
- University's creative feedback through exposure to problems as well as future endeavour of the industry.
- Assessment of the profitable utilisation of the incoming new potential scientific ideas sponsored by active academic institutions, research centres or stimulating firms.
- Generating regional prosperity by the commercialisation of innovative applications" (CPERI, 1991:p.7).

Similarly, the STEP-C mission statement states that the Park "... is expected to facilitate technology transfer and help create another development pole on the island, next to the agriculture and tourist industry"(STEP-C, 2004b). In more details, "...the Park shall

- provide the significant research activities of the Foundation's Institutes with a reliable interface to the outside world
- assume a significant and specific role in the development of the region

- enable companies-members (tenants) of STEP-C to exploit the technology opportunities offered by the Research Institutes and become key vehicles in the technology transfer process." (FORTH, 2006).

The statements describe all those functions that are expected to be part of the technology-led model, based on technology transfer and cooperation of university with industry, new technology based firms and spin-offs' creation support. The attraction of firms and the real estate element is in the background. The only difference between the two is the more explicit reference to FORTH institutes as the source of technology, instead of the general reference to universities and research centres. STEP-C is suggested as the mechanism that should facilitate their connection with the outside world, supporting its entrepreneurial activity.

Inside this broader framework of a technology-led Park, there were still some deviations. STEP-C initially targeted the attraction of R&D units of international and national firms. Following the failure to attract these firms, however, there has been a clear direction since 1996 towards small and new firms (Stratigis, interview, 2006). [66] Much more important, however, is the prioritisation provided by the CERTH director in the case of Thessaloniki Park.

> "We [i.e. CPERI] gave priority to the research [element] as we wanted to provide the necessary infrastructure for the institute and the second was entrepreneurship [support]. Technology transfer was something that we soon realised that was necessary in order to build linkages with the outside world" (Vasalos, interview, 2005). [67] [68]

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[66] The representative of the second main shareholder, Pireaus bank, was also asked to specify objectives and expectations from the Park's operation but their response was

[67] The Greek term used can be directly translated as "shelter".

It highlights the priority given by TTP promoters to the development of the institutes' activity through the use of the Park scheme.

For the industry association (FING – the second most important shareholder) the Park's operation was connected with a linkage to research and industry (technology transfer) and entrepreneurial support (Georgiou, interview, 2005). The third most important shareholder, the American Farm School, referred to the Park as part of a broader plan for the real-estate development in the area east of Thessaloniki (Litsas, interview, 2005), thus pointing to a real-estate focus. However, it did not suggest specific objectives or priorities and, according to the management team, it has been largely inactive in terms of promoting such a direction (Tramantzas, interview, 2005).

In STEP-C, the presence of other entities and shareholders in the management team did not bring additional and deviating priorities. The only other important shareholder of the STEP-C management team, Pireaus Bank, appeared rather indifferent to the Park's operation and did not hold specific expectations:

> "...the bank did not have any specific expectation from this participation. We participated [in STEP-C MDC S.A. capital] because we were invited from FORTH –who is a very important customer – and the amount required was very small" (Kozanas, interview, 09/05/2006)[69].

[68] Based on the whole interview, the term "technology transfer" was used by Prof. Vasalos to express the provision of technology transfer services/support and not the technology transfer activity (licensing, know-how support ,etc.) per se.
[69] Mr Kozanas indicated that the bank management had been willing to transfer its shares back to FORTH, but did not do it due to some legal constraints.

Overall, both Parks' statements follow closely the general objectives of technology-led type STPs: technology transfer, entrepreneurship, and a broader regional development objective. Their differences were rather marginal. What is important is the prioritisation and weight placed by the CERTH directors, and main shareholders of TTP, on the linkage of research activities with the Park's operation, something absent in the STEP-C.

4.5 STPs' operation: partial development and deviating objectives

Initiated by the same organisation and following the same development model, the two STPs have many similarities in terms of the intangible and tangible elements of their operation, their management and the governance structure.

4.5.1 Infrastructure, facilities and basic services[70]

Both STPs are based on a rather small infrastructure that involves research centres' facilities, incubation and limited office space. In both Parks, the incubation space is quite a lot smaller than the EU average for incubators of over 3000 m2 (EC, 2002). In the 2.5 hectares of Thessaloniki Technology Park, 5000m^2 of the build space is dedicated to research institutes (see Table 4-9). The incubator space covers 1200m^2 with flexible office and laboratory space, while the administration and management activities, conference and meeting rooms and a library are located in the third central building. Covering an area ten times larger (25 hectares), STEP-C's total built space is 34,000m^2. Of that, only 4,000m^2 are dedicated to private sector tenants in two separate buildings, 600m^2 are characterised as incubation space, with the remaining made available to firms established on a long-term basis. In practice, these two are interchangeable depending on the needs and demand. The remaining 30,000m^2 (four buildings) are used by the research institutes.

[70] See map of park facilities in Appendix 2

The Parks' quality space is complemented by all the necessary basic infrastructure (sewage, electricity networks), telecommunication networks and other more specialised facilities (gas and a distilled water supply) supervised by the technical support and security services team of the research centres. The standard support also includes free provision of basic office support services (fax, mail, post, networks, etc.) while more specialised services such as use of laboratory and testing equipment are also available through FORTH/CERTH research institutes on a pay-per-use basis. Tenants have also free access to the library, scientific and technical hard-copy (journals and books), electronic databases and other relevant information sources.

Table 4-9: Main facilities of STPs

TTP	STEP-C
-2,5 hectares -5000m2 of research facilities including CPERI pilot plant -1425m2 administration, conference centre, library and training rooms -1200m2 incubator space (12 offices of varying size – between 20-60m2)	-25 hectares -30,000m2 research facilities of FORTH including administration, conference room, library and common areas -4,000m2 total companies space (100 rooms of 12-25m2 and 12 lab units of 45m2) with 600m2 incubator space -2 meeting/computer rooms

Source: (STEP-C, 2004c ;TTP/MDC, 2005)

For the above infrastructures and basic services, TTP tenants pay rent at close to market rates as there is no special rent-subsidy scheme. In TTP, a number of firms were given a gratuity period of up to six months as a way to support high-risk projects (Tramantzas, interview, 2005). STEP-C offered a flat, below market rent for most of the period of its operation, but has recently (2005) introduced a gradual increase scheme after the first three years of tenancy (Stratigis, interview, 2006). In contrast to most other European STPs, neither Park provides any kind of tax cuts or subsidy incentives for the attraction of firms and organisations, very much in contrast to the benefits for firms located in industrial and business parks in the region (Tramantzas, interview, 2005; Stratigis, interview, 2006).

4.5.2 Admission and graduation policies

In the incubation focused Greek STPs, admission and graduation/exit policies of the Parks are important elements with a determining role in their technology character, the firms' turnover rates and the Parks' quantitative results. Both cases have formulated admission policies and a selection process. In the TTP, admission to the Park is decided by an evaluation committee that considers:

- The innovative character of the proposed initiative/firm
- The presence of a complete business plan
- A time schedule pertaining to research, development and technology activities
- Benefit of the development activities to the Thessaloniki area, especially concerning employment of new scientists
- Initiative to be undertaken for the diffusion and transfer of technology and know-how in Northern Greece
- Relationship of the expected technological developments to the economic growth of Greece (TTP/MDC, 2005)

Along similar lines, the admission procedure in STEP-C for interested companies/entrepreneurs involves an assessment to see if they:

- Are non-polluting, innovative and technology orientated
- Are cooperative or have a perspective of cooperation with research institutes
- Are viable, with substantiated perspectives for development.
- Have a detailed business plan referring to the targets of the company, information about the respective market area, competition, costs and cash flow
- Are committed that their staff will personally work on the development of the company
- Are in practical need of the services provided by STEP-C (STEP-C, 2004c).

The above criteria balance the need to bring along dynamic firms and create connections with the research centres with the need for flexibility when assessing the firms' knowledge content and intensity. FORTH representative stated than in STEP-C "...the admissions' criteria have not always been applied very strictly" (Stratigis, interview, 2006). In TTP, the policy was "...to secure a minimum income stream through the presence of one-third of stable/low-risk projects/firms that will allow for taking the risk of failure/no-rent payment of the remaining two thirds" (Tramantzas, interview, 2005).

Much less strict is the application of graduation criteria. In the TTP, at the end of the three year contracts there is an assessment of the firms' performance, their growth levels and the actual need of the incubator services. There is no explicitly defined maximum tenancy period and, in practice, firms may stay for much longer (Tramantzas, interview). In STEP-C, the graduation of firms is again primarily based on rather ad-hoc criteria of available space and facilities constraints. Nevertheless, the recently introduced gradual rent increase scheme is intended to create an incentive for firms to leave the Park's space (Stratigis, interview, 2006).

Overall, it is clear that entry and exit policies have been very flexible, with loose definitions of what constitutes an innovative firm and with no strong/persistent application of processes that targeting a continuous flow of firms.

4.5.3 STPs' intangible support mechanisms

Along with the basic services, the STPs teams focused on the development of a number of more advanced business and technology support mechanisms. The management teams are the main carriers/providers of these activities, complemented by the presence of the CERTH liaison office in Thessaloniki and PRAXI network local office in STEP-C. In each of the cases, there are not more than six employees (the great majority of whom hold higher education degrees) and their annual budget has been in the range of a few hundred thousand Euros (see Table 4-10).

The TTP management team services include:

- information on R&D programmes, funding mechanisms, relevant/possible partners
- organisation of brokerage/partnership events
- technology transfer support activities
- support for intellectual property rights (access to electronic database of the Greek organization of Industrial Property)
- development of horizontal research programs on innovation
- development of innovation management tools
- advanced business consultancy services (management, marketing, accounting)

(Kelessidis, 1998)

The CERTH liaison office, created in 2000 as a result of a relevant government support programme, was also expected to support its connection with industry. In practice, however, the focus of this unit has been on public relations, marketing of CERTH and information dissemination. It has no capacity for the development of technology transfer services of the type usually associated with research organisations' liaison offices (Vasalos, interview, 2005).

In STEP-C, the management company[71] and PRAXI Innovation Relay Centre[72] operate in a more complementary way. Technology information dissemination[73], access to databases and partnership support are developed by the MDC team, while PRAXI focuses on the development of business and technology support services (audits, technology, change)[74] towards firms and researchers and also operates also as the liaison office of FORTH. As part of the broader national network, the PRAXI unit can access the broader pool of experts when more advanced services and expertise are seen as necessary.

Table 4-10: Management team companies' main characteristics (2004)

	TTP	STEP-C[75]
Number of full-time employees	6	4-6
Total budget in 2004 (1000s Euros)	340	270
Income sources (%)		
- public programme participation	60%	70%
- income from rents	13%	29%
- income from direct services	20%	1%
% management team time dedicated to incubator tenants	<5%	<5%

Source: survey data and own elaboration

An analysis of the Parks' support mechanisms reveals important weaknesses in the development of their intangible elements. While TTP/MDC S.A. has implemented parts of the previously described activities (see Table 4-11), in most respects the focus is in information dissemination (in person, through seminars and public events or through the use of the web) and a general brokerage/coordination role. More advanced technology transfer services are provided less often, only in the framework of public programmes/projects (Tramantzas, interview, 2005). Through these programmes they built linkages with regional actors (university, industry, other support entities) and national and international actors, but also support their own operation. However, they have much less

[71] Included here are the activities developed directly by STEP-C/MDC and those developed by MDC employees through FORTH.
[72] PRAXI is a joint venture of FORTH with the Federation of Greek Industries (ΣΕΒ)
[73] FORTH library also hosts the electronic database of the Organisation of Industrial Property in its premises.
[74] PRAXI is a national network – with headquarters in Athens – created by FORTH with the support of the Federation of Industries of Greece (SVE) and that of Northern Greece (FING).
[75] STEP-C data include both the results of the management team of the dedicated Park function of FORTH.

capacity, expertise and experience in areas related to technology transfer and advanced business support. (Ignatiadis, interview, 08/05/2006).

Table 4-11: Main activities of TTP/MDC S.A. in the region during the period 2002-2004[76]

Activity indicator	#
Partnership/brokerage events organised	2
Number of companies that have used TTP/MDC for information	150
Number of companies that used technology transfer services	30
Number of companies that used innovation management support services	110
Training events/seminars	25
Technology transfer programmes implemented	24

Source: TTP/MDC (2004)

Linked with the increased weight of the public programmes is the fact that the provision of services towards the Parks' tenants (firms and researchers) has been gradually left behind, nowadays taking a very limited part (<5%) of the management teams' total time, with no person in the management team dedicated to the tenants' operations. Support for the Parks' tenants has been ad-hoc, usually in the initial period of the firms' entry, not systematically developed and with limited internal expertise. Networking promotion has been limited to information provision from external mechanisms and no brokerage activities among the Parks' tenants have been organised for more than three years (Saitakis, interview, 2006). The two Parks have not developed a risk-capital or other innovation finance scheme to support incoming tenants and start-ups and there was no expressed intention to pursue that in the future. Initial intentions reported in the case of TTP (Kelesidis, interview, 2005) were never materialised. The only financial support available comes through promotion of the participation in public R&D and innovation projects. Overall, in comparison to the European incubators (EC, 2002) (see also Table 4-12), the two Parks have important deficiencies in their incubation support operation.

[76] The information provided is based on the catalogue of research programmes implemented by MDC S.A. in the period 1994-2005. Comparable data from STEP-C were not available

Table 4-12: STPs' tenants' support services – a comparison with an EU incubator benchmark

	EU benchmark[77]	TTP incubator	STEP-C incubator
Tenant monitoring	YES (59% of incubators)	Not continuous – Evaluation at 3 years	Not continuous
Dedicated business support services	Pre-incubation and coaching (66%) Business plan (62%)	Accounting support management, business technical consulting provided on a request base – no internal expertise Focus on information	Accounting services management, business technical consulting provided on a request base – no internal expert Focus on information
Financial support	Subsidised rent gradually increasing Services below market rate or for free (77%) Venture fund (31%)	Market rate rent Basic services and information for free Advanced services charged at cost rates No Venture Fund	Subsidised rent Basic services and information for free Advanced services from PRAXI at market rates No Venture Fund
Networking support	YES (64%)	Not formal Ad-hoc support and access to external mechanisms	Not formal Ad-hoc support and access to external mechanisms

Source: (EC, 2002 ;STEP-C, 2004c ;TTP, 2004b, survey and own elaboration)

The two Parks also serve as focal/reference points for the Innovation Relay centre network and provide access to a number of other relevant national and European technology information sources. Nevertheless, with few exceptions, participation in these programmes does not lead to long-term and strategic partnerships (Tramantzas, interview, 2005). Most of them are characterised as ad-hoc (Papadaki, interview 2006; Katharakis, interview, 2006) and tend to fade-out after the end of the programming period (Tramantzas, interview, 2005). Similarly, services to both Parks' teams only rarely and rather haphazardly developed partnerships and participated in networks with other Parks to promote their tenants' linkages. Their membership in networks such as the International Association of Science Parks (IASP) has a passive form. They remained absent from most partnership

[77] Numbers in parentheses refer to the responses of a total of 76 incubators in the sample of the study.

events and did not show any examples of the promotion of the Parks' tenants or of any other local firm.[78]

4.5.4 Management structure and Park governance

The description of the Parks' operation has already made evident the strong dependence of the STPs on the two research centres. The creation of the private management entities was intended to bring along additional players to the Parks' projects and allow for more independent operation of the management teams. In practice, though, the research centres maintained a controlling role. The active engagement of the Industry Federation with its representative holding the position of the head of the board of directors initially created a balanced arrangement in TTP. However, following personal controversies between CERTH and FING and an unsuccessful attempt of FING to increase management company capital to finance the purchase of land and the transformation of the Park into a property-led structure, CERTH has completely controlled the Park's operation. As stated by the CERTH director "CERTH has the power to impose the preferred solutions [to MDC]" (Vasalos, interview, 2005).

More clearly, in Crete the other main shareholder (Pireaus bank) has no real interest and expectations from the Park's operation (Kozanas, interview, 2006). While FORTH's representative suggested that MDC is a separate entity where FORTH has a minority share (Stratigis, interview, 2006), in practice there has been no real space for a more independent strategy.

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[78] Very recently (07/2006), as an initiative of the central government, the Greek Science and Technology Parks' Association was created with the participation of all seven STPs in the country (www.psp.org.gr). The plans include the promotion of linkages and cooperation. So far, however such activities have not taken place.

This dominant role of the research centres applies to almost all functions of the Parks' operation and mechanisms (see Park management structures in Appendix 10 – Greek STPs management structure). The research centres are the owners of land and the Park facilities and are responsible for all issues related to the real-estate aspects of the Parks' operation (Tramantzas, interview, 2005; Stratigis, interview, 2006). The research centres define rent policy, collect income and give only a small part of it back to the management teams. Large shares of the public programmes implemented by the management team employees are included in the research centres' budgets, with MDC employees working as subcontractors[79].

Based on the limited access to the resources of the management teams and the high risks if they relied on the collection of rents, the above structure provided security concerning the financial viability of the Parks' operation[80]. However, it has clearly nullified the capacity to formulate and implement more independent and Park-oriented strategies. According to Souitaris and Daskalopoulos (2000), it has transformed them into alternative tools/wagons for access to external funding, "shop windows" for the research centres.

4.6 The STPs' knowledge base: PRTOs' capacity and entrepreneurial character

Being the promoters and initiators of the two examined Parks, the research centres, the institutional elements of the two Parks, are by far their most critical inputs. The nature of their activity, their characteristics and their entrepreneurial character are all important for their operation. Their comparison reveals important similarities in terms of general

[79] The main reason put forward was that the PRTOs – being public sector organizations - have access to 100% funding from the central government. On the contrary the management teams – as private entities - need own participation to participate in the above activities.
[80] FORTH STPs related activities have been closing with a deficit for a number of years at levels that could probably could not be sustained from STEP-C MDC S.A.

structure and orientation, but also reveals the differences in the size of activity and their exploitation capacity of their institutional and research results.

4.6.1 R&D areas, orientation and financing

At the time of its creation in 1994, Thessaloniki Park hosted only one research unit (institute), the chemical processes research institute (CPERI) that focused mainly on the areas of chemical processes development, energy and environmental technologies. Created in 1987, CPERI occupied 86 employees (researchers and other support staff) and its budget did not exceed 3 million Euros. During the 1990s, along with the Park's operation, CPERI gradually built up its activity base with continuous growth and addition of research facilities (e.g. a pilot plant) and by 1999 its research budget was at €8 million (see Table 4-13). The three new institutes that were brought in the Park in 2000 covered the areas of transport technology, transportation systems and logistics (HIT), informatics and multimedia applications (ITI) and Agrobiotechnology (INA)[81]. Under the umbrella of the new research centre (CERTH), there was a significant widening of research activity; by 2004, the research budget had reached €18.4 billion and retained 400 employees (see Table 4-14) . Still, CERTH is, according to its current director, still a small research centre when compared to other research centres in Western Europe or even with FORTH in Crete (Kiparisidis, interview, 2007).

The latter currently includes a total of seven institutes, four of which operate in STEP-C premises. Their research areas are Computer Sciences and informatics applications (ICS), biology and biotechnology (IMBB), computational mathematics (IACM) and materials, micro-electronics and laser (IESL). All four institutes had been already in operation for

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[81] In 2002, a fifth institute, the Institute of Solid Fuels, operating in the region of Western Macedonia came under the umbrella of CERTH.

more than eight years when the Park opened in 1994 and had a budget close to €20 billion and around 900 employees: researchers and support staff. Since then, their growth has been more in terms of research budget, extension of activities in additional research areas and building up of research capacity, reaching €37 million in 2005.

Table 4-13: Budget and employment evolution of STPs' research centres

		1994	1995	1996	1999	2000	2001	2003	2004	2005
FORTH	Budget (million €)			26.9	32.31	35.62	31.01	31.5	35.2	37.3
	Employees		920			650		800	800	900
CERTH[82]	Budget (million €)	2.9		4.3	7.66	9.9	9.69	14.565	18.3	17.4
	Employees	86		101		206	293	342	384	

Source: CERTH, 2004 ;GSRT, 2004

The mission of both government centres is to carry out "...basic and mainly applied and technological oriented research, develop products and processes, exploit research results and provide research and technology services to industry and society in general" (Government Gazette, 2000). The above points to the development of linkages with industry and technology transfer as one of the purposes of the research centres' activities. The responses of the institutes' directors did not, however, seem to incorporate this priority at the same level. The institutes' representatives assigned higher importance to the scientific/academic publications and less to the provision of services to firms (see Table 4-15). CPERI in Thessaloniki and IACM in Crete appeared to be the most market-oriented although, for the latter, market related activity is concentrated in one research team related to geographical information systems and technologies in various applications. In most other areas "...the institute research area has a more theoretical character" (Dougalis, interview, 2006).[83]

[82] CPERI until 2000.

[83] In contrast to the provided responses, other secondary sources (PREST, 2002; GSRT, 2005; FORTH, 2006) imply a rather significant activity of ICS in the private sector services area. The fact that, in this case, a less senior researcher, with a less general view of the institute's activities, was made available for the interview may have played a role in this understatement of the institute's activity.

Table 4-14: Research institutes in the two Parks and activity areas

Park	Name of institute	Year of creation	Personnel (2004)	Budget (2004)[84]	Research areas
TTP	Chemical Processes Research Institute (CPERI)	1985	115	6.8	Chemicals production processes, fuels and alternative energy sources, materials, environmental technologies, nanotechnology
	Institute of Telematics and Informatics (ITI)	1998	91	4.3	Multimedia and internet technologies, virtual reality, data communications, computer networks
	Hellenic Institute of Transport (HIT)	2000	67	2.7	Infrastructure and transport systems analysis, vehicle technology, transport services, logistics
	Institute of Agrobiotechnology (INA)	2000	19	0.7	Plant biotechnology, biodiagnostics, food and beverages biotechnology
STEP-C	Institute of Computer Sciences (ICS)	1983	250	8.5	Informatics systems, telematic network services, computer architecture robotics, bioinformatics
	Institute of Molecular Biology and Biotechnology (IMBB)	1983	141	5.9	Gene expression, proteins structure, molecular biology plant protection, bioinformatics
	Institute of Electronic Structure and Laser (IESL)	1983	175	7.1	Materials science, microelectronics, laser applications
	Institute of Applied and Computational Mathematics (IACM)	1985	65	1.8	Numerical analysis models in fluid dynamics, wave propagation models, regional analysis and geo-informatics, computational neurosciences

Source: (GSRT, 2004 ;CERTH, 2005 ;FORTH, 2006)

Table 4-15: Priority level of various types of activities for the research institutes

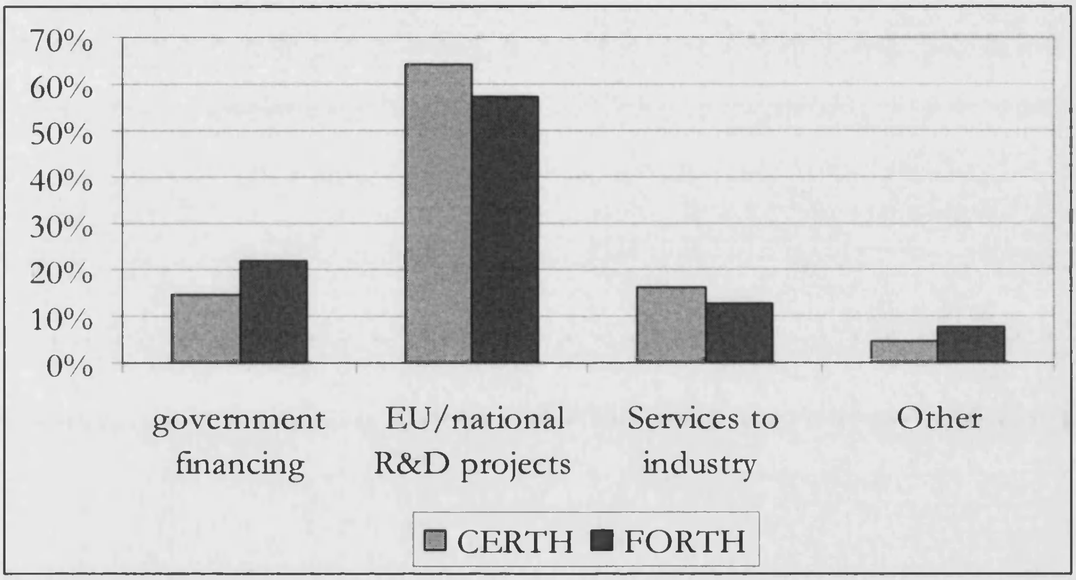
	STEP-C				TTP			
	IESL	IACM	ICS	IMBB	CPERI	ITI	HIT	INA[85]
Contribution to scientific community (publications and conf.erences)	****	*****	*****	****	****	*****	****	-
Education and training (workshops, internships, masters/PhD programs)	***	****	***	****	***	*	****	-
Projects/services to companies (technology transfer, consultancy, etc.)	*	****	**	**	*****	***	**	-
Public sector consultancy/services	*	****	**	***	*****	**	****	-

Source: Survey (Very low:* , Med: ***, Very high: *****)

[84] In million €

[85] No responses provided

The limited role that the private sector plays in the Parks' activities becomes evident from the distribution of the centres' income sources. Less than 15% of their annual budget, on average, comes from direct contracts and services to industry (Figure 4-7) and is concentrated in only a few units. CPERI in Thessaloniki has some important contracts with industry related to the provision of analysis/testing services, mainly to large foreign companies such as BP, Amoco, Dow, Solvay (GSRT, 2001) and very few cases in Greece (e.g. Hellenic Petroleum). IMBB director in FORTH referred to important contracts with pharmaceutical firms in Europe (e.g. Astra Zeneca, Unilever) or the United States (e.g. Pfizer).



Source: GSRT,2004

Figure 4-7: Research centres' budget by funding source (average 2000-2004)

By far the most important income source for all institutes is the participation in national and European competitive research projects, representing over 55% of their annual budget and towards which all institutes have shown particular dynamism. Either as partners or even as coordinators, the institutes or the individual research labs become parts of broader consortia with research organisations and firms at national, European or international levels. Inside Greece, CERTH (mainly CPERI) has greater levels of cooperation with industry based on direct contracts for various types of R&D activity, while FORTH is more active in cooperation through programmes (see also **Error! Not a valid bookmark self-reference.**).

Table 4-16: Participation of FORTH and CERTH in R&D cooperation programmes (1995-2001) – Number of programmes and rank (in parenthesis) among the Greek government research centres

Source of funding	FORTH	CPERI/CERTH	Total number of programs
National programme	50 (2)	13 (5)	273
European programme	97 (1)	49 (4)	451
Direct funding from Greek industry	11 (2)	23 (1)	82

Source: NTUA (2002)

4.6.2 R&D activity results

From an academic perspective, the R&D capacity of both research centres can be verified by the impressive records of their scientific publication activity (see Table 4-17). FORTH institutes had a total annual average of 180 SCI publications during the last ten years (1996-2006), with high citation levels (11.21 citations/papers) against the 5.05 national average. CERTH have so far had a less positive performance, with an average of 40 SCI publications annually and 5.9 citations/paper(ISI, 2006), and around half the levels of the publication/research of FORTH[86]. At varying levels among the institutes, the high quality of research has been recognised and verified through the provision of "Centres of Excellence" status for some of their research units/labs at a national[87] and European level[88] [89] and with international awards presented to researchers and research teams (CERTH, 2005; FORTH, 2006).

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[86] The research centres also refer to many more non-referred publications and conference papers. The researcher used Thomson Corporation SCI index to enhance comparability. Still, it should be kept in mind that different research fields have different publication and citation tendencies. For example, computer sciences have on average 4-5 times lower total SCI publication and citation numbers in comparison to biotechnology.

[87] In the most recent evaluation of all public research centres performed by the central government, both centres were graded with very high overall marks (>4.5/5) "for the quality of their research, their productivity levels, their organization and management" (GSRT, 2005).

88 ITI-CERTH was recognized as an international Centre of Excellence in 3D and Stereoscopic imaging in 2002 (CORDIS, 2006)

89 The laser facilities of IESL institute in Crete were selected from the European Union as European Laser Facilities to be used for experiment by researchers around Europe.

Table 4-17: R&D activity intensity and main results

	FORTH	CERTH
Number of permanent research personnel (2004)	118	24
Total budget in million Euros(2004)	35	18.3
R&D projects (2004)	300	237
SCI Publications (1995-2005)	1871	139
SCI Citations/paper (National average: 5.05)	11.21	5.9
SCI publications/researcher/year (average 2000-2004)	1.6	0.8
Trainees/students (2004)	323	65
PhD theses annually (average of 2000-2004)	175	44
Patents (total period of operation)	29	7
Spin-offs (total period of operation)	10	2

Source: EUA (2001), FORTH, (FORTH), CERTH, (CERTH), ISI, (ISI) and own elaboration

Education and training have been important aspects of their operation, including both long and short term training of undergraduate and graduate students, as well as PhD theses work. FORTH has been particularly active, with over 300 trainees and PhD students (2004) in comparison to a smaller number (65) for CERTH for the same year. Both also organise postgraduate courses in cooperation with the local and other universities, while FORTH has created a training centre for the general public in the use of information technologies and business software.

There is, however, a less positive, but rather different level of performance in the exploitation of research results in the forms of patents and spin-offs' creation. Patenting activity is limited. Compared with an annual 9.2 patent applications/1000 research staff documented for the European PRTOs (Arundel and Bordoy, 2007)[90], FORTH 600-800 personnel have produced a total of 29 patents[91] in 21 years of operation (1984-2005). CERTH have so far only produced seven patent applications during the last five years of operation (Table 4-17). In the Greek context, FORTH is still suggested to be the most active public research organisation (Ignatiadis, interview, 2006).

[90] Another study (Proton) suggests lower levels (4 patents/1000 research staff) – still higher than that of either FORTH or CERTH.
[91] No data on applications

Even greater are the differences concerning the exploitation of research results through spin-off firms, a crucial element as far as the Parks' are concerned. FORTH was active since the first years of its operation (see Table 4-18). The first firm, in the form of a productive laboratory, was created in 1987 and since then nine more spin-offs have been created at rates not very different to the average of other European research institutes (0.5 start-ups/1000 researchers) (Arundel and Bordoy, 2007). While not all researchers show similar interest in the exploitation of research results, FORTH has reached a level where "...without much effort 1 or 2 spin-off opportunities emerge every year" (Tsakalos, interview, 16/05/2006)[92]. In contrast, CERTH had not created any spin-offs until very recently. The first two such projects were initiated in 2005, while two more ideas were in the early planning stages (Oikonomidou, 2005). For CERTH's current director, the small amount of total research activity also means a small number of exploitable ideas and, subsequently, reduced opportunities for successful spin-off projects (Kiparisidis, interview, 2007). This is only one part of the story, however; CERTH still lacks a formulated strategy concerning the exploitation of R&D results and the few recorded cases have so far been dealt by a very ad-hoc approach (Oikonomidou, interview, 2006). For a long time there have been important differences for the two Parks in respect to the demand created from the two PRTOs for spin-off support services and the use of their incubation functions, both tangible and intangible.

However, patents and spin-offs do not represent the only route for the exploitation of research results. The licensing of the developed technologies is an important alternative. In both centres, the web sites (CERTH, 2005; FORTH, 2006) refer to a number of patentable or not new technologies, applications and devices on offer for licensing agreements. While

[92] The standard policy of FORTH is for material/know-how transfer to the new firms and/or licensing rights and no capital. The objective is to exit the company capital after five years.

there are no data concerning annual production rates, the share of income from the private sector and the exploitation of intellectual property suggest a limited weight.

Table 4-18: Spin-off firms/projects from the Parks' research institutes

	Name of firm	Institute	Year of creation	Current location	Activity
CERTH	CPERI-Solutions	CPERI	2005	Park	Analysis and testing of catalysts for chemical processes
	VR Sence	ITI	2005	Park	Software for virtual reality services
	Polymers	CPERI	Planning[93]	-	Polymer processes software
	SERVISIO	ITI	Planning[93]	-	Optical data search and management
FORTH	MinoTech	IMBB	1987	Park	Bacterial derived DNA enzyme production
	Knossos technologies	ICS	1989	Closed (2002)	Picture archiving and communication systems services
	FORTHnet	ICS	1995	Park[94] + Athens	Internet services provider and business telecom services
	ART Innovation	IESL	1997	Netherlands	Diagnostic equipment for art works inspection
	Microchemistry	IMBB	1999	Park	DNA production/Biotechnology services
	Axon-Tech	IESL	2000	Athens	Laser technology for development of defence systems
	Minos Biosystems	IMBB	2000	UK	Gene transfer techniques
	FORTH Photonics	IESL	2002	Athens/ UK[95]	Imaging technologies for diagnosis and screening of cancer
	Compitent	IESL	2002	Athens	Laser equipment for materials processing
	FORTHmed	ICS	Planning	-	Health related telematics applications

Source: survey and Oikonomidou (2005)

4.6.3 Conclusion

The two STPs host dynamic research centres with high quality R&D activity and are competitive at European and international levels. Their recognition as the most dynamic and industry-oriented PRTOs in Greece suggests that they represented, in comparison to the

[93] According to more recent information from TTP/MCD S.A. these spin-off projects did not materialise
[94] Only R&D department.
[95] Operated in the Park for a very brief period.

universities, the most suitable bases for the STPs' creation. The comparison reveals, however, that they are at very different stages of maturity. Even before the creation of the Park, FORTH had an established activity base, an existing exploitation strategy and some results already present. Less than half the size of FORTH and with three new institutions created in 2000, CERTH has still been building the necessary capacity for most of the period of the Park's operation. It has been much less able to support the operation of the Park and to create sufficient demand for services and Park space.

4.7 Evaluation of STPs' performance

Having examined the structure and main operation elements of the two STPs and the characteristics of its main players, the research institutes, the chapter now turns to an evaluation of the STPs' operation and the development of the expected functions. Based on their technology-led character and their promoters' stated objectives, the focus here is on the following parameters:

- The Parks' technology incubation function: the creation rates of new firms and growth
- Technology content of the firms, both new and existing, operating in the Park
- Technology transfer, linkages and synergies creation and innovation cooperation of the Parks' tenants inside and outside the Park area
- Role and contribution of the Parks' tangible and intangible elements in the above functions
- The role and impact of the Parks on regional development and the operation of the regional innovation system

4.7.1 Incubation and new firms creation

As already described, the Parks reached high occupancy levels early on and, after no more than three years, over 85% of the total space available was occupied. While STEP-C maintained this rather high level of activity, TTP has been in a gradual stagnation period since 2000; at the time of the survey (2005), it was limited to seven firms/units operating in the Park with very few new entries. The expected entries of five new firms would increase the tenancy levels for the Park, but still could not change the overall negative picture (Tramantzas, interview, 2005)[96].

Occupancy levels are, however, not necessarily an indication of a successful incubation function. Indeed, in Thessaloniki, of the 21 companies that operated in TTP since 1994, two-thirds (fourteen firms) were newly created companies, while the remainder included one branch of an international company and seven local firms' units (TTP/MDC, 2004). Furthermore, there was no university or research-centre spin-off[97] and only a couple were created with the participation of academics. The total number of fourteen new firms in ten years represents a low firm creation rate. Coupled with the absence of a strict graduation policy at the time of the survey, almost all tenants had been established before 2000. The resulting average tenancy period was over six years - two times higher than the respective European average (see Table 4-19).

Data limitations in STEP-C concerning past tenants' activity impede a similarly thorough analysis. Of the 21 tenants in site at the time of the survey, a little more than half (twelve) were new firms: three FORTH spin-offs (FORTHnet, Minotech and Microchemistry)[98] and nine start-ups (four by researchers and university students). However, six more were new units of existing firms (mainly R&D labs). Based on a stated annual entry/exit rate of three firms (Saitakis, interview, 2006) the total number of new firms/units created is calculated to

[96] I managed to contact three of the five new entries and arranged short interviews focusing on their profile, the reasons for their location in the Park and their expectations.
[97] Concerning the exploitation of knowledge and research results developed within the university
[98] Minotech and Microchemistry operate from FORTH research labs and do not occupy incubator space.

be around 40 to 50. This number is clearly better than TTP even when the larger space of STEP-C is taken into account, but is still significantly lower than the respective EU average (66 firms) (EC, 2002).

The incubation function and character of the Parks, especially TTP, is also questionable in many respects. The most recent entries of TTP are primarily subsidiary units, supporting the conclusion that the incubation function is not consistently pursued. In STEP-C there is no clear separation between incubation and general Park space and firms are characterised according to the status (incubation/Park status). Still, some subsidiary units of existing firms (ISD, Ellemedia) were listed under the first group.

Table 4-19: Performance metrics of Parks' incubators – a comparison with the EU average

	TTP	STEP-C	EU average
Average number of tenants	9.5	~20	18
Average occupancy rate	>85%	~85%	85%
Average company size (empl.)	4.5	-	6.2
Average tenancy period (years)	6.5	>5	2.9
Average annual graduation rate[99]	1.4	2-3	6.6[100]
Failure rate	>25%[101]	No data	15.2%
Total new companies created	14	40-50[102]	66[103]

Source: TTP/MDC(2004), TTP/MDC(2005), STEP-C(2004), EC(2002), Siegel et al.,(2003) and own elaboration

In terms of the individual firm performances, the survey data show that the majority (over 2/3^{rds}) experienced positive growth rates during their operation in the Park (Table 4-21 and Table 4-22 below). A small number of firms in TTP experienced zero or even negative employment growth rates with a number of failures/closure cases (1 in 4 in TTP). There have also been very few high success cases (the gazelle firms suggested in the literature (Autio, 2007)) and they have only occurred in STEP-C. FORTHnet (see profile in Table 4-20) represents the greatest success example. Based on the advanced telecommunication

[99] Number of firms/year

[100] This number should be divided by the average number of tenants in each case. In both cases it is still more than double the performance of the two Greek Parks.

[101] This is only an estimate, as there were data missing for some of the companies that left the incubator.

[102] Calculation based on average graduation rate provided.

[103] Based on ten years of operation.

infrastructure and technological capacity of the ICS institute of FORTH and with financing from private sector investors[104], FORTHnet reached 600 employees in 2005 and has expanded its range of ICT services, now being one of the main firms in the sector in Greece(KANTOR, 2005). It has also created a number of subsidiaries and spin-offs, although none of them operate in the Park or in Crete.

Table 4-20: FORTHnet S.A. profile

Year of establishment	1995
Sector	Informatics and Telecommunication services
Employees (2005)	600
Turnover (2005)	90 million EURO
R&D expend. (2005)	1.5-2% of turnover (1.5 million Euros)
R&D employees (2005)	5% (35 located in park)
Activity in park	R&D and software development
R&D activity results	New products/services, copyrights, product prototypes
Spin-off/subsidiary firms	Telemedicine Technologies (France), FORTH-crs -information management systems services(Athens), FORTH e-com -electronic commerce (Thessaloniki), Mediterranean Broadband Access (Athens)

Source: FORTHnet (2005) and survey results

Other high performance firms currently operating in STEP-C are Virtual-Trip, CyTech and Phaistos. The first reached a total of 35 employees in total, creating a group of five firms operating in Athens, Patras and Thessaloniki. Cytech created two more spin-offs, while Phaistos was integrated in the group of a large Greek publishing company. In their study, Souitaris and Daskalopoulos (2000) refer to five more cases in STEP-C with positive growth rates. In comparison, in TTP the most positive examples, Ampeloeniki and Heletel[105], had only limited employment growth-rates. Souitaris and Daskalopoulos (2000) refer to one more case in the recent past (AST[106]).

[104] The main shareholder was Minoan Lines, one of the strongest coastal services providers in Greece, based in Crete.
[105] Heletel reached a total of eighteen employees in 2003, but was scaled down to eight in 2004.
[106] AST (Advanced System Technologies) left the Park in 2004. In 1999 it had four employees and, at the end of 2000, twelve.

Table 4-21: Profile of TTP tenants (06/2005)

	Firm name (year establ.)	Sector and main activity in the Park	Type	Size (Year est.)	Size (2005)	Sales growth	R&D intensity[107]	Innovative output[108]
1	Heletel* (1995)	E-commerce software applications	Start-up	2	8	30%	T:30% P:>30%	3 new products 1 patent
2	Ampeloeniki* (1996)	Winery/Vineyard technical support, analytical services and R&D	Start-up	3	7	10-20%	T: 35% P:>50%	2 new products
3	Metek (1997)	Installation and service of analytical systems and automation systems	Start-up	1	2			
4	Hellabio* (1998)	Development of biological reagents for diagnoses - Analytical services	Start-up	1	4		T:40% P: >75%	6 new products
5	IQS* (1999)	Web-based business services software	Start-up	7	7		T: >20% P: >60%	2 new products
6	Intelligen* (2001)	Chemical processes simulation software	Branch office	1	3		T: 100% P: 100%	3 new products
7	FORTHnet	Internet server hosting office	New unit					

Source: survey (*: firms that participated in the survey)

Table 4-22: Profile of STEP-C tenants (05/2006)

	Firm (year established)	Activity in park	Type	Size (Year est.)	Size (2005)	Sales growth	R&D intensity	Innovative output
1	Minotech* (1987)109	Production of bacterial derived DNA enzymes	Spin-off	3	4	110	T:21-40% P:>40%	1 new product
2	Katrea Travel (1994)	Travel agency (Park unit)	New unit	1	1			
3	Mitos SA (1994)	Conference organisation	Start-up					
4	Katrea Travel (1994)	Travel agency (Park unit)	New unit	1	1			
5	FORTHnet* (1995)	ICT services development -	Spin-off	5	32	111	T:1-5%112	Improved products/

[107] T: R&D expenditure as % of turnover, P: % of personnel occupied in R&D activities
[108] Results of the last three years
[109] Minotech was and still is operating inside the university labs and does not occupy space in the Park buildings.
[110] No data available

	Firm (year established)	Activity in park	Type	Size (Year est.)	Size (2005)	Sales growth	R&D intensity	Innovative output
		R&D unit					P:1-5%	processes Copyrights
6	Synaptic (1995)	IT applications in automation and biology	Start-up	2	2			
7	Micro-chemistry* (1999)	DNA production Biotechnology services (IMBB production unit)	Spin-off	3	5	1-10%	T:21-40% P:21-40%	Improved products/ processes
8	Virtual Trip* (2000)	Business software information systems/networks	Start-up	5	10	>40%	T:21-40% P:>40%	New + improved products
9	ISD (2000)	Microelectronic circuits design	R&D unit		3			
10	Phaistos Networks (2002)*	Internet based services/applications development	New unit	7	10	1-10%	T:>40% P:21-40%	New products + processes
11	CyTech* (2002)	Software, internet based business services development	Start-up	2	5	20-40%	T:21-40% P:>40%	New products
12	Palmera* (2002)	Telematic applications	Start-up	2	2	21-40%	T:>40% P:>40%	New products
13	Infocharta* (2000)	Digital maps, GIS applications	Start-up	1	6	21-40%	T:>40% P:21-40%	New, improved products + processes
14	VEIC* (1998)	Optical equipment laboratory	New unit	2	2	21-40%	T:>40% P:>40%	Improved products
15	ARTT* (1996)	Laser systems for materials processing	Spin-off	3	3	1-10%	T:>40% P:>40%	New products + processes
16	TUV Hellas* (2002)	Certification body (offices)	New unit	1	3	11-20%	T: 0% P: 0%	No
17	Noveltech (2004)	IT business services	Start-up					
18	Ellemedia ()	Multimedia network systems	R&D unit					
19	Last-Minute ()	Internet based tourism services	Start-up					
20	ULAC (n.d.)	Local authorities union (offices)	-					
21	Crete on-line (n.d.)	Online tourism services	Start-up					

Source: survey (*: firms that participated in the survey)

[111] No data for local R&D unit. Firms sales growth

[112] In FORTHnet the data refer to the whole company and not the R&D unit operating in the Park.

4.7.2 Technology content of Park firms

The knowledge intensity of the tenants is the second critical evaluation criterion of the Parks' operation. The analysis of the tenants' sector classification (Table 4-23) reveals the dominance of the informatics/telecommunication sector in both STPs. Specialised software development, internet-based applications and customised network/telecommunication business services and products are the most dominant activities, following the picture of most other STPs in Europe (Kelessidis et al., 1999). Other high-technology sectors include biotechnology applications for medical purposes or the agro-food industry, while four firms in TTP operated in the industrial automation and robotics areas. All are cases fitting well with the Parks' focus towards high or medium-high manufacturing and knowledge intensive services sectors.

Table 4-23: Park firms by sector of activity

TTP (whole period 1995-2005)		STEP-C (tenants in 2006)	
Sector	**#**	**Sector**	**#**
Informatics/telecommunications	8	Informatics/telecommunication	10
Product design	3	Engineering/business services	2
Medical/biomedical	2	Medical/biomedical	2
Agro-bio	1	Biotechnology	3
Automatics-robotics	2	Tourism services	4
Audiovisual applications	1	Bank	1
Other	4	Local association	1
Total	**21**	**Total**	**23**

Source: survey and TTP/MDC (2004)

The firms' stated activities inside the Park also appear to fit with the requirement for knowledge intensive activities. R&D and product development are the most commonly stated (Table 4-24), while in the case of TTP there is also common reference to consultancy and testing services (three out of five). At the same time, though, as expected from small independent firms operating in a single site, sales/distribution were also stated by a number of STEP-C tenants (4/11).

Table 4-24 – STPs' tenants main activities (firms stated up to 3 most important activities)

	TTP (n=5)		STEP-C (n=11)	
	No.	%	No.	%
R&D	5	100	9	82
Software development	3	60	6	54
Product design/engineering	0	0	3	27
Production	2	40	3	27
Consultancy/analysis/testing	3	60	1	9
Sales/distribution	1	20	4	36

Source: survey

Table 4-21 illustrates the typical firm that is targeted by the Parks' management. High R&D intensity (above 20% of turnover and high shares of personnel dedicated to R&D) and the presence of new and improved products/processes during the last three years indicates a minimum level of innovative character. It includes new or improved software and/or internet-based applications for business services (Heletel, IQS, Intelligen), biological agents' development (Hellabio) and applied research and consultancy services in the winery sector (Ampeloeniki). Most of the firms are not based on cutting edge or state-of-the-art technologies at international levels; however, they are clearly innovative in regional and national contexts.

STEP-C firms reveal similar types of firms/units with significant knowledge intensive profile (Table 4-22). With the exception of the TUV certification[113] unit, all other firms reported high shares of R&D expenditure (above 20% of sales), R&D employment and similar positive and continuous innovation– results (new products and processes). Besides FORTHnet's 35-person strong R&D unit, all firms in the survey suggested that they dedicate an important part of their, albeit limited, resources in R&D activity development and referred to a number of new or improved products. The informatics and telecommunications start-ups (e.g. Virtual Trip, CyTech, Palmera and Infocharta) stated innovative and state-of-the-art services and products, at least in the national context, along

[113] TUV unit in Crete is the local branch of TUV Rheinland, a global technical certification company.

with more mainstream activities such as web-site development. The bio-tech units operating inside IMBB use the technology developed by the FORTH institutes in niche markets such as DNA sequencing and have customers in national and international markets.

Nevertheless, along with those positive cases, both STPs have tenants with much lower levels of technology/knowledge intensity. The survey conducted by the TTP Park management in 2000 concluded that around 1/3rd were using the Park's space as local sales branches. Offices/companies offering internet based tourism services and conference organisation, a bank branch (in STEP-C) and local, professional sector association offices do not easily fit with the expected high-technology profile of the Park. When asked about the suitability of the last group of tenants mentioned, the STEP-C director suggested "...these companies are not considered as actual park tenants. They offer additional important support services to the firms on site" (Saitakis, interview, 2006).

The less risky character of such tenants was suggested by TTP management as a mechanism to secure a minimum level of rent and support more risky and innovative enterprises (Tramantzas, interview, 2005). Still, the dedication of 20% or 30% of an already small incubator represents a strong sacrifice and a clear indication of weakness in terms of both technology intensity and the incubation operation.

To summarise, in both Parks there are new, knowledge-intensive and innovative small firms which fit the STP label to a great extent, at least in the form that Massey et al. (1992) in the UK characterised as innovation adopters, if not cutting-edge technology creators. However, they are next to an important number of tenants that do not belong in high-tech sectors and do not have any knowledge intensive characteristics. Flexible admission processes, pressure to maintain high occupancy levels and to secure a minimum level of income have jeopardised part of the Park's high-tech character and new firms' creation rates.

4.7.3 Linkages, cooperation and knowledge flows

The concentration of knowledge intensive activities and the support mechanisms in the Parks was expected to facilitate the development of linkages and synergies among the different tenants and promote their connection in broader networks. Based on survey responses and the interviews, the various forms of linkages developed by the research centres and the Parks' firms towards the creation of an innovation intensive environment inside as well as outside the Parks are examined.

4.7.3.1 Market based linkages

An examination of the tenants' market-based relationships does not provide a dominant profile in terms of supplier and customers linkages. The very small number of tenants could not support extensive Park-based interactions. Furthermore, as many of them are services firms, their input, besides basic consumables or widely available standardised equipment and software programmes, was not seen as important. Still, most STEP-C firms relied on national or even international suppliers and this included specialised equipment or software. In comparison, regional markets represent the main supplier for four out of five firms in TTP and only one firm referred to imports for some very specialised inputs.[114]

The customer base of the Parks' firms (see Table 4-25) is balanced between the regional and the national market. In comparison to TTP firms, STEP-C firms state again greater focus on the national (10/11) and less so on the smaller regional picture. Export oriented

[114] In the case of the ICT firms, the respondents focused more on material inputs as their product development activity includes software applications and modules usually based on software platforms created by firms outside Greece.

firms are fewer, the most extreme case being one firm in TTP for which over 90% of sales come from exports, due to the limited size of a national market for its specialised products. However, in STEP-C a significant number (4/11) confirmed important exporting activity.

Table 4-25: Importance of different markets for Park firms' inputs and sales (number of firms stating medium to very high importance)

	TTP (n=5)		STEP-C (n=11)	
	Customers	Suppliers	Customers	Suppliers
Park	0	0	2	1
Region	2	4	6	4
Greece	2	0	10	7
International	1	1	4	8

Source: survey (Firms responded from 1 – very low, 3-average, 5 – very high)

4.7.3.2 Access to skilled labour sources and mobility

Confirming their knowledge-intensive character, the great majority of firms in both cases referred to the hiring of skilled personnel and training as very important sources for new knowledge acquisition and innovation development. In the survey, four out of five firms in TTP and six out of eleven in STEP-C assigned such activities medium to very high importance.

The Parks' space did not provide a critical supportive role in this direction. Only one firm in each STP stated that more than 25% of their recently (last three years) hired personnel came from inside the Park (see Table 4-26). Personnel mobility is present, but it is not a strong form of knowledge exchange inside the Parks' space (see Table 4-27). It does not represent a problem for STEP-C tenants, who stated satisfaction with the regional education system and the availability of skilled labour in Crete. In contrast, in Thessaloniki there is a rather moderate assessment of the regional education system, with only two of five respondents referring to the use of local sources.

Table 4-26: Skilled labour sources for Park tenants (number of firms stating % of R&D and management personnel hired during the last three years)

	TTP			STEP-C		
	0	<25	>25	0	<25	>25
Park	4	0	1	9	1	1
Region	3	0	2	2	3	6

Source: survey

Table 4-27: Assessment of skilled-labour sources (number of firms stating)

	TTP			STEP-C		
	No	1-2	3-5	No	1-2	3-5
Importance of Park as source of skilled-labour	3	0	2	4	5	2
Quality of regional education system	3	0	2	2	4	5
Availability of skilled labour in the region	2	1	2	2	1	8

Source: survey (Firms responded from 1 –weak, 3- satisfactory to 5 – very strong or No opinion)

4.7.3.3 Research institutes' linkages

The survey among the Parks' research institutes revealed the presence of important connections and interactions with other public research organisations and a less developed level of linkages with firms and industry. The former type of partners are present at all spatial scales, while the latter are primarily outside the country.

In TTP, CERTH institutes did not refer to any linkage with firms during the last three years, either formal of informal, and there was only one example of intra-institute cooperation[115]. In comparison, FORTH institutes have developed some strong internal partnerships through a number of joint research projects and the creation of cross-disciplinary research units (e.g. IMBB-ICS in the area of Bio-informatics), but also with some of the Park's firms. The presence of researchers in a few of the firms' management teams, the joint participation in public R&D projects or other formal and informal types of interaction (see Table 4-28 for summary and a more detailed analysis in Appendix 12 – Detailed analysis of Greek STPs PRTOs linkages by partner, importance and type of

[115] One common project between ITI and HIT

linkage) are documented in the case of ARTT with the Laser Institute (IESL), Infocharta with IACM, Minotech with IMBB and FORTHnet with ICS. Still, none of the research institutes gave particular weight to these linkages.

At the regional level, the Parks' PRTOs' linkages are focused on the respective/relevant university departments of the two regions. Most senior researchers hold positions in the university departments and many of the university professors and PhD students in related departments spend time in the research centres performing part of their research work. Joint participation in government funded research projects/programmes, use/exchange of specialised research facilities and laboratories (e.g. HIT in TTP, ICS in STEP-C) or the joint development of postgraduate courses are partnerships stated in both cases. This close partnership between university departments and the research institutes is not always seen positively. According to an AUTH representative, the partnerships represent a practical way for some professors to reduce the control and constraints set by the university procedures in the R&D programmes. "...some of the university faculty transfer the programs and students to the research institutes in order to extract a higher level of return/income from publicly funded projects" (Panas, interview, 2007). The above reflects, in many respects, the tension that characterises the relationship between the two main research organisations of Thessaloniki at the institutional level.

In contrast to the linkages with other public research organisations, interactions with local firms remain limited. While all institutes' representatives referred to some linkages with firms, they also stated their limited weight and importance, especially in comparison to national and (even more so) international firms. Joint participation in public programmes, many of them requiring the presence of public and private entities, is the most common form, while direct technical consultancy was also reported. The larger market size and the presence of more firms in sectors relevant to their R&D activity explain the comparatively greater level of linkages reported by CERTH institutes in Central Macedonia against the extremely limited connections of FORTH institutes with the Cretan economy; primarily public sector organisations(e.g. hospitals, local authorities, schools)[116].

When it comes to R&D cooperation, the clear priority of most researchers is directed outside the region. Inside Greece, the partnerships again refer mainly to other research units and university departments in relevant or complementary fields and a few firms, most of which are located in the capital area of Athens. Joint participation in publicly funded R&D programmes, exchange of researchers and students training with other PRTOs or the provision of technical consultancy services are the most common linkages reported. These linkages were still considered to be limited, as Greek firms are not seen as displaying real interest in innovation and technological collaboration, and are thought to be attracted only by the prospect of access to the funds of public programmes (Vasalos, interview, 2005; Stratigis, interview, 2006).

Table 4-28: Relative importance of research institutes' linkages – by location and type of partner

	Institute	Partner	Park	Region	Greece	Int'l
TTP	CPERI	PRTO	-	****	***	*****
		Firm	-	**	**	*****
	ITI	PRTO	-	****	****	*****
		Firm	-	**	***	*****
	HIT	PRTO	-	****	***	****
		Firm	-	**	****	**
	INA	PRTO	No data	No data	No data	No data
		Firm	No data	No data	No data	No data
STEP-C	ICS	PRTO	****	***	****	****
		Firm	***	***	****	**
	IESL	PRTO	****	*	**	*****
		Firm	*	-	**	****
	IACM	PRTO	****	****	****	****
		Firm	*	**	**	**

[116] ICS reported that a higher level of importance is the result of the implementation of a number of public projects for public organisations (hospitals, schools, public administration services) in the framework of the national ICT operational program "Information Society".

	Institute	Partner	Park	Region	Greece	Int'l
	IMBB	PRTO	****	***	****	*****
		Firm	*	*	**	*****

Source: own elaboration based on survey results (*: Very low, *****: Very high, - : Does not exist)

It is thus the international connections to which the research institutes give priority. Joint participation in research and technology networks and other EU competitive programmes that involve firms and public research organisations are critical for funding, the networks with foreign research centres and the formal and informal connections they bring. Long-term R&D contracts, provision of specialised R&D services (testing/analysis and expert consultancy services) joint R&D activity, sponsoring of research and transfer of technology (licensing) agreements with some international firms (CPERI with BP and AMOCO and IMBB with Pfizer and Bayer) were the most highlighted examples.

4.7.3.4 Firms' linkages

For the Park firms, the overall tendency, which is much clearer in STEP-C and less so in TTP, is largely towards connections and linkages with public research organisations and much less with other firms (Table 4-29). University labs and research centres, irrespective of location, are given an important weight by more than 70% of STEP-C and 60% of TTP firms. Client firms were also given weight as innovation partners by the majority of STEP-C tenants. Their counterparts in Thessaloniki appeared much less connected.

Table 4-29: Important innovation partners (firms stating partners as being of medium to very high importance)

	TTP (n=5)		STEP-C (n=11)	
	#	%	#	%
Universities	2	40%	8	73%
Research/Technology centres	3	60%	9	82%
Clients	1	20%	7	64%
Suppliers	2	40%	3	27%
Companies in same sector/competitors	-	-	2	18%
Companies/units in the same group/firm	1	20%	1	9%
Experts/consultants	2	20%	1	9%

Source: survey (1-5 Likert scale with 1: very low importance and 5 very high importance)

Examining the location of their partners, the linkages developed and their spatial reach (see Table 4-30 and Table 4-31 and firm by firm analysis in Appendix 13 – Detailed analysis of Greek STPs firms linkages by category of partners, type of linkage and location[237]), very few connections can be seen inside Thessaloniki Park and only moderately more developed associations are visible in STEP-C. A couple of TTP tenants referred to linkages with CERTH research institutes, one a case of a joint R&D project, one joint venture and two examples of the use of technology services. More informal links such as personnel exchange or social interactions expected to take place due to physical proximity were absent and the same applied to the linkages among the Parks' firms. Comments such as "there is complete absence of communication" (FT-3) or "there is no interest in collaboration" (FT-5) illustrated a situation of firms operating in isolation.

Table 4-30: Important innovation partners by location and type (number of firms stating as important)

	TTP (n=5)				STEP-C (n=11)			
	Park	Region	Greece	Internat.	Park	Region	Greece	Internat.
Universities	-	4	1	1	-	8	4	3
PRTOs	3	-	1	-	9	5	2	2
Clients	-	-	-	-	1	4	7	2
Suppliers	-	2	1	2	1	2	3	2
Companies in same sector	-	-	1	1	2	1	6	1
Companies in same group	-	-	-	1	-	-	3	-
Experts/consultants	-	3	-	-	-	1	2	-

Source: survey

TTP tenants referred to more linkages in their region. Four of them mentioned partnerships with the university research units and there was also reference to linkages with local consultants or specialised suppliers. Again, the joint participation in R&D projects with the university and consultant/expert firms (usually through publicly funded programmes) and training of personnel from the research organisations were the most common forms (see Table 4-31). On the contrary, outside the region, at national and international levels, interactions were not very widespread. Ampeloeniki made reference to partnerships with research and technology organisations, Heletel mentioned joint development of new

products and Inteligen indicated linkages with the firm's headquarters in the US. Although the sample is small, it is still clear that most Park firms did not give strong weight to external connections for the development of innovation.
The firms in STEP-C reveal a rather different picture. The role of external sources in the development of cooperation is considered important for three out of the ten respondents and exists for the remaining seven. Linkages with FORTH institutes inside the Park were reported by nine out of eleven firms (Table 4-30), including both formal (e.g. participation in research projects, use of facilities) and informal (information on R&D activity, personal relationships) contacts. There are also few inter-firm partnerships, primarily among the ICT sector firms. Palmera, CyTech and Infocharta formed a joint venture and exploited complementarities for the development of a new product for a local customer[117]. FORTHnet has partnered with two Park tenants (InfoCharta and Virtual Trip) in both product development and public R&D projects. Informal social contacts were also reported in parallel to the development of these contracts by the same group of firms (see Table 4-31). Even though not of prime importance, unlike the Thessaloniki Park some forms of interaction and synergy were identified.

Most STEP-C tenants also stated formal and informal linkages with various departments of the University of Crete (8/11 firms). Six out of the eleven referred also to linkages with local firms, including both formal joint R&D activities, provision of technology and consulting services, but also more informal/social personal contacts (Table 4-31).

However, this pattern of cooperation changes outside the regional scale. Interaction with research organisations and universities is less common while there is a greater number of

[117] The project was the development of an automatic taxi dispatching system for a local taxi company and was developed in cooperation with a company from Athens and utilised a technology platform of an Italian company (Loquendo, 2005)

connections and interactions with other firms, primarily customers. The dominant form is the provision of technology services (mentioned by seven firms). FORTHnet has the most extensive form of linkages with other firms and PRTOs inside and outside the country. Other firms (VEIC, Infocharta, Virtual Trip and Minotech) also stated inter-firm cooperations.

Table 4-31: Linkages of Parks' firms according to type, location and partner (number of firms reporting for the last three years) [118]

	STEP-C (n=11)				TTP (n=5)			
Linkages with Research and Technology Organisations (PRTOs)								
	Park	**Region**	**Greece**	**Int'l**	**Park**	**Region**	**Greece**	**Int'l**
Formal								
Licensing of R&D results	1	2	1					
R&D contracts	6	3	1		1			
Joint ventures			1		1	1		1
Analysis/testing services	3	3	1	1			1	
Use of consultancy services	3	4	1	1	1	1	1	1
Informal								
Use of equipment/facilities	3	3						
Information on research activity	5	3	2	2				
Training of personnel	2					1	2	1
Personnel exchange	1	1	1				1	1
Student traineeships		3	2					
Social contacts	4	5	3	1	1			
Linkages with firms (suppliers, customers, competitors)								
	Park	**Region**	**Greece**	**Int'l**	**Park**	**Region**	**Greece**	**Int'l**
Formal								
Joint R&D projects	4	4	4	4	-	2		1
Joint ventures	1	1	1		-			2
Technology services provision	2	4	7	4	-			
Informal								
Equipment use	1	2	2		-	1	1	
Researchers exchange	1	1	2		-			
Social contacts	4	5	4	2	-	1	1	

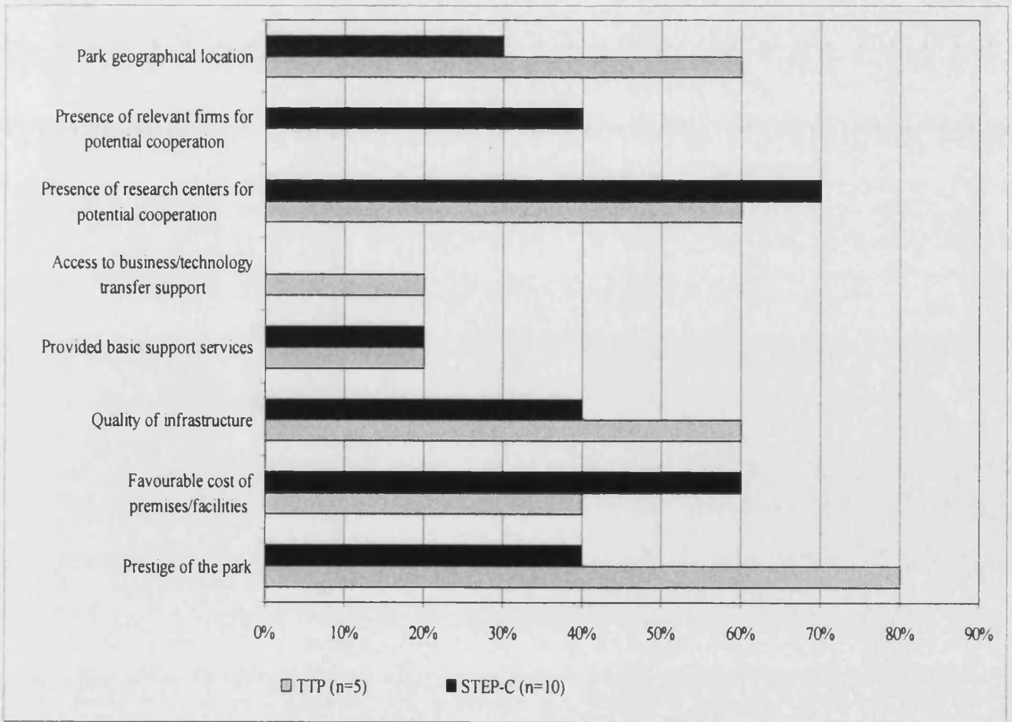
Source: survey

[118] Linkages classification (formal or informal) follows Bakouros (2002)

The survey results show that neither of the two STP spaces has developed strong and intensive knowledge flows, synergies, interactions and cross-fertilisation processes, while broader external linkages tend to be more important. For the PRTOs, they are almost exclusively outside the region. Having said that, a comparison of the two cases reveals that, while cooperation and knowledge flows are indeed developed and some form of interaction does take place in STEP-C, in Thessaloniki Park all expected connections, interactions and networking are almost completely absent.

4.7.4 The role of the Parks' mechanisms

Already, the analysis of the STPs' operation pointed to the deficiencies and weakness of the examined STPs. The survey responses concerning the attractive parameters of the Parks and the added-value of the Parks' tangible and intangible elements confirm the above picture, but also point to some important differences (see Figure 4-8).



Source: survey

Figure 4-8: STP tenants' reasons for locating in the Park (% of firms stating)

With regards to the reasons that attract the Park tenants to establish themselves inside the Parks' space, some important deviations can be observed (see Figure 4-8). The only common element is the PRTOs' presence and the prospects for cooperation and potential knowledge exchange, in accordance with the expected flagship role that the PRTOs should assume. Beyond that, however, TTP tenants focused exclusively on infrastructure elements such as Park location, prestige and quality of infrastructure. In contrast, few STEP-C tenants gave priority to the Park's hardware or even the prestige factor. More focused on less tangible elements such as support services or the presence of other firms for possible cooperation.

When asked to identify the actual added-value coming from their operation in the Park (see Table 4-32), the respondents verified a large part of their limited expectations and revealed a sense of disappointment. Infrastructure elements and basic services, together with the Parks' address profile, were given high marks although there were complaints because raised rents were seen as making the cost/value balance no longer attractive. More importantly, while the positive expectations from the presence of FORTH research centres were confirmed in STEP-C, TTP tenants did not see any added-value from their presence. Other firms' operation in the Park space also had no role in TTP and was given increased weight among only a small subgroup (3/10) in STEP-C.

Table 4-32: Perceived added-value from operating in the Park

	TTP (n=5)			STEP-C (n=10)[119]		
	Not apply	1-2	3-5	Not apply	1-2	3-5
Park prestige/profile	-	-	5	2	3	5
Access to basic services	-	-	5	1	1	8
Quality of infrastructure	-	-	5	1	3	7
Presence of research centres for cooperation	3	1	1	2	1	7
Access to skilled personnel	3	-	2	3	5	2
Reduced rent	-	4	1	2	2	6

[119] One respondent did not complete this part of the questionnaire.

	TTP (n=5)			STEP-C (n=10)[119]		
	Not apply	1-2	3-5	Not apply	1-2	3-5
Relevant firms for cooperation	5	-	-	3	4	3
Access to finance	5	-	-	4	6	-
Advanced business services	3	1	1	3	7	-

Source: survey (1-5 Likert scale with 1: very low importance and 5 very high importance)

As expected from their reported weak development, the Parks' tenants do not generally attach positive added-value to the intangible support elements, the easier access to financial sources or the provision of advanced support services. On further analysis of their role (see Table 4-33), dissatisfaction or no use for most provided services is clearly evident. Against the expected coordination and active business/management support, even the provision of the necessary information, stated as a priority by both Park management teams, was given negative marks by more than 50% of respondents. TTP tenants' comments were that "there is absence of support mechanisms" (FT-3) or "we do not use the Park services" (FT-5). In STEP-C, even if the reported level of use is higher, almost all services (with the exception of support in R&D projects' participation) were rated as below average. A number of firms referred to the need for greater marketing and cooperation promotion, something that they consider to be clearly absent. In both cases, the feeling of being left alone was not different to that documented by Souitaris and Daskalopoulos (2000).

Table 4-33: Use and satisfaction with the provision of advanced services in the Parks

	TTP (n=5)			STEP-C (n=10)		
	No use	1-2	3-5	No use	1-2	3-5
Information provision services	2	1	2	1	5	4
Business/management/marketing support	3	1	1	4	5	1
Support in participation in R&D and innovation related projects	3	2	0	1	6	3
Technology transfer support	5	0	0	5	5	0
Support in identification of innovation partners	3	2	0	2	5	1

Source: survey (1-5 Likert scale with 1: very low importance and 5 very high importance)

The above negative results are also reflected in the PRTOs' responses (Table 4-34). Besides the use of the Park services for the provision of information related to EU and national programmes, there is no particular contribution linked to the Park mechanisms. In

TTP, neither the management team nor, to an even greater extent, the liaison office were considered able to support the development of linkages and to provide technology transfer services. Even some support that was provided for the recent spin-offs was considered to be marginal. In most cases, the researchers are seen as "more able and competent to develop linkages and cooperation with industry". In STEP-C, the picture is more or less the same concerning the role and the use of the Park mechanisms by FORTH researchers. There was, however, clear recognition concerning the contribution of the PRAXI office, through the non-local network, in the creation of a number of spin-off firms.

Table 4-34: Use and added-value of STP support mechanisms by the research institutes
(-: no use, *: very low added-value, ***: moderate *****: very high added value)

	STEP-C				TTP			
	IESL	**IACM**	**ICS**	**IMBB**	**CPERI**	**ITI**	**HIT**	**INA**[120]
Information provision	***	**	***	**	-	-	**	n.a.
Support in participation in public R&D programmes	-	-	**	-	***	*	-	n.a.
Business support services/spin-offs creation	***	-	**	*	-	-	-	n.a
Technology transfer services	-	-	-	-	-	-	-	n.a.
Partners identification and cooperation support	-	-	-	-	*	-	*	n.a.

Source: survey (respondents stated their use and level of satisfaction with each type of service)

4.8Assessing the Parks' role in regional development

In the objective statements, the promoters of both STPs referred to the Parks' expected contribution to regional development as the ultimate goal of their operation. In this section, the presence and intensity of the various mechanisms and forms through which the Parks are expected to contribute to regional development are evaluated. The Parks are examined as potential growth poles, as mechanisms supporting and strengthening the local endogenous capacity and their role in the operation of the regions' innovation systems.

[120] No responses provided

4.8.1 STPs as growth/development poles

The Parks' structure, size, and subsequent evolution presented rather limited opportunities for either case to assume a real growth pole function, as described by Luger and Goldstein (1991). In 2004, STEP-C and TTP total economic activity represented no more than 0.45-0.5% and 0.07-0.09% of the regional GDPs of Crete and Central Macedonia respectively and no more than 0.38% and 0.05% of total employment in the two regions (see Table 4-35).[121] The necessary threshold levels of demand were not present in either of the two cases. Possibly greater weight can be identified if one focuses on their regional R&D activity share. In 2003, the CERTH institutes of TTP concentrated 10% of the total regional R&D expenditure[122] in Central Macedonia and around 3.5% of the total R&D personnel (GSRT, 2006) (see Table 4-35). As suggested by the local industry association, the Park and its tenants represent an important asset for the region (Georgiou, interview, 2005). In Crete, FORTH represented 35% of the total R&D activity in the region and concentrated around 25% of total regional research personnel, while the FORTHnet research budget on its own is around 70% of the total 2.15 million Euros of the total business R&D expenditure in Crete (FORTHnet, 2005; GSRT, 2006). In that respect, both STPs comprise an important part of primarily public R&D activity.

Table 4-35: Share of STPs' activities of the total regional R&D activity

	Central Macedonia	Crete
Regional R&D expenditure - million € (2005)	143	88
Regional R&D personnel (2005)	11617	4204
R&D activity in the Park	13.86	31
R&D personnel in the Park	384	1050
Parks share of R&D expenditure	9.7%	35%
Park share of R&D personnel	3.5%	24%

Source: EUROSTAT (2005b), survey results and own elaboration

[121] The total of the Parks is even higher if the turnover of the firms for which data were not available is added.
[122] The number is based on the ratio of the CERTH budget in comparison to the total R&D expenditure in the region, assuming a share of the business sector equal to 1999, given the absence of actual data.

Nevertheless, this concentration has, so far, led to very little benefit for the two examined regions. There has been no attraction of non-local firms eager to exploit agglomeration forces. A few foreign firms have linkages with the PRTOs, but there has been no relocation to the region. The CERTH director referred to US firms that expressed initial interest to move next to the Park in the late 1990s, but such investment never materialised (EC, 2001)[123]. The only example of large, non-local firms inside STEP-C left the Park only a couple of years later. In the case of Thessaloniki, TTP management connected the Park with the location of technology-oriented activities in the surrounding area (Tramantzas, interview, 2005), but these were local-origin firms transferring their offices from the centre of Thessaloniki to a less congested area. Similarly, the responses to the survey have rather clearly revealed that the linkages, backward and forward, and the respective multiplier effects between the local economy and the STPs' tenants are limited, making any impact via this type of mechanism rather marginal.

As a result, the growth pole mechanisms and the expected employment and economic impacts are reduced to the induced impact from the wages and expenditures of the research centres, the researchers and the firms' employees. No dynamic and growth creating effects have been identified. Detailed data on firms' purchases and wages were not available for more elaborate calculations of these types of impacts, but it is clear that the small size of both Parks could not be linked to particularly strong/sizeable effects.

4.8.2 Strengthening endogenous capacity and supporting the regional innovation systems

The Greek STPs had targeted the promotion of entrepreneurship and the strengthening of the local firms' capacity through the transfer of technology and the support in the creation

[123] In a more recent communication, the TTP manager commented that some ICT sector firms operating in the region (e.g. InfoQuest, Compucon) selected the particular site, partly because of its proximity to the Park (Tramantzas, pers.communication, 04/01/2007).

and adoption of innovation. The evidence shows that, while their positive contribution in initiating some of the above processes cannot be dismissed, the overall picture is problematic and well below initial expectations.

On the positive side, there are the advanced technology services and the consultancy services provided by the few start-ups or spin-offs (in the case of FORTH) that operated in the two cases. The important shares of the local markets in their total turnover, mainly for the ICT firms, meant a positive role in integrating new technologies and knowledge with local firms' production systems, upgrading the technological capacity and productivity. Through more or less advanced partnerships with the research centres of FORTH and with non-local firms and organisations, these firms serve for the transfer and adoption of new knowledge to the local market. The same technology transfer and adoption role applies to the research centres' operation, primarily based on the high level of practical training for students/graduates of the universities or professionals, strengthening the local human capital. The limited consultancy work and technical services of the research institutes/units for local firms and public organisations (hospitals, universities, public authorities)[124] are activities that have a positive role in the regional technological capacity.

Along with them come the activities of the Park management companies and the implementation of regional development, innovation support and training programmes that target the diffusion of technology related information and, less often, hands-on support in technology transfer and innovation management for local firms. The 150 firms supported by TTP based on the various programmes are positive outputs. Particularly in the case of Crete, but to some extent also in Central Macedonia, the Parks' management teams have

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[124] One example is the setting of a Telematics network for the provision of medical services (Hygeianet) from ICS-FORTH. HIT of CERTH has conducted a number of studies in relation to the development of the transportation infrastructure in Thessaloniki and Central Macedonia.

been the sole entities/organisations with the ability to participate and implement such types of activities for a long period. The Parks have provided a mechanism that the local market appeared unable to develop and, in the case of Crete at least, "... [has] succeeded in raising the dust in the air" (Katharakis, interview, 2006), namely by introducing the importance of innovation and entrepreneurship to the local industry.

However, these contributions remain limited. The number of new technology based firms has been very small and their supportive role in technology adoption very limited. Their contribution to the restructuring of the local economies towards more technology oriented and high value added activities is even smaller; more so their role in challenging local firms' monopolies. Fourteen new firms in a period of twelve years in TTP are clearly not important and have not played any role in the above average increase of knowledge intensive high-tech services activities (KIHTS) in the period 1994-2005 (Table 4-36). The 40 or 60 high-tech firms (assuming that all are still operating) are clearly a more sizeable contribution, given the size of the economy and the absence of such activities, but there is still no apparent change in the region's structure. Especially in Crete, some of them (including FORTH's recent spin-offs (Forth-Photonics, Art-Innovation, Minos-Biosystems)) moved away to access larger and more dynamic markets.

Table 4-36: Change in regional employment and specialisation in knowledge intensive high-tech services (1994-2005)

	C.Macedonia		**Crete**		**Greece**	
	1994	**2005**	**1994**	**2005**	**1994**	**2005**
Employment in KIHTS	6569	10883	2738	3746	54620	76046
% change 1994-2005	66%		37%		39%	
Location Quotient	0.69	0.85	0.89	0.82		

Source: (EUROSTAT, 2005b)

4.8.3 The Parks' role in the regional innovation system

Similarly weak is the Parks' intermediation support role and the contribution to the regional innovation system. In the case of the Cretan Park, the responses suggest an isolation of most parts of the PRTOs' activity by the local economy. According to the representative of the Chamber of Commerce of Herakleion, "...FORTH has very limited interest beyond its access to the regional funding sources" and "the Park does not have contacts with industry" (Katharakis, interview, 2006). The regional authority representative pointed to "...a small level of synergies with local business [from FORTH side] and a lack of communication and information concerning FORTH activities from the [local] companies" (Dialinas, interview, 2006). The above reiterates the findings of older studies, which concluded that the research centres are largely disconnected from the regional economy (CIRCA et al., 1999). Concerning the role of STEP-C mechanisms "...there is reduced capacity to support cooperation and the activities organised from the Park management have led so far only to discussions and reports and hardly any proper discernible results" (Katharakis, interview, 2005). Despite being a very important asset for the region, the Park and FORTH are "... not connected with the other players" (Dialynas, interview, 2006).

When compared with STEP-C, it is clear that "Thessaloniki Technology Park is in comparison [to STEP-C] more successful in the promotion of cooperation" (Tsakalos, interview, 2006). A recent study of the regional science and technology intermediary system suggests that the Park's management team has a central position among the various relevant players in the region with various types of connections (URENIO, 2006). Against this, however, external stakeholders and players of the regional innovation system considered the connections and the support to local firms to be quite weak. On the one hand, the CERTH director suggested that "...the local firms show limited interest in cooperation" (Vasalos, interview, 2005). However, the industry representative claimed "...CERTH is an important asset for the region but the technology transfer and diffusion activities are limited and problematic" (Georgiou, interview, 2005). Linking it to the Park mechanisms' capacity, the FING representative concluded that "...the Park management unit lacks the active, dynamic and outgoing character necessary" (Georgiou, interview, 2005). The regional authority representative observed that "..the Park is unable to connect to the industry and transfer technological knowledge [and its] role in technology transfer, linkage of university and industry and cooperation support is limited. More needs to be done" (Tsiakiris, interview, 2005). In relation to the promotion of broader collective learning processes, Komninos' (interview, 2005) opinion was that the Park "has not played any role in the development or support of any form of cluster in the region and has a limited role in the promotion of cooperation". Even if stronger than its counterpart, TTP has underperformed against what external players considered its expected role, not addressing any of the limitations identified at the time of its opening, but rather being constrained by them.

Finally, despite the different initial expectations, neither Park has served as a cooperation and partnership platform among the various local stakeholders. In Crete "...there is low interaction between research and technology capacities themselves and between them and the civil society networks, both in the social and economic spheres" (Galanakis et al., 2005,p.2). The absence of any real participation of local players/stakeholders with the management team is an indication of the Parks' failure. The common view is that the Park exclusively serves the objectives of FORTH. The common expression is that STEP-C is "not the park of Crete [but] the park of FORTH" (Katharakis, interview, 2006; Tsakalos, interview, 2006). Thus, FORTH does not consider local players to be relevant or competent (Stratigis, interview, 2006), while the local players, with the possible exception of the university, consider that the Park has no real routes in the region (Katharakis, interview, 2006).

Such a gap among the local players was less evident in the TTP. FING participation in the management firms' capital reflected the industry association interest and capacity to formulate a local development strategy. Other players, critically the university, maintained a distant or even negative attitude and are still largely disassociated from the Park. Still, the initial positive prospects did not lead to a real formation of partnerships, jeopardised by diverging personal strategies and the tendency of CERTH to maintain a dominant role and control. The Park's management team has since lost its relevance as such a mechanism in the region. Other intangible initiatives of greater scale and with more resources attached have been more successful in this direction, for example, the EU innovative initiatives programmes (RTP and RIS) or the recently developed regional innovation pole (Tsipouri, 1998a).

4.9 Synopsis

This chapter examined the two most typical cases of technology-led type STPs developed in Greece, promoted by the central government and developed around research centres. The prime focus was the linkage of public research with industry and the support of knowledge-based entrepreneurship. In both cases, the regional context was characterised by the dominant role of the public sector and the absence of real interaction and linkage with a private sector. Central Macedonia provided a more promising environment, given the larger local market, a significant (albeit traditional) industrial base and an active local industry association. In contrast, in Crete the small market limitations were matched by the dominance of agriculture, tourism and commerce and an extremely thin and traditional industrial base.

The analysis revealed that, while both started with similar dynamism, TTP gradually entered into a period of decline and has nowadays lost not only its activity and occupancy levels, but also most of the incubation and the technology support functions. STEP-C has shown greater capacity to maintain the activity levels and its profile in the development of linkages and entrepreneurial activity. The better performance is largely linked with an increased capacity and the greater entrepreneurial character of the FORTH research centres in the STEP-C in comparison to CERTH in the TTP. Still, in both cases there is clear sacrifice of the expected high-tech content and an absence of the relevant mechanisms that would promote linkages, interactions and technology cooperation and provide advanced innovation management services. Entrepreneurship and the support for the creation of new firms, the incubation function, were left underdeveloped and limited to the quality infrastructure elements, the offer of basic services and a vague prestige element. The STPs have weak management teams, with limited resources and expertise and with a loose application of the important elements of the incubation function. The limited internal success is also matched by very weak impact on the broader regional context. The Parks' operation is translated only in the diffusion of information or the implementation of various national and European programmes, while research activity remains disconnected from the local economy with no indication of a role in the development of high-tech clusters or collective learning processes.

Created in regions with limited innovative capacity and fragmented innovation systems, the two STPs of Greece have not managed to address most of the limitations, weaknesses and constraints identified in the regional environment. This was matched by the absence of the necessary commitment from the relevant regional and national stakeholders. It is thus only the difference between the two research organisations that differentiate the almost complete failure of the Thessaloniki Park from the moderate performance of the Park of Crete.

5 Chapter 5 - The property led Spanish STPs: Cartuja93's techno-dream and Asturias Technology Park's restructuring role

5.1 Introduction

The Greek Parks had a common starting point, similar objectives and a comparable operating structure, but the two selected Spanish STPs, the Technology Park of Asturias (PTA) and Cartuja93 Science and Technology Park (Cartuja93), deviate from the above parameters. The common element is that they were large-scale projects with a strong role and a focus on the property element. However, in this group they represented the different strategies/priorities of the two waves of Spanish STP development (Ondategui, 2002). Asturias Park is representative of a technology Park model of the first period, while Cartuja93, on the other hand, is suggested to be one of the first examples of the second wave of STPs in Spain, developed around and linked more directly with science and research (Ondategui, 2002; Rubiralta and Vendrell, 2004).

This chapter analyses the evolution of the two Parks, examines the main elements of their operation and evaluates their performance. A comparison of the two cases is used to identify and illustrate the role of common and differentiating parameters.

5.2 STPs' context – local conditions and resources[125]

5.2.1 Regions' socioeconomic characteristics

5.2.1.1 Principado de Asturias – restructuring an old industrial region

The autonomous region of Asturias is located in the northwest of the Iberian Peninsula (see Figure 5-1 and 5-3) . It is a mountainous region with a total of 1.1 million inhabitants (2001), the great majority of whom (>80%) are concentrated in its central area in the triangle formed by the cities of Oviedo, Aviles and Gijon – the so called "ciudad Asturias"[126] (Rodríguez and Menendez, 2005). The western and eastern parts of the region are mainly rural and sparsely populated areas with small urban centres.

Asturias has an important industrial history that starts from the beginning of the 1900s, based on its rich mineral resources and the strong concentration of heavy industry sectors including mining, metallurgy, metal processing, shipbuilding and energy production. During the 1950s, industrial activity reached its highest levels and at that time Asturias was one of the most prosperous regions of Spain with GDP per capita levels well above the national average (Fuente, 2003). Since the 1960s, however, and even more acutely after 1975, the international crisis that hit these sectors led the region into a steep decline with closure or drastic downsizing of public and private production units and important job losses. From a total of 125,000 employees in industry in 1980, around 85,000 in 1992 and around 62,000 in 2000 remained in employment (Rodríguez and Menendez, 2005, p.171). This decline was not compensated by the growth of the construction and services sector and

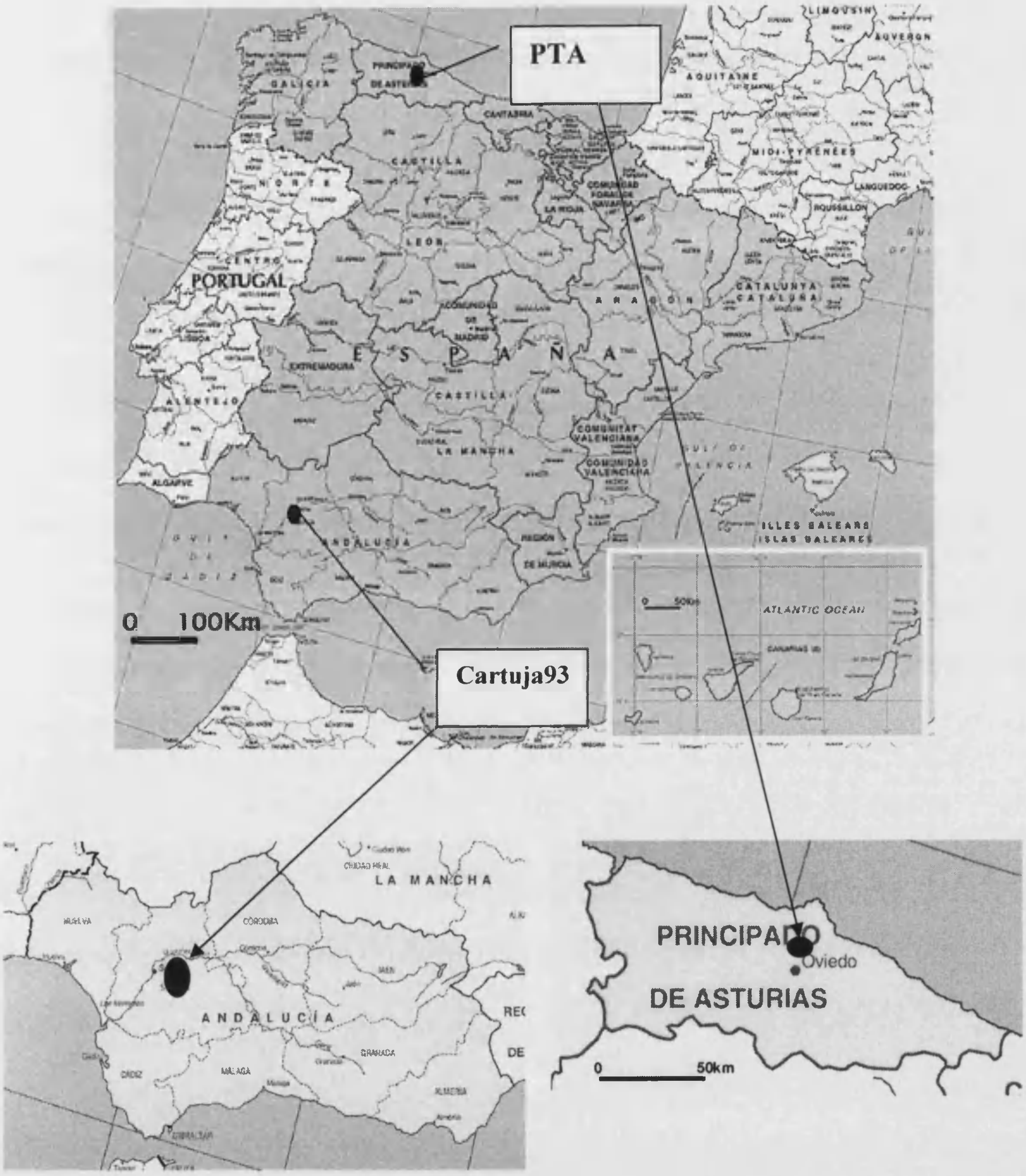
[125] Given the significant difference in size and population of the two regions (Andalusia is almost nine times larger and has a population seven times greater) the province of Seville was focused upon as a comparable unit. However, as data (especially concerning innovation activities) are only available at a regional scale and there is an important/critical role of regional authorities in the formulation and implementation of relevant policies, a combination of the regional and provincial scale was use in the analysis.

[126] City of Asturias

GDP dropped to 92% of that of Spain by 1990 (from 107% in 1980) and 70% of EU15, while unemployment levels rose above 16% in the middle of the previous decade (Figure 5-2 and Table 5-1)[127] At the time of the PTA creation (1991), Asturias was a region in crisis, in urgent need of restructuring and employment creation.

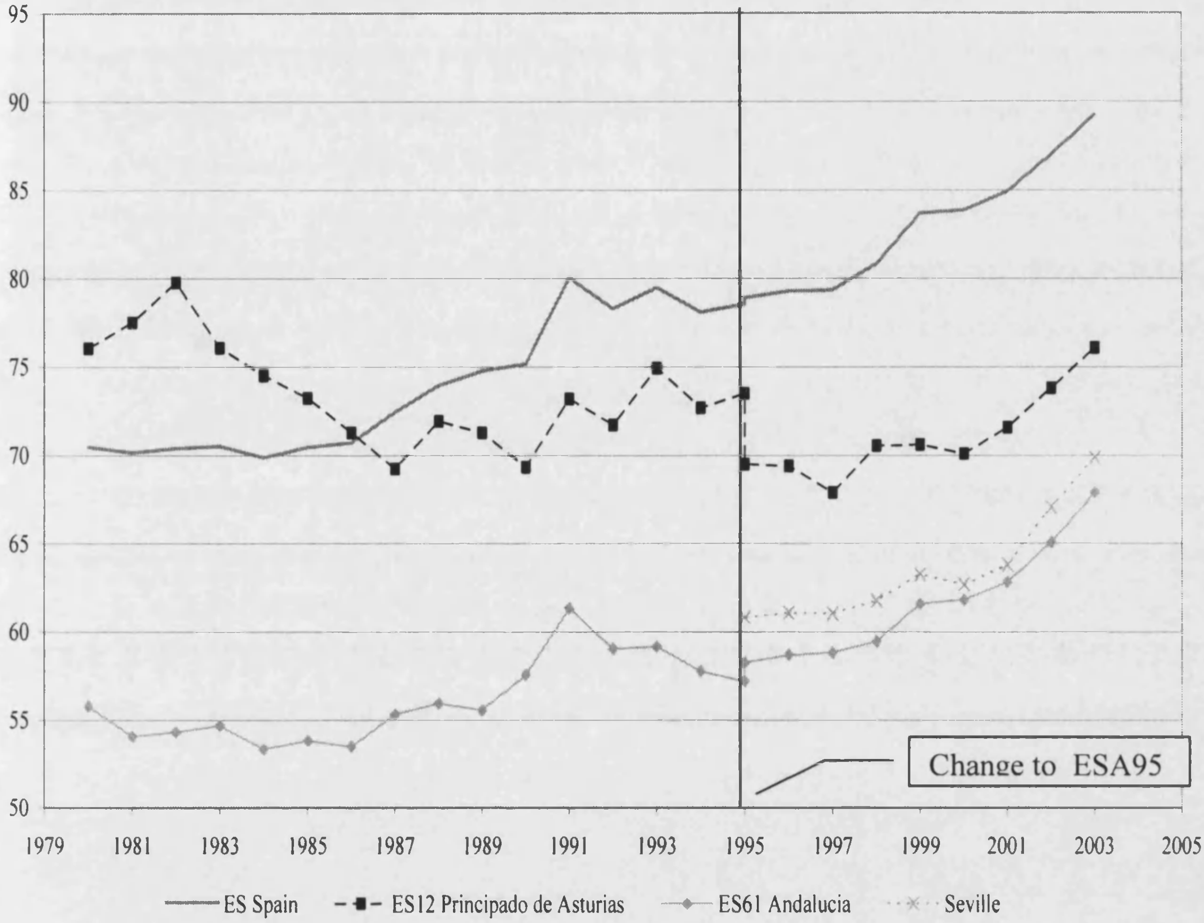
Nevertheless, even after 20 years of decline, in 2005 manufacturing represented a relatively high 18.3% of the total workforce (this figure rises to 30% if the construction sector is included) concentrated on low and medium-low technology sectors (75% of total industrial employment), while higher-technology sectors' activities (chemicals and pharmaceuticals, electrical and optical equipment) are limited (see Table 5-2). The increasing role of the services sector has been primarily driven by commerce and other less-knowledge intensive services, with only a minor increase in more knowledge intensive services since 2001.

[127] For an elaborate analysis of the region of Asturias see Volume 20 of Papeles de Economia Española of the Fundaccion de las Cajas de Ahoros



Source: own elaboration from (Europa, 2004)

Figure 5-1: Location of STPs in Spain and the regions



Source: (EUROSTAT, 2005a ;INE, 2006a)

Figure 5-2: Spanish regions' GDP per capita evolution 1980-2003 (pps) EU15=100

Table 5-1: Main indicators of the two regions

	Asturias			Andalusia (Seville)			Spain		
	1981	**1992**	**2005**	**1981**	**1992**	**2005**	**1981**	**1992**	**2005**
Population (millions)	1.12	1.10	1.06	6.4(1.5)	7.0(1.6)	7.8(1.8)	37.74	39.13	43.8
GDP (% of national)	3.0	2.8		17.0(4.0)	17.9(4.1)		-	-	-
Employment (1000s)	380	352	405	1630	1888(438)	2959	11600	12900	18973
Unemployment	11.7	16.1	10.2	20(22.3)	26.7(26.1)	13.8	14.0	17.4	10.2
Workforce									
Agriculture	25	13	5.4	23(17)	12.5(8.5)	9.2	18	9.3	5.3
Industry	30	23	18.3	17(19)	14(15)	11.1	26.9	21.7	17.3
Construction	7	9	11.5	11(10)	9.6(11.2)	14.7	9	9.3	12.4
Services	38	55	64.8	49(54)	64.9(65.3)	65.0	46.3	59.7	65.0
GVA (market prices)									
Agriculture		2.5	2.5	11.7	7.0(3.5)	5.4 (4.2)		3.5	3.2
Industry	45.3	26.1	22.4	24.6	17.6(15.2)	13.1(17.7)		24.2	18.4
Construction	6.3	10.6	13.7	7.3	9.8(10.5)	14.0(11.6)		8.5	11.6
Services	39.3	60.8	61.4	57.2	65.6(70.8)	67.5(67.2)		63.8	66.8

Source: INE (2006a), EUROSTAT(2005a), EUROSTAT(2008)

5.2.1.2 Andalusia and Seville – agriculture, tourism and small pockets of industry

The province of Seville, where Cartuja93 Park is located, is one of the eight provinces of the autonomous community (region) of Andalusia in Southern Spain (see Figure 5-1). Andalusia is the largest autonomous region in Spain, with a total population of over seven million and it makes a contribution to the total Spanish GDP of around 14%. Seville is the largest city (the metropolitan area had a population of over 1 million in 1991) and the administrative centre of the region, while the province of Seville accounts for around 25% of the total employment and economic activity in the region, followed by Malaga and Cadiz, the other two main urban centres (Rodríguez, 2005).

Andalusia has, for long periods, been dominated by agriculture and related activities and is one of the poorest regions in Spain and Europe. In the early 1980s, Andalusia's GDP/capita was at 70% of the national average and only 57% of EU15, with very sluggish or even negative growth rates (see Figure 5-2). An important boost to the regional economy came during the mid 1980s as a result of the preparations for the Expo World Fair of 1992 that was hosted in Seville and the consequent extensive public investment in infrastructure projects. Since 1991, however, Andalusia has experienced a significant slowdown and, during most of the 1990s, growth rates in comparison to the EU were close to zero (Vazquez-Barquero and Carrillo, 2004). Only after 1998 did the region start growing again, following the general performance of the Spanish economy, driven primarily by the expansion of the construction sector (Garvia et al., 2006).

At the time of the opening of Cartuja93 (1992), the economy of Andalusia was still characterised by important shares of the primary sector (12.5% of employment) and the dominant role of services that included non-market services (25%), wholesale and retail, transport and tourism and only a very limited presence of knowledge intensive activities (see Table 5-2). During the last few years, there has been a gradual emergence of the ICT sector, especially in the area around Malaga, even if it remains at levels well below the national average (Garvia et al., 2006). As for the industrial base of the region (less than 14% of the workforce), it is concentrated in low-tech industries of energy, agro-food and basic metal processing, with a very limited presence of the higher technology sector (Ferraro, 2000).

The province of Seville is, in relative terms, the most industrialised of Andalusia (concentrating 26.5% of total industrial GVA of the region in 1995) and includes some advanced manufacturing activities such as transport equipment (developed around the presence of production units of aeronautics construction firm CASA and car manufacturer Renault) and chemicals production. These have, however, been primarily export oriented branch plants with limited linkages with the local supply chain (Ondategui, 1997), although recent policies have attempted to create a cluster around them (Garvia et al., 2006). Still, industry has only a minor role in the Seville economy (only 6.4% of the provincial GVA in 1995), dominated by services (74% of GVA in 1995), tourism and transport, public administration and other non-market services (22.5%) (Rodríguez, 2005; INE, 2006a).

Table 5-2: Workforce share of advanced manufacturing and services activities (% of total)[128]

	Asturias		Andalusia		Spain		EU15	
	1994	2003	1994	2003	1994	2003	1994	2003
High tech manufacturing	-	0.06	0.16	0.28	0.62	0.5	1.4	1.25
Medium-high tech manufacturing	2.44	2.85	2.27	2.1	4.79	4.55	6.33	5.86
Medium-low tech manufacturing	7.63	7.85	2.76	2.92	4.72	4.58	4.88	4.5
Low-tech manufacturing	5.18	5.57	7.46	5.74	9.71	8.03	8.33	6.95
Knowledge intensive high-tech services	1.52	2.6	1.16	1.63	1.72	2.33	2.63	3.49
Knowledge intensive market services	4.24	5.34	4.38	5.93	5.09	7.48	6.27	8.01
Knowledge intensive financial services	1.81	1.45	2.34	1.81	2.65	2.35	3.50	3.35
Less knowledge intensive services	38.02	39.2	42.6	40.8	38.5	37.9	30.8	34.5

Source: EUROSTAT (2005b)

5.2.2 The regional innovation systems

Besides the dominant role of low technology activities in the two economies, the available statistics and a number of studies during the 1990s pointed to important weaknesses in the operation of both two regions' innovation systems. The most critical elements mentioned were the low levels of total R&D expenditure (below 0.7% of GDP) and the strong dependence on public sector research activity (more than 60% of total expenditure) (Table 5-3). The shares of both regions in national R&D activity are well below their respective GDP. In 2003, Andalusia concentrated more than 10% of the total national R&D activity (5th largest), while Asturias was responsible for no more than 1.4%, although Andalusia experienced a small increase in its levels during the last few years.

[128] The classification of sectors follows the definition of OECD based on R&D intensity

Table 5-3: Main innovation indicators (period 1993-2003)

	Year	Asturias	Andalusia	Spain
Total R&D expenditure	1993	68.7	415	4427
	2003	127	1013	9211
R&D expenditure share of GDP	1993	0.56	0.64	0.91
	2003	0.67	0.85	1.10
R&D exp. share of national	1993	1.6	9.3	-
	2003	1.4	10.9	-
Business sector share of total R&D	1993	27.8%	22%	48%
	2002	38%	35%	55%
R&D employment/1000 popul.	1992	2.9	2.7	4.6
	2001	6.5	4.9	7.0
R&D employment share of national	1992	1.6	10.1	-
	2001	2.0	11.8	-
% of workforce with tertiary education	2002	23.1	19.9	24.4

Source: EUROSTAT (2005b), INE (2006a)

The public sector (universities and research centers) performs most of the R&D activity in both regions and there have been significant efforts during the last few years to increase and strengthen the R&D and innovation capacity (see Table 5-4). In Asturias, knowledge creation is driven by the University of Oviedo (80% of total public sector R&D personnel, 75% of R&D expenditure), with faculties located in the four main urban centres (Oviedo, Gijon, Aviles and Mieres) in a wide range of disciplines and specialisations including physics, chemistry and biology, medical and biomedical sciences, engineering/technology(altogether 87% of total research budget) as well as humanities and social sciences (UNIOVI, 2004). Although R&D activity in the University increased during the 1990s with the creation of seven new research institutes, additional funding through the regional R&D programme and an attempt to reorient university activity closer to industry, it is still considered to be problematic and limited (COTEC, 2005b). Regional, national and EU government programmes are the main funding sources, although specific units (mainly in engineering fields) receive over 20% of their R&D income from the private sector. The exploitation research results (patents and spin-offs) by the university have so far been limited, with an average of eleven patent applications annually and only three examples of spin-offs created in the period before 2006 (UNO, 2006).

Table 5-4: Characteristics and research capacity of the main Universities in Asturias and Seville (2001)

	University of Oviedo	University of Seville[129]
Total students registered	38700	73500
% students in engineering, natural and life sciences disciplines	40%	43%
Professors/Researchers (2001)	1993	3900
R&D activity financed by external sources[130] (2001)	14323 K€	19030 K€
% of external R&D financed by companies	21%	15%
Publications in SCI (aver. 2000-2004)	589	718
SCI Citations/paper[131]	7.31	5.87
% of national	2.13%	2.27%
Patent applications (aver. 1997-2001)	11	13

Sources: INE (2006d), Uniovi (2004), US(2005), ISI (2006)

Besides the University of Oviedo, two institutes of the national research centre of CSIC (INCAR focusing on steel and IPLA for dairy products), the Oceanographic Centre of Gijon, the Technological Institute of Materials (ITMA) and four technology centres/laboratories related with agriculture production were also operating in Asturias by 1992[132] (Ondategui, 1997). The first focused on basic and applied research and the remainder on technology and innovation support services. During later years (after 2000), the regional government supported the creation of three more centres that provide technological services and conduct applied research in the areas of information technologies (CTIC), industrial design (PRODINTEC) and steel (CEAMET) (FICYT, 2001).

In Andalusia, the nine public universities concentrate over 40% of the total regional R&D expenditure and around 60% of the R&D personnel. Two of them are located in the province of Seville (University of Seville and University Pablo de Olavide). The University

[129] The second university in the province, the University of Pablo de Olavide, has 5,600 students, 10% of whom study natural sciences and medical disciplines and the remainder read social sciences and humanities (INE,2006d).

[130] Regional/national government, EU, private sector, not for profit organisations

[131] This is the number of SCI citations in the same period 2000-2004.

[132] Instituto de experimentación y promoción agraria (SERIDA), Centro de experimentación pesquera (CEP)

of Seville is the largest HEI in the region, with over 73,000 students registered and more than 400 research groups (in 2000). More than 50% of the research units are in engineering, natural and life sciences and some of them were formed in the period before Expo92 when, in parallel to the infrastructure projects, significant investment was made in public education and research systems. However, a number of studies show that many of these research units are small, focus on basic/theoretical research and produce low quality research (Rodriguez, 2005). R&D funding comes mainly from the public sector, but a smaller extent is provided by the private sector (15% of R&D funding from external sources), linked primarily to the engineering school.

Andalusia also has an extended number of government research centres that represent more than 20% of total R&D. In 1993, it hosted seventeen institutes of CSIC, seven of which were located in Seville. Five more research centres were created after 1993 as partnerships of CSIC with the regional government and Seville University. In 2004, the total number of CSIC institutes in Andalusia was 39(Garvia et al., 2006). During the 1990s, the regional government financed, through regional R&D and innovation plans, five more technology institutes in a number of disciplines (ICT, energy, agro-food) that focused on technology development and the provision of services to the local industry. However, by 1997 only one was actually in operation (Ondategui, 1997).

In comparison with the public sector, private sector participation in R&D has, in both cases, been below both the EU and the national average, despite a significant increase since the opening of the Parks. In 1993, the business sector accounted for around 25% of R&D expenditure in both regions, a number that increased by around 10% in both cases in the subsequent period, but was still well below the national average. More than 50% of total private sector research expenditure in Asturias is concentrated in the metallurgy, metal and non-metal processing sectors and a few large private R&D units in the region (e.g. Acelor, Sain-Gobain) (PCTI Asturias). Agro-food, aerospace (mainly through the presence of EADS-CASA) and ICT are the main sectors investing in R&D in Andalusia (Garvia et al., 2006). One additional constraint for private sector investment in R&D and innovative activity is the dominant role of very small firms (> 95% of firms have less than ten employees) with only a handful of very large firms in both regions (INE, 2006b).

The low level of private sector participation in R&D activity is also reflected in the poor innovation activity results. Patenting increased since 1993, but is still well below the national average (30%) (Table 5-5). The Community Innovation Surveys revealed that local companies in both regions have a very low propensity for innovation, with the main source of technology upgrade and innovation coming from the acquisition of capital equipment and machinery (embedded technology). Only a small share (10% in Andalusia and 25% in Asturias) of innovation related expenditure is dedicated to internal R&D activity and much less (<4%) for external R&D sources (COTEC, 2005a).

Table 5-5: Innovation activity – patents, share of innovative firms and expenditures

	Andalusia	Asturias	Spain
EPO pat./million population (1990-1992)	1.8	3.1	8.28
EPO pat./million population (1999-2001)	6.5	9.3	24
% of innovative firms (1998-2000)		14.9	19.7
% of innovative firms (2005)	25%	23.6	27.0
Innovation expenditure in firms (2000) million €s	634	154	10147
% of GDP (2000)	0.76	1.11	1.67
Innovation expenditure in firms (2004) million €s	1182	142	12490
% of GDP (2004)	1.02	0.79	1.56

Source: INE(2005b)

5.2.3 Innovation policy framework

Since 1978, the regions of Spain have enjoyed increased levels of legislative and financial autonomy that include the formulation and implementation by the elected regional governments of their own regional research, technology and innovation policies in parallel and in coordination with the respective national ones (Muñoz et al., 2000; Garcia et al., 2006). Dedicated regional ministries (consejerias) are responsible for a large part of the design of the respective policies which are implemented by regional development agencies created during the 1980s[133].

In Asturias, the first industrial policies with a technological content were developed by the 1980s. In an attempt to support the reindustrialisation of the region, the government created a number of new industrial zones (Zona de Promoción Economica, Zona de Industrialización en Declive) and provided tax breaks and other location incentives[134](FICYT, 2001; Rodríguez and Menendez, 2005). In the area of technology policy, the first regional R&D programme[135] was formed during the period 1989-1993 and was followed in the subsequent period by two more programmes (1994-1999, 2001-2004) targeting the technological upgrade of the region through the support of existing and new public R&D units, the strengthening of R&D personnel, subsidies supporting private sector R&D activity and collaboration with the public sector. Nevertheless, despite the increase in the amount invested, the share of R&D funding in the regional budget of the period 2001-2004 was no more than 0.8% (COTEC, 2005b).

Andalusia formulated its economic development programme even earlier (1980)[136] and strengthened it further with additional funds and programmes in the subsequent periods. The first science/research support programme was implemented in the period 1984-1987

[133] Currently these are IDEPA (earlier IFA) in Asturias (Instituto de Desarollo Economico de Principado de Asturias) and IDEA (IFA) in Andalusia (Agencia de Innovacion y Desarollo de Andalucia). Both have changed their names.
[134] By 1992, around 40 subsidiary units of multinational firms (among which DuPont, Thysen Nort and Suzuki) had established their facilities retaining around 840 employees (Ondategui, 1997)
[135] Plan regional de investigacion
[136] Plan de Urgencia para Andalucia

and was followed by three regional research support programmes[137] (90-93, 96-99, 2000-3) with a continuous increase of dedicated funds (Ferraro, 2000)[138] rising to 1.8% of the regional budget. In addition, through the Industrial Spaces Programme[139], it has invested significantly in the creation of industrial and business Parks in all provinces of the region. Finally, in the late 90s, both regions designed and implemented their own Regional Innovation and Technology Transfer Strategy[140] programmes (Community initiatives) that provided an assessment of the existing regional technological infrastructure and capacity and focused on setting strategic priorities.

Part of the above support policies included the creation of technology centres, innovation intermediaries and other support mechanisms. In Asturias, these include: the Foundation for the Development of Applied Research and Technology (FICYT), initially established in 1984, the Office of Technology transfer (OTRI) of the University of Oviedo (1988), CEEI Asturias (1994) and local business centres. The Club Asturiano de Calidad (created in 1995) and more recently the Club Asturiano de Innovacion (2002) are public-private partnership initiatives focusing on cooperation support, dissemination and promotion of innovation. In Andalusia, together with the Cartuja93 and the Malaga Technology Park, additional Park projects were developed in other provinces of the region[141]. Other support units include the European Centre for Enterprises and Innovacion, two Innovation Relay Centres (Bic Euronova, CESEAND), technology transfer agencies (Citandalucia) and Offices of Technology Transfer (OTRIs) in all nine universities and a number of

[137] Plan Andaluz de Investigación
[138] For an analysis and evaluation of the regional technology and industry policies in Andalusia see Ferraro, 2000.
[139] Plan de Suelo Industrial
[140] Regional Innovation and Technology Transfer Strategies
[141] Currently there are two more operating in Cordoba and Granada and four more planned (RAITEC,2006)

specialised centres of innovation and technology[142]. After 2003, regional governments also promoted the development of high-risk funding mechanisms and, in cooperation with the private sector, regional venture capital schemes. In addition to the regional authorities' activities, the respective national programmes in relation to science and innovation as well as the respective EU funds should be added. The most relevant is a measure designed by the central government that specifically targets firms and organisations operating in STPs (Muñoz et al., 2000).

Despite a significant increase in the related effort, a number of studies suggest important deficiencies of programs that include a lack of a clear direction, management and integration/coordination with other relevant regional and national policies. An analysis of the Asturias innovation support plans (FICYT, 2001) reported weaknesses in the absorption of the funds, a lack of coordination and conflicts between science and technology policy and broader business/industrial policy, with an absence of an organisation able to bring the different elements and partners together. In Andalusia, recent evaluations of the public research programmes characterised them as insufficient, inclined towards supporting basic research with limited results in increasing the participation of the private sector in R&D activity and innovation cooperation with the public sector (CICE, 2005; Rodríguez, 2005). Still, in comparison, Andalusian innovation policy is seen as being in a more advanced stage than that of Asturias, having passed from a purely science and research targeting policy towards a more holistic innovation focus (Fernandez et al., 2006).

5.2.4 Synopsis

Both Parks were created in regions with weak innovation systems where R&D activity, innovation and the cooperation of firms and research organisations are limited and the role

[142] Asociación de Investigación y Cooperación Industrial de Andalucia (AICIA), Instituto Andaluz de Tecnología (IAT) y Centro de Investigación de Nuevas Tecnologías de Agua (CENTA).

of the private sector limited and problematic. The presence, however, of regional authorities with the legal and the financial capacity to implement relevant and encouraging innovation support measures represented a potentially supportive environment when compared to their Greek counterparts.

At the same time, though, there are important differences between the two regional contexts. Asturias Park was created in an environment experiencing industrial and economic decline, with an increasing number of jobs lost for its technically skilled workforce. There was thus demand and a priority for job creation, restructuring and diversification. The industrial tradition brought with it obstacles against the adoption of new and more flexible production structures, the integration of knowledge and the adoption of innovative processes in the firms' production process (Kohler, 2003). Andalusia, and Seville, did not present similar rigidities. However, the region had limited endogenous capacity and relied on non-technology oriented activities, limited and low-tech industry and an under-skilled labour force. At the same time, though, the public sector investment of the period before the Expo92 period brought improved infrastructures and created a particularly supportive public R&D activity base for the Park project.

5.3 Historical review: STPs' promotion, creation and evolution[143]

5.3.1 Parque Tecnológico de Asturias (PTA)

5.3.1.1 The Park as part of the regional industrial policy

The creation of the Technology Park of Asturias (PTA) was the result of a decision by the regional government of the Principado of Asturias in the late 80s, following similar projects

[143] See Table 5-8 at the end of section 5.3 for summary table of important dates in the Parks' evolution.

initiated in other regions of Spain. It was instigated by the department for industry (Consejería de Industria) of the regional government as part of a policy that targeted the industrial upgrade of the region and the replacement of the dominant traditional industrial activities through the creation of over 350 hectares of industrial Parks' space (Ondategui, 1997).

The Park, covering a total of 61 hectares, was located in the municipality of Llanera in the very centre of the region. Initially, the specific location had been selected by the US firm Corning Glass for the establishment of an optic fibres unit. As that project did not materialise, the regional authorities decided to move on with a Technology Park project. The specific site is strategically located less than 15kms distance from the three main urban centres, Oviedo, Gijon and Aviles (see Figure 5-3), that concentrate more than 80% of the regional GDP and employment and constitute the development centre of the region. The Park is adjacent to two industrial parks (both public (Silvota) and private (Asipo)) that host over 300 manufacturing firms/units (one fifth of the industrial establishments in the region). The total initial investment made was 12 million Euros, financed mainly by the regional government (75%) as well as national and EU structural programme funds (programmes STAR and PINC). It included the development of all necessary infrastructure and networks for 25 plots to be sold or rented to companies to create their own premises. It also financed a new building for IDEPA, for the Technological Institute of Materials (ITMA) and the CEEI-Asturias (European Centre for Enterprise and Innovation) in the institutional zone of the Park. An additional space of 17 hectares was set aside for possible future expansion (see Table 5-6). The Park was officially inaugurated in June 1991 with the opening of the IDEPA building in the institutional zone, followed by ITMA in 1992 and CEEI in 1994.

Table 5-6: Technology Park of Asturias' space and uses

Institutional zone	4 hectares
Space for companies plots	25 hectares (50 plots)
Green area and streets	15 hectares
Future expansion area	17 hectares
Total area	61 hectares

Source: IDEPA, 2006

5.3.1.2 PTA evolution and milestones

The first years were characterised by a very slow uptake of space by interested companies. In 1994, seven companies had expressed an interest in establishing themselves inside the Park. By 1996, two were actually established (Gonzalez Soriano S.A., electrical equipment, and Pentia S.A., engineering services) and a few more (Telefonica, Surgiclinic Plus[144], Tecnia Ingenieros, Sapma and Hypermedia, ECA, Correos, Fluor Daniel) had reserved plots planning to establish their own facilities inside the Park. Still, as late as 2000 most of the above had not started operating in the Park and some withdrew their interest in the intervening time period.

As a response to the low level of interest, in 1997 IDEPA pursued more actively the attraction of companies to the Park through marketing, provision of important subsidies and the lowering of the land price by 25%[145], but also by relaxing the criteria concerning the minimum high-tech and innovative content/activity of the Park's tenants (Maldonado, 2001; Gonzalez, interview, 02/10/2005; Gumiel, interview, 08/03/2006). The 17 hectares initially reserved for a expansion phase of the Park were declassified from the technology Park zoning restrictions (IDEPA, 1998; BOPA, 2002) and now host a tinplate can production unit.[146] Another rather negative development was the departure in 2000 of

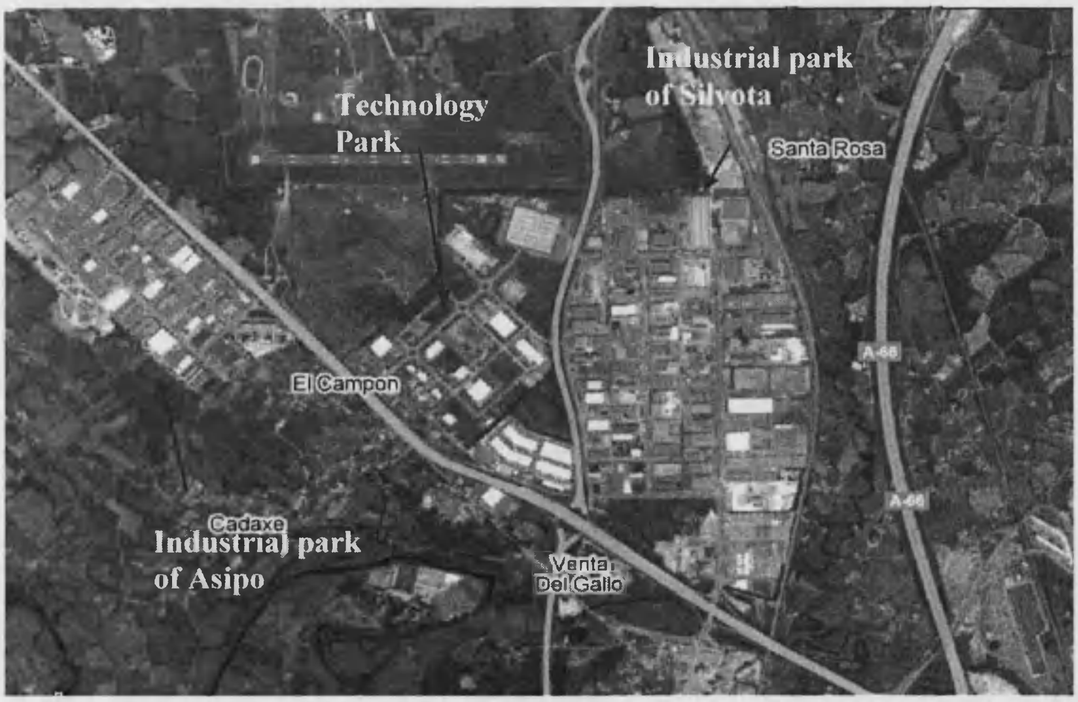
[144] The above firms were not mentioned in the list provided by IDEPA. They were found in the study of Ondategui (1997) which was based on official information provided at that time.
[145] From 8,000 to 6,000 Spanish pesetas (Maldonado, 2001).
[146] Mivisa Envases

FICYT, (the main technology transfer organisation present) from the Park and its transfer to the centre of the city of Oviedo.

During the same period, a second and smaller (10 hectares) Park structure, the Science and Technology Park of Gijon, opened in 2000 on the outskirts of the city of Gijon next to the engineering faculty of the University of Oviedo. This Park adopted a science orientation closer to the technology-led model, in contrast to the PTA. The two newly created regional technology centres on industrial design (PRODINTEC) and ICT (CTIC) moved inside the Park and, in contrast to the PTA, it managed to fill most of the available space by 2006 (PCTG, 2006). Although the presence of direct competition between the two Park structures was denied by its managers (Gumiel,interview, 2006; Pola, interview, 2005), according to the Industry Federation General Director "...in a region as small as Asturias the presence of two technology Parks does not make sense"(Gonzalez, interview, 2005).

Source: own elaboration from ViaMichelin,(2007)

Figure 5-3: Location of PTA in the Asturias region



Source: own elaboration from Googlemap(2007)

Figure 5-4: The Technology Park of Asturias and its surroundings

The CEEI incubator experienced higher occupation levels. By 1996, it already hosted fifteen small newly created or existing firms (Menendez, interview, 04/10/2005) and since then it has maintained an average of 20 tenants and 85% occupancy. In 2001, a real-estate firm (Quinta-Mobilis)[147] created two office buildings (Centro Elena I and II) in the Park, providing office space for small businesses (IDEPA, 1999) and four years later (2005) both buildings were fully occupied, hosting around 40 small and very small firms. In the period after 2001, an era of a positive economic growth for the whole region, PTA attracted a number of firms, including a few multinational (STR- España, Autotex Millicen, Tecsolpar, Fluor Daniel S.A.) and national (ERVISA) subsidiaries. Even so, in 2005 the occupation level was at 68% of the total available space with another 12% reserved. At the time of the survey, early 2006, the PTA directory recorded a total 104 firms employing around 1,700 employees (PTA website). A negative development that took place after the end of the survey was the closure of the Autotex Millicen unit, the largest firm in the Park, only five years after its establishment (Rubio, 2006), which left the regional authorities to seek again for candidates willing to acquire the plant.

5.3.2 Cartuja93

5.3.2.1 The Expo92 project and Seville's techno-dream

The Cartuja93 Science and Technology Park is the direct consequence and legacy of the Expo92 World fair that took place in Seville in 1992. The Expo92 fair was awarded to the Andalusian capital in 1983 and its location was the quasi-island of Cartuja formed by the Guadalquivir river, less than 20 minutes walk from the historical centre of Seville (see Figure 5-5). The land mainly belonged to the regional government and a smaller part

[147] The researcher requested an interview with the real estate firm in order to understand the reasons for locating in the Park and the operational framework, but received a negative response. As a result, it could not be verified whether the admission criteria also applied to the office space buildings or if the real-estate firm was allowed to operate independently.

(around 35%) to the Spanish state, managed by a public entity set up for the purpose (AGESA)[148]. To meet the needs of the Expo, a number of highly designed buildings, along with other quality installations and infrastructure, were to be created on the island. The post-Expo utilisation of these expensive facilities posed an important concern for the Expo promoters, as the previous World Fair in Seville in 1929 had left behind buildings of architectural elegance, but did not contribute much to the city's economic development. Expo92 was considered to be an opportunity to revitalise the city and regional economy (Castells and Hall, 1994).

With the guidance of two famous scholars, Manuel Castels and Peter Hall, the regional government issued a two-year study of the regional technological needs (Project PINTA)[149] that led to the proposal for the creation of Cartuja93 Tecnopolis to reutilise the infrastructure and buildings created on the Expo site. The proposal foresaw the creation of an area focusing predominantly on R&D activities including (Castells and Hall, 1992, p.788):

- Centres of applied research
- R&D centres/units of private companies
- Public research organisations including CSIC national research centre and regional government research institutes
- Centres for technology transfer including an Andalusian Centre for Applied Technology Services (CASTA) to link the R&D activities in the Park with the regional economy and an International Centre for Technology Transfer (CITT) to connect the activity of the Park with global technology demand.
- International research and technology institutions

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[148] Sociedal Estatal de Gestion de Activos
[149] Proyecto de Investigaci6n de Nuevas tecnologias de Andalucia

The proposal urged that the Park should not become a business centre hosting commercial activities that would break the synergies among the R&D centres. The proposed criterion was that no more than 25% of personnel should be occupied in activities not related to R&D.

Project PINTA also incorporated the development of a second Park project, the Technology Park in Malaga, that had already been decided by the regional government. Envisioning the two projects as having a complementary role, the proposal suggested that Cartuja93 should focus on applied research in strategic technologies and connect this research with the regional productive system, while the Malaga Park should focus more on technological innovation and industrial production of multinational corporations (Vazquez-Barquero and Carrillo, 2004).

The project did not evolve as planned, however. While the initial proposal was adopted by the regional government (Junta de Andalucia) and the Spanish central government, local business and real-estate interests intervened, favouring the creation of a space for business offices and other commercial activities. A political change in the municipality of Seville at that time (1991) complicated the process even further. In 1992, the final proposal approved (Table 5-7) a total area of 199 hectares and projected a total of 61.8 hectares for R&D centres, high technology companies and the University of Seville Engineering School. Next to the STP area, they defined a metropolitan zone (110 hectares) for sport facilities, museums, a thematic and metropolitan park and a tertiary sector zone for public administration services, private service sector firms and hotels (27.5 hectares). In addition, the final plan allowed for a greater share of administration and sales activities of firms to develop inside the Park (Castells and Hall, 1994).

In order to manage the project, a new private entity was created (Cartuja93 S.A.) with the participation of regional government, state and the local (provincial and municipal) authorities. The Park officially opened in October 1993, one year after the end of Expo fair following the demolition of a number of non-reusable pavilions and other necessary modifications.

Table 5-7: Distribution of space in Cartuja93 project (final proposal)

Cartuaj93 Tecnopolis - Cartuja93 STP - Engineering School	61.8 hectares
Metropolitan area - Thematic park - Monumental zone - Sport activities zone - Metropolitan park of Alamillo	110 hectares
Services zone - Public administration - Business services - Hotels	27.5 hectares
Total area	199.3 hectares

Source: Cartuja93 S.A.(Cartuja93 S.A., 1994)

Any assessment of the actual cost of the Park project is rather problematic due to the strong connection with the broader Expo92 project. An estimate given (EXPO, 2008) for the total cost of Expo92 infrastructures is in the range of 450 thousand to 1 billion Euros(75 to 160 billion Spanish Ptas). However, this includes expenditures irrelevant to the Park project itself and excludes costs assumed by Cartuja93 or AGESA[150] for the necessary modifications made to some of the buildings.

[150] For those building leased/sold to firms, the necessary modification costs were covered by their new owners. For some, however, the management company had to cover the expenses. For example the central building of the Park, Pabellon de Italia, opened as late as 1998 with significant costs (over 10 million Euros) for the necessary moderations (Gil, interview, 17/02/2006).

Source: own elaboration from Googlemaps(2007)

Figure 5-5: Cartuja93 location in Seville

5.3.2.2 Cartuja93 evolution – a problematic start, change of direction and subsequent growth

The situation at the time of the opening of the Park appeared quite promising. Even before its official launch, 17% of the space[151] had been allocated to interested local, national and multinational companies and public research institutions (Benjumea Pino, 2003). The first tenants included R&D centres from major multinational firms (e.g. IBM, Fujitsu, Siemens, XEROX, Alcatel, Philips, Sony), the EU Institute of Prospective Technology Studies and four public (national and regional) research centres. Altogether, they should have brought over 1,000 researchers and 2,000 support personnel to the Park (Castells and Hall, 1994).

[151] According to Castells and Hall (1994), by 1991 this allocated space was more than 33%.

However, this initial interest did not materialise in the subsequent years. According to some accounts (Benjumea Pino, 2003), this was primarily a result of a global economic recession that led multinational firms to downsize and implement cost-cutting strategies rather than new investments in R&D activities. New entries were thus limited to the four public institutes of CSIC[152] (CNA, ICSM, IBVF,IIQ), established in partnership with the University of Seville and the regional government. They were brought in to support the Park's growth prospects in a period when there were questions concerning its viability (Vazquez-Barquero and Carrillo, 2004). In 1997, the engineering school of Seville University was also transferred to the Park space. Some of the firms that had initially expressed interest did not move into the Park at all and by 1998, five years later, the total occupancy level of the Park area was at 30%, while an additional 23% of the space was reserved (Benjumea Pino, 2003).

The subsequent period (1998-2000) brought changes that proved to be critical for the Park's evolution. The most important was the decision by the management team to allow the purchase of land by firms replacing the initial scheme, based on a long-term lease without transfer of ownership. As suggested by many interviewees (Gonzalez, interview 2006; Benjumea-Pino, interview, 2006; Rivas, interview, 2006) this change triggered interest of local firms. Around the same time (1999), two of the few high profile multinational tenants (Siemens and XEROX) announced their decision to leave the Park space, reducing even further the number of international firms with presence in Cartuja93. The response to this development from the Park's managers was the decision to re-direct the project's strategy and focus towards local firms (Vazquez-Barquero and Carrillo,

[152] Consejo Superior de Investigaciones Científicas

2004). It is not clear whether this had an impact on the admission criteria used, something that was denied at least by both the management and some tenants (Gonzalez, interview 2006; Benjumea-Pino, interview, 2006). The same year, the buildings previously occupied by Siemens and Xerox were bought by two local companies (MacPuarsa and INERCO)[153] to establish their headquarters, as well as their research and development functions/units.

In the period 2001-2005, there were high growth rates of Park occupancy and activity levels. The 40% occupancy level rose to 75% in 2005, with the remaining 25% already reserved. The entry rate of firms was more than 30 per annum and, from 180 tenants in 2000 with 6,800 employees, the Park had 330 tenants with 11,000 employees and a total activity turnover of 1.6 million Euros by 2005 (APTE, 2005)[154]. In 2001, a group of tenants, including firms, research organisations and public sector entities, created the Cartuja93' tenant association (Circulo de Empresarios) with the goal of promoting the tenants' interests and developing relationships going beyond that of only good neighbours (Gonzalez, J., interview, 2006). The same year, the reconstruction works in the central building of the Park were finally completed (Pabellon de Italia) and the Park managers decided to offer reduced rent schemes to attract and support high-technology firms, creating a semi-incubation structure. Ten years after the Park opened, the regional government director for employment and technological development, Jose Antonio Viera[155], suggested: "Cartuja93 is now transforming itself to a technological agent...it is no more a 'Babel tower' urban space" (Bolanos, 2003).

[153] MacPuarsa was a manufacturer of elevators and their R&D and quality assurance departments were located in the Park. INERCO was a successful spin-off of the Engineering School of the University of Seville on civil and environmental engineering consultancy.
[154] As witnessed during the field work period, the Park is experiencing significant parking space problems given the limited public transport connection with the city of Seville.
[155] Currently president of Cartuja93 S.A.

Recently the municipality of Seville approved the extension of the Park space by 30% (Circulo de Empresarios de Cartuja93, 2006)[156] in order to accommodate part of the backlog of applications from interested firms (Gil, interview, 17/02/2006). The Park management has also secured funds for the creation of a pre-incubation and incubator facility for new technology-based firms (Invertia, 2005).

Despite the initial slow progress, the Cartuja93 Park has nowadays reached high levels of activity in a period of less than twelve years since its inauguration. According to its managers, it is an impressive enough record when compared to all the other projects in Spain, especially against the "emblematic Park of Sophia-Antipolis" (Benjumea Pino, 2003).

[156] The initial proposal for the municipality also foresaw residential use in a specific area with the intention to increase the urban life of the Park (Rivas, 2002)

Table 5-8: Evolution of the two Parks - important dates

PTA		Cartuja93
	1984	Seville wins the contest for the organisation of Expo92
	1986	The regional government of Andalusia characterises Cartuja island space as a metropolitan park area
Decision for the development of TP by the regional government – Amendment of Silvota Poligono zoning restrictions for an area of 61 to be used for the PTA	**1988**	
	1990	PINTA project proposal for Cartuja93 Science and Technology Park
Inauguration of Parque Technologico de Asturias Creation of Urban Entity responsible for the facilities maintenance	**1991**	Creation of Cartuja93 S.A. management company
	1992	Expo92
	1993	Approval of final spatial plan of Cartuja Opening of Cartuja93
ITMA and CEEI establishment	**1994**	17% of space occupied
1st company establishes itself in the Park	**1996**	Establishment of CSIC research centres
Relaxation of admission criteria	**1997**	30% of space occupied Establishment of the Engineering school
17 % of Park space occupied	**1998**	Siemens and XEROX leave Park premises Change of land use scheme
FICYT technology centre leaves the Park	**2000**	40% of space occupied
Creation of Centro Elena business offices	**2001**	Opening of central building of the Park Creation of Park tenants' association
13 hectares of Park space declassified for establishment of general industry activities	**2002**	
The Park reaches 104 tenant firms/entities with 1,700 employees and 68% space occupied	**2005**	The Park reaches 330 companies and over 11,000 employees – 75% of space occupied, 100% reserved - Approval for the expansion of Cartuja93
Autotex Airbag announces the closure of the production plant	**2006**	Plan for the creation of an incubation and pre-incubator building structure approved

Source: own elaboration

5.4 Stated objectives and promoters' priorities

As already stated, both Parks were created and promoted as part of broader regional development strategies. However, their focuses, as identified in their objective statements, were very different.

The official document of the Technology Park of Asturias states that "the Technological Park of Asturias represents part of the industrial and technology policy carried out by the Principality of Asturias through the council for Industry and regional promotion, aiming for the creation of innovative activities..."(IFR, 1991). Elaborating on the above, the document specifies that the main objectives of the Park are "...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..." (ibid.). In the interview, the Park's management representative added that the Park is a "space for diversified activities" and "...a space for innovative companies with strategic character for the region" (Pola, interview, 2005). The activation of the endogenous resources incorporates also the CEEI operation that should "...fulfill the need to create in [our] region an entity that supports the promotion of innovative and future oriented firms"(CEEI, 2005). For its promoters, the "Technology Park" label of PTA reflected their focus on the attraction and establishment of the production units of companies in high-technology sectors, less so on attracting basic or applied research units.

In comparison, in the case of Cartuja93, the initial proposal of the PINTA team adopted by the regional government saw in the Park "...the creation of a global scale innovative environment (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 projected to the global market north-south cooperation in the area of technology transfer" (Cartuja93 S.A., 1994, p.19). The Park should aim for:

- the development of applied research in new technologies in a number of strategic sectors for the region, namely biotechnology, IT, robotics, laser, new materials and renewable energies
- the linkage of the applied research activities with the production structure of the region including agriculture, industry and services and the development of the necessary linking/interaction infrastructure
- the creation of a global scale "innovation environment"[157] that will include research centres and companies of national and regional character, as well as international, and whose activities should be looking towards the global market
- the support and facilitation of north-south cooperation in the area of technology transfer (Cartuja93 S.A., 1994, p.20)

This statement describes a Science and Technology Park without production/manufacturing activities that targets knowledge creation through research, attraction of regional and international R&D firms, technology transfer and cooperation development. It should help to reposition the region as a centre of innovation activity on an international scale. It represented, for some, an attempt for technological "leapfrogging" for the region of Andalusia (Rivas, interview, 2006).

This initial objective statement was transformed, however, after 1996 following the limited attraction of foreign firms and promoted a "... a more endogenously focused strategy for the attraction and establishment of local/regional companies" (Benjumea Pino, interview, 2006) The international orientation of the Park was seen as "too ambitious" and not

[157] Translated from Spanish "medio de innovación"

compatible with global economic developments (Vazquez-Barquero and Carrillo, 2004). According to Carillo Benito (cited in Vazquez-Barquero and Carrillo, 2004), the focus changed towards the "...establishment between the public and the private local sector of a common action framework, whose formalisation was consistent with a set of strategic planning initiatives (...) dully coordinated and addressed to (...) the promotion of the new Seville economy for the year 2000". Nevertheless, the Park's management maintained the goal for "...the support of knowledge and technology transfer and the development of networks/linkages with the immediate environment as well as with other Technology Parks in Spain and internationally" (Gil, 2003, p.37).

However, these general objective statements regarding the Park's creation need to be considered against the more short term mandate that the Park's management team was given. The reuse of Expo92 facilities had a particular priority in the period after the Park's opening (Benjumea Pino, interview, 2003; Gil, interview, 2006). AGESA, a public company created with the sole purpose of securing the reutilisation of the part that belonged to the central government, supported this direction. Law 31/1992 of the Spanish state describes the subsidies and other support provided to firms located in Cartuja93 and makes this prioritisation even more clear: "...the project Cartuja93 aspires to accelerate the location or guarantee the permanence in the island of Cartuja of economic activities that reutilize the internal and external infrastructures created for the Universal Exposition, maintaining the island of Cartuja as a focal economic stimulus and generating employment after the end of the Exposition" (translated from original text)[158] (BOE, 1992).

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[158] "El Proyecto Cartuja 93 pretende acelerar la implantación o garantizar la permanencia en la Isla de la Cartuja de actividades económicas que reutilicen las infraestructuras internas y externas generadas por la Exposición Universal, manteniendo la Isla de la Cartuja como un foco de impulso económico y de generación de empleo tras la celebración de la Exposición" (BOE, 1992 / art.1.2.)

The analysis reveals important differences between the general objectives of the two STPs, but also the rather common short-term priorities of their promoters and shareholders. In the PTA, the objective is the contribution to the diversification of the regional economy through the attraction or the creation of new firms in sectors with higher knowledge content (see Table 5-9). The Park is to be a privileged space, distinct from the industrial areas/poligonos that shall symbolise and promote the break from the region's traditional industrial past. Against that, Cartuja93 was designed with the intention to create a research intensive space and an innovative milieu. The promoters focused on the attraction of R&D, technology development and transfer activities (public and private) of all types to develop a place of synergies and interactions. Even if the initial international orientation changed towards endogenous sources, this did not change (at least in the rhetoric of its promoters) the character of the project. The aim was still to concentrate R&D activity, to build synergies and create innovation and technology and to diffuse it through technology transfer mechanisms to the regional economy. At the same time, though, both had to fulfill the short-term mandate that required filling up the Parks' space and recovering their costs. This appeared particularly pressing in the case of Castruja93, but was equally present in the case of the PTA.

Table 5-9: Summary table of the Parks' stated and implicit objectives

PTA	Cartuja93
- Attraction of high-technology firms/activities - Support diversification of regional economy structure - Activate endogenous sources/capacity - Support entrepreneurship (through CEEI operation)	- Reuse of Expo92 facilities - Creation/development of applied R&D activity - Support linkage of research activities with production (technology transfer) - Creation of an innovative environment with concentration of national and international (until 1997) and local (after 1997) R&D centres and companies - Development of synergies/interaction - Contribute to the development of the productive base of Andalusia

Source : Own elaboration

5.5 The Parks' operation

5.5.1 The Parks' tangible elements: infrastructure, facilities and basic services

The space dedicated to the Cartuja93 Technopolis (62 hectares) is similar to that of the PTA. They differ, however, in the amount of built space made available. In the PTA, the focus was on empty plots to be built by firms themselves. There was only a limited offer of 8000m2 rentable, ready built office spaces in the CEEI incubator and the two Centro Elena buildings. In comparison, Cartuja93's World Fair legacy was 30 pavilions with a total office space of 447,000m2. The basic restriction was that, in contrast to the PTA, the urban location of the Park and the land use plan did not allow for any large scale manufacturing/production activities.

Along with the plots and office space, the Parks provide high quality basic infrastructures such as power and gas supply, water and sewage systems and advanced telecommunication networks. Planning regulations and green zones targeted the creation of a pleasant and attractive environment, differentiating them from industrial parks and fitting the high-tech image. The quality facilities are supplemented with basic services including maintenance, cleaning and security services (see Table 5-10).

Both Parks are conveniently located inside the two regions. Rather untypically, the Cartuja93 Park is close to the centre of the city of Seville and has good access to most transportation networks. In a rather more common form, the Asturias Park is outside the urban area, but is in the centre of the "ciudad Asturias" triangle, next to the main regional highways and is less than 30 minutes drive from the region's two ports (Gijon, Aviles) and the airport.

The attractive infrastructure is complemented by subsidies and tax breaks. In Cartuja93, the national government produced legislation 31/1992 to provide tax breaks for the construction works and other investments made by companies and supplied additional subsidies for their R&D expenditures (BOE, 1992). This support was continued by the regional government after 1999, focusing on the R&D and innovation related activities (Chaves, 2003). Furthermore, rent prices are subsidised at below market rates for the technology based firms established in the Cartuja93 "Pabellon de Italia" (Gill, interview, 2006). In Asturias, new tenants have access to subsidies that reach up to 40% of the total investment (Pola, interview, 2005). The firms established in the Park's incubator also have access to a reduced rent scheme[159] for the first three years of their Park operation.

Table 5-10: Main characteristics of the Spanish STPs

	PT Asturias	Cartuja93
Management entity	IDEPA (Regional gov't institute) (100% control of regional government)	Cartuja 93 S.A. Shareholders: national (34%), regional and local authorities
Total Park size	44 hectares	62 hectares
Plots	25 hectares (50 plots of 2,000 to 14,000m^2)	33 hectares (71 plots)
Total space for use	293,137m^2	447,427m^2
Existing office spaces	7,500m^2 (alter 2000)	315,000m^2
Basic services	Gas, electricity, water and telecommunication networks Security service	Gas, electricity, water networks Advanced telecommunication networks Security service
Basic support services provider	Conservation entity with participation of all land owners	Conservation entity with participation of all land owners
Incubator	YES (900m^2)	YES (business centre focusing on new firms)
Financial incentives and support	Subsidy up to 40% of investment cost for establishment Reduced rent in CEEI incubator	National and regional government tax cuts (15% VAT for expenditures in infrastructure and construction, 30% tax credit for R&D) Reduced rent in "Pabellon de Italia" building

Source: IDEPA, 2006a ;Cartuja93, 2004

[159] 30% of market price the 1st year, 15% the 2nd year and 0% thereafter (CEEI, 2005).

5.5.2 Admission and graduation

The admission criteria set by the Parks' managers define the architectural characteristics of the buildings created in the Parks (with the intention of maintaining a high-tech profile), as well as the content of the tenants' activities. In the PTA, companies must fulfil the requirements of the development plan of the Park (Plan Parcial) (IFR, 1991) setting minimum architectural, environmental and activity benchmarks. The admission committee examines the feasibility of the proposed product/service, its capacity to attract other companies, the percentage devoted to R&D activities, linkages with universities/research centres and the share of qualified personnel to be employed (IFR, 2002). Specific/clear benchmarks are not defined, however. In the CEEI incubator, new entries must be companies "...of recent creation with no more than two years in operation, that have an innovative or technology-based activity that is neither industrial (production) or exclusively commercial. They shall also intend to use CEEI services for their creation and consolidation" (CEEI, 2005). Much less explicit is the graduation policy of CEEI. There is a three year target, matching with the three year rent support scheme, although it is rather flexible (Mendendez, interview, 2005).

In Cartuja93, the official presentation document (Cartuja93 S.A., 1994) includes a broad range of criteria. It states that the incoming project (firm) shall:

- be closely associated with the presence and use of the Park's provided advantages and services (tangible and intangible)
- preferably reutilise one of the existing infrastructures created by Expo92
- be able to contribute to the development of synergies phenomena
- be able to contribute to the elimination of technological deficits in Andalusia
- be able to contribute to the modernisation strategy of Andalusia and Spain
- be able to transfer the results of their economic activity

- be able to contribute to international cooperation, especially with Latin American and North Africa (Cartuja93 S.A., 1994)

Again, there are no explicit benchmarks set concerning the tenants' R&D intensity (e.g. percentage of turnover or employment) as was initially suggested in Castells' proposal; there is still increased flexibility in the admission processe.

This flexibility has been evident in practice in both cases. In Cartuja93, in the initial period of lower occupancy levels, companies "...with a lower technological profile were accepted in the Park space" (Gonzalez, interview, 2006). The change towards an endogenous strategy "...did not affect the admission process but it may have lowered the technology-intensity standard/benchmark" (Gil, interview, 2006; Benjumea, interview, 2006). Even more clearly, in the Asturias case, the admission processes were formally relaxed in 1998 by the Park's managers in an attempt to attract more firms inside a Park that still had` low activity levels (Maldonado, 2001).

5.5.3 Intangible elements: business, technology and cooperation support

Besides the basic services offered to all tenants, the Parks have attempted, although at rather different levels, to develop support, networking and coordination mechanisms.

5.5.3.1 PTA

The services offered to PTA tenants include business support, cooperation promotion, information dissemination (printed bulletins, Internet/e-mail and promotion events), R&D project participation support, training events and technology consulting services (see Table 5-11). They cover activities with importance in the promotion of innovation, technology transfer and knowledge exchange. However, with only a few exceptions, none has an explicit Park character and dedication. They are all mechanisms and services developed or financed by IDEPA programmes with reference to the whole of the region. Park tenants possibly have increased access to information on the support structures, but not much more beyond that. There is also no dedicated coordination and networking mechanism, formal or informal (Pola, interview, 2005). Only recently (after 2003), Park tenants gained access to the RedInfo business, a cooperation and matchmaking support online service developed by the Spanish Association of Technology Parks (APTE), and also to the national government programme supporting R&D cooperation among Spanish Parks' tenants (IDEPA, 2006). Both are externally defined mechanisms.

The CEEI incubator offers a more supportive environment that includes one-to-one coaching for the development of the business project, business training, support in placing the product in the market and promoting the tenants' R&D and market linkages and access to finance. CEEI does not participate in the capital of the incubated firms in the form of a risk capital scheme, but it does support firms in raising risk capital from external sources. These activities are developed in parallel to the more general and active entrepreneurial promotion that CEEI has at a regional scale that includes a virtual business support service (Centro SAT), entrepreneurship courses and other support activities. In the eleven years of its operation (1994-2005), it has implemented over 3,000 business initiatives/projects (over 270 annually) of all types, supporting local firms/entrepreneurs as well as students and researchers and leading to more than 20 new firm projects on an annual basis (CEEI, 2006). While still considered important, Park activities represent only a small share (<20%) of its annual budget (Menendez, interview, 2005).

5.5.3.2 Cartuja93

In comparison to the PTA, Cartuja93 tenants have, over time, been provided with a wider range of "soft" support services from the Park management entity (Cartuja93 S.A.).

Cartuja93 managers focus on information dissemination, cooperation and partnership support activities. Besides the Park's bimonthly publication, the Internet databases and electronic information services, formal cooperation support mechanisms include activities such as the thematic breakfast meetings between Park companies and research centres (Desayunos Cartuja93) on a weekly basis (see Table 5-11). Furthermore, advanced support is provided by specialised public (regional or municipal) and semi-private entities located inside the Park. CITANDALUCIA, the agency created in 2003 by the regional government, manages the two regional information dissemination and technology transfer networks (RATRI and RAITEC)[160], develops brokerage and other matchmaking activities. The Andalusian Institute of Technology (IAT) offers technology services, with a focus on manufacturing firms mainly outside the Park space. In addition, there are a number of private business support services in accounting, consulting, law and human resources that operate in the Park. As in the PTA, the Cartuja93 tenants also have access to the APTE virtual cooperation network and IASP mechanisms. In addition, the Cartuja93 managers have signed cooperation agreements with other Parks and technology organisations in Europe (Italy, Portugal, France), Latin America and Asia promoting the tenants' linkages and their access to foreign markets (Gil, 2006, interview).

Additional services and networking mechanisms, with both explicit and non-explicit reference to the Park, were developed during the last 3-5 years. The tenants' association (Circulo de Empressarios) has a prime objective of promoting tenants' common interests based on "...the diffusion/management of knowledge of the other tenants' activities and the development of synergy among the Park tenants to transform them to something more that just good neighbours..." (Gonzalez, interview, 2006). The Circulo has been active in

[160] RAITEC (www.raitec.es) focuses on dissemination of technology to companies and RATRI (www.ratri.es), mainly directed towards researchers.

networking through formal cooperation agreements with the University of Seville and other education organisations, business services firms and other industry associations. The Business Confederation of Andalusia (CEA) and Seville (EPYME), the regional federation of ICT companies (ETICOM) and the Andalusian Network of Innovation (RAI) are also possible networking structures. Finally, in 2005 the regional government created a network of innovative spaces of Andalusia (RETA) that supports collaboration among the technology agents operating in the Park and the companies in industrial poligonos and business centres.

Table 5-11: Business, technology transfer and networking mechanisms and the organisations involved

	PTA	Cartuja93
Business/management services	IDEPA, CEEI, Park tenants	Cartuja93 S.A.: Information dissemination and training Business services for public and private Park tenants
Technology transfer mechanisms/agencies	IDEPA, CEEI	CITANDALUCIA IAT, SevillaSigloXXI, VEIASA, AENOR
Financing support	No dedicated support capital or venture capital SRP, ASTURGAR Access to regional mechanisms (subsidies for location, support programmes for R&D activity, entrepreneurship/NTBF support funds)	No dedicated support capital or venture capital Access to regional mechanisms (subsidies for location, support programmes for R&D activity, entrepreneurship /NTBF support funds) CTA, Invercaria
Networking support mechanisms	No internal mechanism Access to APTE Red Info Business Access to IASP networking mechanism	Desayunos Cartuja93 Circulo de Empresarios Access to APTE Red Info Business Access to IASP networking mechanism Contracts with other Parks (AREA Park (It) and Taguspark (Pt))
External networking support structures with Park presence	ACIPA, Club Asturiano de Innovación, Club Asturiano de Calidad	CEA, EPYME, ETICOM RAI, RETA, CTA

Source: survey and own elaboration

5.5.4 STPs' management structure and actors' role

In both examined cases, the management of facilities and the provision of basic services is the responsibility of separate private entities (Entidad Urbanística of PTA or Entidad de Conservacion de Cartuja93), where all Park plot owners have shares according to the plots' size. They followed different models for the more advanced and intangible activities of coordination, business and technology services and the Parks' promotion.

Being the sole promoter of the Park, the regional development agency of Asturias (IFR/IDEPA) supervises the Park operation in a similar manner to all the other public industrial areas (poligonos) in the region. There is no separate entity (public or private) or even a specific unit inside the IDEPA organisation dedicated to the Park's operation. Services are provided by the relevant innovation and business project units of IDEPA and the promotion and marketing of the Park's space is the responsibility of the unit responsible for the regional infrastructures. There is no separate "Park budget" and all expenditures for Park-related activities (less than 10% of its total annual budget) come as part of the annual regional government appropriations for the industrial/business space of the region (Pola, interview, 2005). The incubation function of the Park is coordinated by CEEI and controlled by IDEPA, with the limited participation of other regional partners (university, Industry Federation).

The described structure with no dedicated management entity/unit has not allowed any formal participation of other local players. The regional industry or the university are not formally present in the Park management and have shown very limited interest. This structure has decreased the visibility of the Park. According to a FICYT representative "...the technology Park is not recognised as a separate institution but rather as the sum of its individual tenants" (Suarez, interview, 2005), a view shared in most interviews with local players.

In comparison, the Cartuja93 Park's governance structure is based on the operation of a single management unit; a separate legal entity (Cartuja93 S.A.) responsible for most of its operations. It is a clearly visible management entity whose executive director is indeed the "Mr/Mrs Science Park". The regional government, as the main shareholder (51%), maintains the driving role in its operation, but other shareholders (central government through AGESA, the municipal and provincial authorities) have the potential to influence the Park operation at different levels. The ownership of Park land by AGESA and the competence of the municipal authorities to define land uses in the area surrounding the Park space are such examples. The tenants association (Circulo de Empresarios), with the participation of more than 80 tenants, represents a player that has also assumed an active role. Its success in negotiations with the municipal authorities for an extension of the Parks' space are indicators of its relevance and role.

5.6 The STPs' institutional base

The objective statements from the examined cases already defined their rather different roles and the weight of public research organisations representing one of the main differences in the operation of the Parks. The following analysis highlights these very different approaches and points to the strengths and weaknesses of these organisations in relation to the Parks' operation.

5.6.1 PTA – limited technology base

One of the most important features of Asturias Technology Park is the limited presence, formal and informal, of public research organisations inside the Park's space. The Instituto Tecnologico de Materiales (ITMA), established in the very early days of the Park's operation (1992), is the only technology organisation operating inside the Park. It is a semi-public technology centre founded in 1990 by the regional government with the participation of the University of Oviedo and a number of local companies. It specialises in the processing and manufacturing of non-metal materials (plastics, ceramics, heat-resistant materials), closely linked to the regional industry's dominant activities[161]. The 45 employees operating in the Park, 33% of whom are researchers, focus on the provision of technology services including support in R&D projects, laboratory material and processes testing and analysis, certification, metrology activities and training (see Table 5-12). Services to firms (accreditations, testing, analyses) represented 67% of its 4 million Euros turnover in 2004, while 28% involved applied R&D for public and private companies. The focus is clearly at the regional level, 80% of its 400 clients (annually) are located in the region of Asturias. The participation in EU projects is rather small (eight in 2005) and although present in selected EU technology platforms, cooperation with international players is considered to be rather limited (Pastor, interview, 2005).

ITMA's small size and the nature of its activities do not represent a strong knowledge creation base with exploitation potential. The scientific publications record is almost non-existent (three papers/year); during the fifteen years of its operation, no patent applications have been filed and no spin-off company has been created. In all respects, ITMA did not have the capacity to play a driving/anchor role in the Park's operation and growth.

[161] The second unit – in the city of Aviles – focuses on technologies for metal materials (steel, aluminium)

Table 5-12: Profile of ITMA

Indicator	Performance
Employees (2004)	45 (33% researchers)
Total budget (2004)	4 million Euros
Main activities	Applied R&D projects, material and processes testing/analysis and certification, training
Share of budget from technology services	67%
Regional market share in turnover	80%
Number of R&D projects	39 (2004)
Firms used technology services (2004)	371
Firms used technical assistance (2004)	97
Trainees/PhD students (2004)	1
Training projects	10/year
Total Publications/year (average 2000-2004)	3[162]
Publication/researcher (2004)	0.04
Patents	0
Spin-off companies	0

Source: survey and own elaboration

No other PRTO has formal linkages with the Park. FICYT, a technology transfer intermediary, but not a research centre itself, left in 2000 for a central location in Oviedo (Suarez, interview, 2005). Ondategui (1997) referred to intended linkages with the University of Oviedo engineering, chemistry and informatics departments; however, these never materialised. There is neither physical presence nor any other formal participation. Their only partnership is with CEEI for the provision of entrepreneurial support services to researchers and students and none of the few spin-off companies created by the university were located inside the Technology Park area (Muro, interview, 2005).

Overall, the PTA area is by design a "thin" knowledge and technology creation base with limited potential for knowledge spillovers through labour mobility, interactions and cooperation for established and interested tenant firms.

[162] The number of peer reviewed publications (SCI) is one per year (ISI, 2006)

5.6.2 Cartuja93 – a cluster of research and technology creation organisations?

In contrast, Cartuja93 has a high concentration of PRTOs that include R&D institutes, university laboratories and technology centres and covers the whole spectrum from basic research to technology/innovation adoption services in a large number of sectors (see Appendix 15 - Research and technology organizations operating at the end of 2005 in Cartuja93). By 2004, Cartuja93 hosted 28 PRTOs, with more than 1,500 employees that accounted for 7% of the total Park turnover and 20% of its personnel (IAT, 2004).

The majority of the PRTOs in the Cartuja93 Park were established in the initial years of its operation (1993-1998), providing at that time an important impetus to the Park's viability and growth. The four research institutes of CSIC[163] (CNA, ICSM, IBVF,IIQ) focus on basic and applied research and have a sizeable publication record (50 peer reviewed papers annually (ISI, 2006). CSIC institutes' R&D activity is funded primarily through the public sector and their participation in competitive regional, national and EU projects. Direct contracts from industry represent a smaller part (10-15% on average) of their total annual R&D budget. Patenting activity is also limited (1-2 patents/year at maximum), with the exception of IBVF[164], while no spin-off companies were reported from any of the four institutes.[165]

A second group of PRTOs includes the research institutes of the Engineering School of the University of Seville (AICIA, CENTRE, IAR, CAM), all with a more applied R&D

[163] Consejo Superior de Investigaciones Científicas
[164] IBVF reported filing for 22 patents during the period 2000-2004.
[165] After the end of the research (03/2006), a fifth CSIC institute was created in the Park. The Centre of Molecular Biology and Regenerative Medicine of Andalusia (200 employees), focusing on basic and applied biomedical R&D, is a joint initiative of the regional government, the two universities of the province and CSIC.

character. AICIA[166] is the most important and is a public-private partnership created by the professors of the engineering school with the participation of Andalusian companies; it operates as the umbrella structure for most of the engineering school's 40 research groups. The focus is on technology development and industrial applications, with particular strength in the aeronautics sector (RC93-1). AICIA represents almost 25% of the annual R&D budget of the University of Seville and the majority (over 75%) of its activity is financed directly through contracts with more than 100 local and non-local firms, in stark contrast to most other university faculties/departments. AICIA also has an important record of research results exploitation through patenting (eighteen patents in 2004, 50% of the total of the university) and a smaller number of spin-offs (eight). The remaining institutes[167] were recently created (1990s) and are still small in size.

In the area of technology support services, the Andalusian Institute of Technology (IAT) has more than 100 employees dedicated to the implementation of innovation and advanced technologies and technology services provision to regional companies in a number of sectors. IAT also created CITAGRO, an organisation that specialises in agriculture and food processing technology and hosts the regional branch of AENOR, the Spanish certification and normalisation agency. Other research centres include CENTA[168], water sciences, a research unit of the Spanish postal services company (Correos) and an aquatic ecology station (EEA)[169]. Institutes are also found in social sciences including the regional and national institute of statistics (IEA, INE), a gerontology institute[170] and a foundation for the promotion of research in architecture (FIDAS). Particular reference should be made to

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[166] Asociación de Investigación y Cooperación Industrial de Andalucía,

[167] These institutes did not respond to the survey. As a result, there is no detailed information concerning their exact activities.

[168] Centro de Nuevas Tecnologías Acuáticas (Centre for New Aquatic Technologies)

[169] Estación de Ecología Acuática Príncipe Alberto de Mónaco

[170] Fundacion Gerontologica Internacional

the Institute of Prospective Technology Studies (IPTS), one of the institutes of the European Joint Research Centre. Being one of the first organisations established in the Park (1994), it was brought into Cartuja93 as a result of a political decision and in an effort to support the Park's profile. However, IPTS is an advisory body of the European commission, and its modus of operation requires direct reference to Brussels, allowing limited direct contact with the Park's organisations (RC93-6).

Cartuja93 also hosts a number of education and training organisations that include the Engineering School of the University of Seville, with 5,000 students and 300 professors registered in seven engineering disciplines. A second faculty brought into the Park was that of Communication, with 2,500 students registered in audiovisual, journalism and other media studies (US, 2005), but with limited R&D activity (Palma, interview, 2006). Three private business schools (EOI, ESIC and CEADE) and a number of public and private training centres cover areas such as IT/computing and marketing etc. EOI and ESIC have been quite active in entrepreneurial training and other forms of specialised education programmes for the Park's tenants (EOI, 2006; ESIC, 2006).

Brought together, in 2004 Cartuja93's public or semi-public research and technology entities concentrated more than 1,500 employees and a research budget of 80 million Euros (IAT, 2004). Even if only part of them has a social sciences orientation, it represents a strong knowledge creation base with a sizeable pool of skilled labour.

5.7 Evaluation of the STPs

This section is dedicated to an evaluation of the two STPs and examines the growth and the knowledge/technological intensity of the tenants' activities, the creation of new technology based firms and the cooperation, interactions and knowledge flows of the Parks' tenants. It also assesses the role that the Parks' tangible and intangible elements actually play in the development of the above processes and outputs.

5.7.1 Activity growth and occupancy levels

As already presented in section 5.3, both Parks experienced initially low occupancy rates that caused significant costs pressure and led to changes to their admission policies and priorities. In more recent periods (after 2000), they had greater growth rates (see Table 5-13). Even so, the Asturias Park occupancy level in 2005 was 68% with 12% reserved (see also Figure 5-13). In 2005, it hosted 102 firms that employed around 1,700 employees. The majority (>85%) are small firms (<50 employees) with only five establishments with more than 100 employees. Given the age of the Park (fourteen years) and the fact that more relaxed criteria were applied in the period after 1998, the performance of the PTA is considered poor and it is ranked among the least developed STPs in Spain (APTE, 2005). The closing of the multinational plant of Autotex Airbag left a large plot (14.000m2) unoccupied and further reduced the activity and occupancy levels. The park incubator (CEEI) and the two office-space buildings of Centro Elena show, on the contrary, a more positive performance and managed to attract tenants at a more rapid rate. Of the overall total of 102 firms, 64 were located there (2005). Centro Elena was fully occupied with 40 firms and around 250 employees, while the CEEI incubator achieved high rates of occupancy (>70%) and has continuously hosted 20-25 firms since the third year of its operation.

Cartuja93 has almost reached full capacity and is nowadays moving towards further expansion. During the last five years, activity growth rates have been over 20% annually (IAT, 2004) and the 167 tenants and 7,500 employees in 1998 grew to 311 tenants retaining over 11,450 employees with a total economic activity of around 1,7 billion Euros, comprising around 20% of the total 51,000 employees of all Spanish Parks (APTE, 2005). No plot/building is left unoccupied or unreserved (see Figure 5-). A backlog of applications from firms interested in moving inside the Park are an indication of its attractiveness and they are expected to be partly addressed with the extension of the Park space by an additional 30% (Gil, interview, 2006).

Table 5-13: Number of tenants and employees in the Park[171]

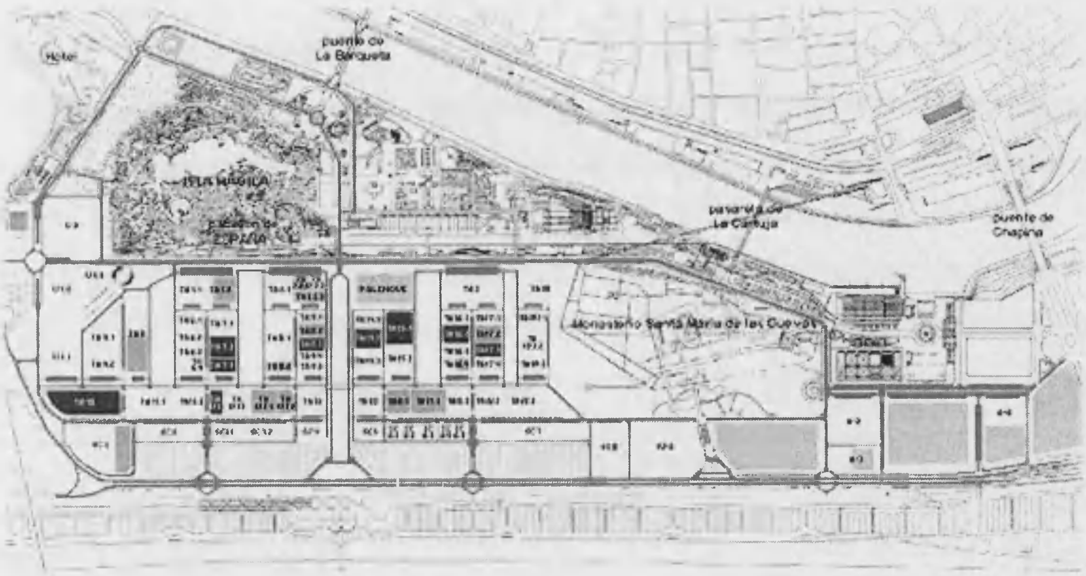
	1994	1998	2001	2005
PTA				
Tenants	9	28	31	102
Employees	322	420[172]	965	1700[173]
Economic activity(million €s)	n.d.	n.d.	n.d.	n.d.
Space Occupied	14%	17%	36%	68%
Space Reserved	2%	6%	21%	12%
Cartuja93				
Tenants	51	167	195	311
Employees	1525	4290	7590	11.455
Economic activity(million €s)	n.d.	n.d.	984	1686
Space Occupied	17%	30%	43%	75%
Space reserved	17%	23%	46%	25%

Source: Ondategui, (1997; 1999; 2001), IAT (2005) and own elaboration

171 Refers to total number of entities in the Park

172 Data for 1999

173 Figure based on estimate from available data



October 2005	floor m2	%	edificability m2	%
requested	23.208	7,0%	46.259	10,4%
assigned	39.166	11,9%	61.847	13,8%
in works	32.679	9,9%	55.172	12,3%
in use	234.618	71,2%	284.150	63,5%
TOTAL	**329.672**	**100%**	**447.427**	**100%**

Source: Cartuja93 (2004)

Figure 5-6: Occupancy of Cartuja93 in October 2005

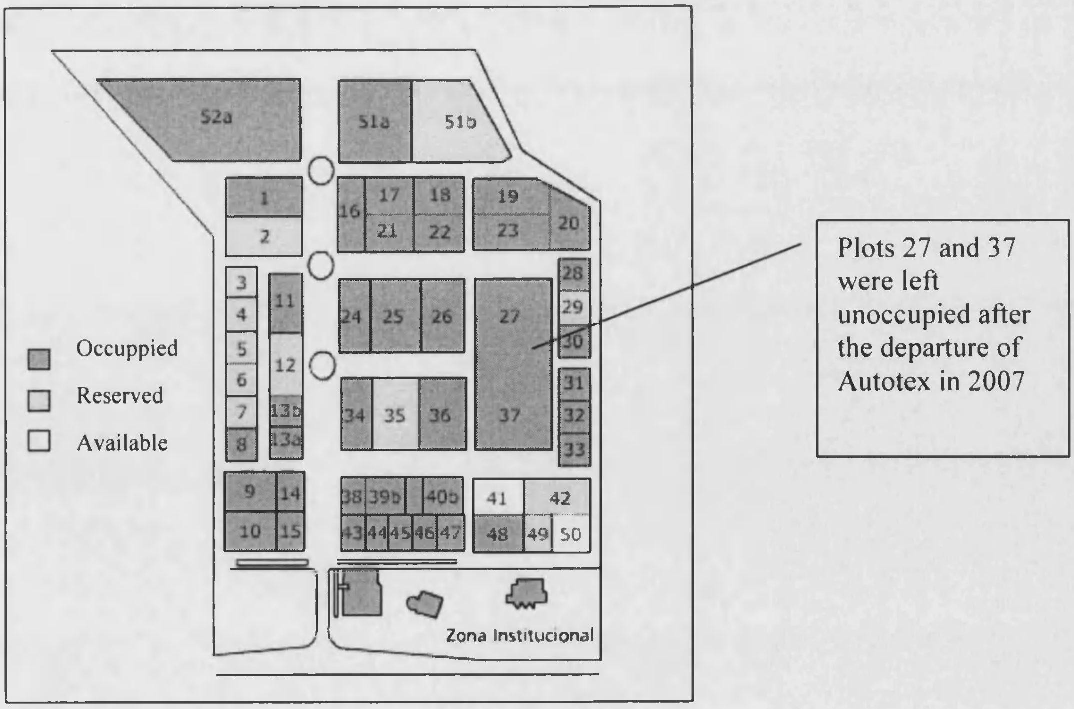


Figure 5-7: Occupancy of PTA space in May 2006

5.7.2 Tenants' technology and knowledge intensity

More critical for the assessment of the Parks' real STP character is the actual technological intensity of their tenants. The sectoral composition, the R&D and innovative content (inputs and outputs) and the activities brought inside the Parks' space were examined and used to assess whether the Parks are real high tech spaces.

5.7.2.1 Sectoral analysis

Over 60% of both Parks' firms belong to sectors with a high-technology or knowledge-intensive character, following the classification and the categorisation provided by OECD (1997). Informatics, telecommunications and engineering/technical services represent the most sizeable groups in both STPs. The majority are small firms (<25 employees) that focus on customised software applications, internet/telecommunication business services, data processing and other computer-based business services. Another important group are the engineering services firms, with relatively few established companies (>50 employees) and many more very small firms (<10 employees) with a very broad range of specialisation from construction to transport and aerospace. Alongside these two main groups, in Cartuja93 a small number of firms in technology intensive areas such as biotechnology, medical technologies/services, environmental and energy technologies are also present.

PTA also hosts a number (fourteen) of manufacturing sector tenants. Less than half (six) are in high and medium high technology sectors that include electrical machinery and equipment, scientific equipment and pharmaceuticals production units. Next to these, however, are also units of firms in the low or medium-low technological intensity textiles, rubber or plastics production sectors.

In Cartuja93, where large scale manufacturing activity is not permitted, there is also an important number (over 35) of other advanced services firms that include business consulting, marketing, financial intermediation, accounting and legal counselling firms. Firms in the creative industries sectors of media and communications were also present, namely offices of local, regional and national newspapers and radio/TV broadcasting stations (e.g. ABC Seville, Antenna Radio, Diario AS, RTVE). Their suitability for the Park appears questionable. The technical manager of Cartuja93 S.A. stated that "the presence of the radio and TV stations inside the Park cannot be considered as the most fitting..." although he added that "...their interest and willingness to locate in the Cartuja highlights the attractiveness of the Park area..." (Benjumea, interview, 2006).

However, greater criticism is directed towards the important concentration of firms and organisations in sectors with a very clear absence of knowledge and innovation creation character (see Table 5-14). Restaurants, transport services, business associations, distribution and retail centres are present in numbers that do not fit with the Park's character. In Cartuja93 they comprise close to 40% of the total number of tenants, although their weight in total employment and economic activity is around 15% and 10% respectively and is decreasing over time (IAT, 2005). In the PTA, around 35% are less-technology intensive firms that, besides the low-tech manufacturing units, include tourist agencies, commercial/sales/distribution units and other non-knowledge based services. Cartuja93 also hosts a high number (eighteen) of public agencies and other regional and local administration services units that occupy some of the largest Park buildings. While some are closely related to innovation (e.g. the regional ministries of economy, innovation and science and education), agencies responsible for transport or tourism or a large police unit can also be found. For the managers of the Parks, the above entities provide support services to the Park's tenants (Gil, interview, 2006; Pola, interview, 2005). However, their increased presence is at the cost of reducing the space available for other, possibly more advanced uses/activities.

Table 5-14: Distribution of STPs' firms by activity sector

PTA			Cartuja93		
Sector	**N**	**%**	**Sector**	**N**	**%**
ICT	25		ICT	57	
Engineering/technical services	35		Engineering/technical services	36	
High + medium high tech manufacturing	6[174]		Medical/pharmaceutical	6	
Education/training	1		Biotech/agro-food	6	
			Energy + Environment	17	
			Management consulting	19	
			Media/communication	14	
			Education/training	14	
Firms in high-tech sectors	**67**	**65**	**Firms in high-tech sectors**	**169**	**61**
Low and medium-low tech manufacturing	8[175]				
Wholesale/retail	8		Wholesale/retail	10	
Public administration	2		Public administration	18	
Other services	18		Other services	81	
Firms in non-technology sectors	**36**	**35**	**Firms in non-tech sectors**	**109**	**39**
Total	**103**	**100**	**Total tenants**	**278**	**100**

Source: Cartuja93 (2004), IDEPA (2006a) and own elaboration

5.7.2.2 Activities and knowledge intensity of Park tenants

The results of the survey among the technology related firms (i.e. not including firms in basic services sectors) provided information concerning the type of activities developed inside the Park and their knowledge and innovation intensity. A comparison of the two cases reveals some important differences.

Only 24% of PTA respondents stated R&D as one of the important activities developed in their Park's premises, and only a little more than half of Cartuja93 (see Table 5-15). This is combined with the important share (36%) of the PTA firms that referred to the dominant role as sales/distribution activities, almost double that of Cartuja93. It illustrates that, in many cases, PTA tenants are characterised as high-tech solely based on their sectoral

[174] Pharmaceuticals (1), chemicals(1), medical equipment (1), electrical (1), transport (1), other machinery equipment (1)
[175] Textiles (2), Plastic (2), Printing/publishing (2), Recycling (1), Metal processing (1)

classification; this applies even if they are sales units or regional delegations. It is a practice that is also present in the Cartuja93 Park, albeit at lower levels.

In many other respects, the Parks' profiles are quite similar. Close to 40% of respondents in both Parks are focused on software development. Even more, 64% of the firms in the PTA and 74% in Cartuja93, gave high priority to consultancy/testing related activities, including firms in ICT informatics, the engineering and technical services and the business/management consulting firms. Product design activities were mentioned by a smaller number. Production activities are limited in both cases, although in the case of PTA, the survey does not capture the activities of an important number of manufacturing sector firms.

Table 5-15: Main activities of STPs sample firms (% of firms stating as one of the 3 most important)

	Cartuja93		PTA	
	No.	**%**	**No.**	**%**
Consultancy/analysis/testing	20	74	16	64
R&D	12	44	6	24
Software development	10	37	10	40
Sales/distribution	6	22	9	36
Product design/engineering	5	18.5	6	24
Other	5	18	2	8
Production/manufacturing	3	11	2	8
No response	0		3	
n	27		28	

Source: survey results –numbers do not add up to 100% as firms could mention up to 3 activities

Examining the R&D intensity of these firms, around 66% of tenants stated the presence of R&D dedicated personnel and expenditure (see Table 5-16). For about half of them, the shares of R&D in employment and expenditure were above 5%, at levels above the national average for firms with innovative activities (4.9% in 2003) (INE, 2006c)[176]. The differences between the two cases are limited, although there is also a possible role of firm size.

[176] The recently published IAT 2005 study found that, among the advanced technology sectors, 21% of personnel is dedicated to R&D activity, with an average share of 28% of total expenditure (IAT, 2005).

Cartuja93 respondents included a greater share of firms with more than 50 employees (30% against 7% in the PTA) so R&D intensity was rather expectedly smaller in relative terms. Possibly reflecting differences in the quality of R&D, close to 40% of Cartuja93 tenants stated participation in public, national and EU R&D projects; however, PTA firms are primarily limited to the less competitive regional support programmes.

Table 5-16: STPs' tenants R&D inputs

		CARTUJA93		PT ASTURIAS	
		No.	%	No.	%
% of total employees participating in R&D activities	0	9	33.3	7	29.2
	1-5	5	18.5	3	12.5
	6-10	3	11.1	3	12.5
	11-20	3	11.1	0	0.0
	21-40	2	7.4	8	33.3
	>40	5	18.5	3	12.5
	Total	27	100	24	100
	No response	0		4	
RD expenditure (% of sales)	0	10	37.0	7	30.4
	1-5	8	29.6	3	13.4
	6-10	2	7.4	4	17.4
	11-20	1	3.7	4	17.4
	21-40	2	7.4	3	13.4
	>40	4	14.8	2	8.7
	Total	27	100	23	100
	No responses	0		5	
Participated in public R&D programmes [177]	No	14	52	16	64
	Regional	10	38	8	32
	National	10	38	1	5
	EU	10	38	0	0
	No response	0		3	
n		**27**		**28**	

Source: survey

The firms' innovation record (Table 5-17) illustrates the presence of additional differences between the two cases. More than half of the firms in the two Parks introduced a new product or service (radical innovation) during the last three years; 60% in the PTA and close to 70% in Cartuja93. However, PTA tenants appear to have a greater propensity

[177] More than one answer was possible.

towards incremental innovation (improved products and processes), in contrast to Cartuja93. Compared to the national average of 30% of innovative firms in 2004(INE, 2006c), the two Parks concentrated higher shares of firms with a propensity towards innovation. Furthermore, for more than 40% of both Parks' tenants, innovative (new or improved) products contributed more than 25% of their total sales, which is the national average for innovative firms[178]. Where the difference is more obvious is in the patenting activity of the two Parks' tenants. Only two Asturian firms stated applications for patents or other IPR protection during the last three years, while more than 33% of firms in Cartuja93 referred to patenting activity.

Table 5-17: Innovative outputs (firms reporting)

		CARTUJA93		PT ASTURIAS	
		No.	%	No.	%
New products/services introduced during the last three years	No	8	30.8	10	41.7
	Yes	18	69.2	14	58.3
	No response	1		4	
Improved products/services introduced during the last three years	No	13	52.0	9	37.5
	Yes	12	48.0	15	62.5
	No response	2		4	
Share of new/improved products in total sales	0	4	15.4	6	25
	<25	11	42.3	8	33.3
	25-50	6	23.1	6	25
	>50	5	19.2	3	19.7
	No response	1		4	
Filed for patents or other IPR during the last years	No	17	65.4	22	91.7
	Yes	9	34.6	2	8.3
	No response	1		6	
n		**27**		**28**	

Source: survey, own elaboration

5.7.2.3 Flagship tenants

While both Parks are dominated by small firms, the presence and the characteristics of a few large tenants, those that the Cartuja93 manager called "the engines of the park"

[178]The national average is 12% and 24% for innovative companies (Hytti and Mäki, 2006)

(Angeles Gil, interview, 2006)[179], have particular importance for the technology intensity of the two STPs.

In Asturias Park, the management (Pola, interview, 2005) made reference to two important manufacturing units, Autotex Airbag (a subsidiary unit of American firm Milliken manufacturing airbags) and Ervisa (subsidiary of a Spanish firm that produces plastic films). A third firm is STR España that manufactures encapsulant polymers for solar panels (see Table 5-18)[180]. Reflecting the focus of the Park's promoters on production activities, these units are production/assembly units based on technological advanced equipment and processes. R&D and technological development is absent, taking place primarily in the companies' headquarters. In ERVISA there are, according to its own director, ongoing projects for the improvement of the existing production processes (IDEPA, 2003). In Autotex, most of the 206 employees were semi-skilled workers, with less than 5% holding engineering/science degrees administrating the production process and the necessary quality control (IDEPA, 2002a). Autotex focused on assembly for exporting to the European market and did not appear to have any connections with the local supply chain (IDEPA, 2002a). Besides their size and capital investment, the above units have few differences from those operating in the adjacent industrial Parks. According to the regional industry representative "...these companies are very interesting for the Asturias economy, but they do not have any high-technology content, nor any important R&D activity and could be located in another site in the region " (Gonzalez, interview, 20/10/2005).

More positive examples with a higher level of technology character include the foreign Fluor and Phoenix Company and some local-origin firms. The first, a subsidiary of the

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[179] The expression used in Spanish was "empresas tractoras"

[180] None of the three wanted to participate in the survey. As a result, the information provided here is based on secondary sources.

American firm Fluor Daniel, is a specialised engineering consulting firm that covers a wide range of sectors, providing support to the construction, operation and maintenance of large scale projects and industrial units. It came to the region in 1996 to support the operation of the DuPont plant established a few years earlier, but extended its operation to the Spanish market; 40% of its employees were stated as participating in projects with an R&D element. Phoenix Contact is a joint venture of a local firm (Temper) with a German firm (Phoenix) and focuses on design, production and distribution of electrical components and machinery, with more than 20% of the Park-based employees occupied in R&D related activities and a sizeable research budget. There are also a few local firms with R&D activity and innovative character in engineering services (Ingenieros), pharmaceuticals (Tecsoplar, Laboratoris Kiove) and electrical equipment production.

Table 5-18: Profile of main manufacturing companies in the PTA

Firm	Sector of firms and activity in Park	Origin	Located in Park	Employees in Park[181]	Turnover (million €s)	R&D intensity[182]
Fluor*	Engineering consultancy Consulting activity	USA	1996	85		S: - E: >40%
Normalux	Lighting equipment Design and production	Local	1996	50	6-30	YES
Modital/Rinachenti	Female apparel Design, production and distribution	Local	2000	58	n.d.	NO
Autotex Airbag	Manufacture of airbags Production	USA	2001	206	n.d.	NO
ERVISA	Manufacture of plastic film Production	Spain	2002	54	6-30	NO
STR España	Manufacturing of encapsulants for photovoltaic cells Production	USA	2002	54[183]	6-30	NO
Ingenieros acesores*	Environmental consultancy R&D and	Local	2002	112	6-30	S: 6-10% E: 6-10%.

[181] Latest year available
[182] S: R&D expenditure as % of sales, E: % personnel occupied in R&D activities
[183] In a very recent development (2008), STR decided to extend its production and bought the plant that was empty since 2007 from Autotex. The new unit will duplicate its production and add 65 employees

Firm	Sector of firms and activity in Park	Origin	Located in Park	Employees in Park[181]	Turnover (million €s)	R&D intensity[182]
	consultancy					
Tecsolpar*	Medical/parenteral solutions and devices R&D and production	Local	2002[184]	10[185]	n.d.	S: 20-40% E: 1-5%
Phoenix contact*	Electronics and automation systems R&D, product design, production and distribution	Germany	2003	48	n.d.	S: 6-10% E: 21-40%

Sources: survey, companies' websites, IDEPA business directory *: participated in the survey

In comparison, Cartuja93 hosts a number of relatively large firms in the engineering/technical services and ICT sectors, with high levels of knowledge and technological intensity, new products or services development and performance levels above the average of their sector[186](see Table 5-19). All are local origin firms that were created during the 1980s, that had experienced significant growth before their establishment in the Park and had diversified to other related activities/sectors through more than 30 new subsidiaries. Inerco, Tecnologica, MacPuarsa, Detea, Clever, Ayesa or the public-owned firms Sadiel, EGMASA, naming only some, occupy the high-design and profile buildings, hosting headquarters and administration functions, but also engineering services, R&D laboratories and product development units. Altogether, they employ a minimum of 2,000 employees, a sizeable share of the Park's activity, and the potential for the creation of linkages with firms and research organisations is clearly greater than Asturias Park's firms.

[184] The unit started operating at the beginning of 2006

[185] The projected number for the end of 2006 was for 60 employees with the unit in full operation (Gallinar, interview, 06/03/2006)

[186] Sadiel was included in the 500 more dynamic and entrepreneurial European companies in 2004 (BusinessWeek, 2005), INERCO, MacPuarsa and EGMASA leader companies (sales size) in the region and AYESA as one of the fastest growing companies in Andalusia (Analistas Economicos, 2006).

Table 5-19: Profile of selected companies in Cartuja93

Name (firms in group)	Sector and activity in the Park	Origin	Located in Park	Employees in Park	R&D activity
Tecnológica*	Engineering services and quality assessment for space industry components Headquarters, technical, R&D unit	Local	1993	70	10-20% sales 10-20% pers.
Grupo Ayesa (4)	Engineering, construction, ICT, energy Headquarters, R&D, consulting, product develop.	Local	1994	No data for Park unit (total 550)	
EGMASA*	Environmental engineering services/construction Adminstration, R&D	Local	1994	600	<1% sales 1-5% pers.
Sadiel* (5)	Business ICT applications Headquarters, technical, R&D unit, sales	Local	1997	712	1-5% sales 1-5% pers.
Grupo Detea* (6)	Construction, real estate, energy production/distribution, environment and agriculture services Headquarters, technical and R&D unit	Local	1999	300	1-5% sales 10-20% pers.
Inerco* (3)	Industrial engineering, energy, environment, industrial safety Headquarters, technical, R&D unit	Local	2000	200	6-10% sales 10-20% pers.
MacPuarsa (4)	Elevator manufacturing, construction, environment, ICT consultancy Headquarters, technical, R&D unit	Local	2000	No data for park unit (total of firm 573)	1-5% sales 1-5% pers.
VEIASA*	Inspection and industrial control, metrology Administration and consulting, control laboratory	Local	2000	55	<1% sales <1% pers.
Grupo Clever* (2)	Technology business services Headquarters, Product develop.	Local	2004	150	1-5% sales 6-10% pers.
Endesa Ingenieria*	Engineering /technical services Administration, consulting	Subsidiary of Madrid based firm	2004	120	1-5% sales [187] 6-10% pers.

Source: survey, companies' websites, Cartuja93 tenants' directory *: firms included in the survey

5.7.2.4 Conclusion

To summarise, there is a rather mixed picture concerning whether the Parks' tenants' technological intensity justifies the reservations and critiques of local experts (Palma, interview, 2006) and researchers (Ondategui, 2001). A significant part of the Parks' space was dedicated to firms with no innovative capacity as the Parks struggled to fill their plots

[187] The R&D unit of the firm is outside the park in a centre of the University of Seville

due to the managers applying the admission criteria in a flexible manner. Nevertheless, also it is possible to find knowledge intensive firms, mainly in the services sector, which fit with the high-tech area profile, that are active in new product and services development and that invest in research or development activity. In comparison, Cartuja93 clearly has a higher share of such firms and represents a stronger base for the development of synergies and cooperation.

5.7.3 Entrepreneurial activity and NTBFs' creation

While large companies can (potentially) operate as anchor tenants, together with research organisations, the creation and operation of new technology based firms (start-ups and spin-offs) represents an equally important element of the most dynamic part of the Parks' operation.

5.7.3.1 PTA and CEEI incubator

In the PTA, there are currently 25 firms (28% of the total) that started their operation inside the Park area (start-up firms) and the CEEI incubator is the main location where new firms are created. The CEEI incubator's performance has been so far one of the most positive elements of the Park. In the period prior to 2002, 71 new companies had operated in it and by 2005 (IDEPA, 2002c) that number had reached a total of 100 (Menendez, interview, 04/10/2005)[188], an average graduation rate of slightly less than ten firms/unit. Around 70% of CEEI tenants in 2005 were start-up firms, with the remainder being either subsidiary units, delegations or offices of associations[189]. According to the CEEI data, the survival

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[188] More recent data increased that to 150 new companies in thirteen years (CEEI, 2007)

[189] ACEPPA (Association of Public Business Centres of Asturias is established in CEEI), APIA (Federation of Industrial Poligonos of Asturias) .

rate[190] among the graduating firms was close to 65%, below the EU benchmark of 85% (EC, 2002), but 19% above the survival rate for new firms in Spain (CEEI, 2006).

As in the Park more generally, the majority of the 22 tenants belonged to the ICT (45%) and engineering/technical services (32%) sectors. Table 5-20 presents the profile of the eight CEEI tenants that could be considered to be characteristic of the type of firms targeted by CEEI directors (Menendez, interview, 2005). In the majority, they are firms of an innovative and knowledge intensive character, although there are also examples of standardised services of unclear technology orientation. Most of them are recently created (<3 years) although there are also examples such as Asturnet operating in the CEEI far beyond the five years deadline. In the period 2005-2007, more than 60% of the firms moved out of the Park (CEEI, 2005; PT Asturias, 2007). Firms' founders are, in all cases, skilled individuals with a high (tertiary) education level and with previous professional experience. Academic or research spin-offs, however, have been completely absent in either CEEI and or the Park more generally throughout the period.

Table 5-20: CEEI tenants' profile

Company	Sector and main activities	Type	Est. year	Empl. (last year)	Sales Growth	R&D[191] intensity	Innovative results (last 3 years)
Asturnet	Internet services R&D, Software, consultancy	Unit of local firm	1995	8	11-20%	S: >40% E: >40%	New/improved products Patents
Isotelco	ICT systems - Systems installation /technical support	New firm	2002	2	11-20%	NO	NO
Alamo Systems	Informatics - Data protection systems R&D, Software, Consultancy	Unit of local firm	2004	4	11-20%	S: >40% E: >40%	New/improved products Patents
Isastur servicios	Electrical installations Engineering services Consultancy	Unit of local firm	2005	20		S: 2-5% E: 2-5%	New/improved products

190 Firms operating after five years from graduation.
191 P: personnel S: sales

Company	Sector and main activities	Type	Est. year	Empl. (last year)	Sales Growth	R&D[191] intensity	Innovative results (last 3 years)
Firm A[192]	Industrial design R&D, Product design, Software, Consultancy	New firm	2006	5		S: >40% E: >40%	New/improved products Patents
Selegna Design	Industrial design Product design	New firm	2006	2		S: >40% E: >40%	New products
Imagine800	Multimedia applications for mobile telephony Software design, Consulting/testing	New firm	2006	3	>40%		New/improved product
E-Prozes	Business services Consulting/Testing	New firm	2007	2	n.a.	S: >40% E:21-40%	New product

Source: survey and own elaboration

Besides the incubator tenants, the activity of CEEI employees outside the Park's space has led to an important and increasing number of entrepreneurial initiatives/projects; from 209 in 1995 to over 370 in 2004 (IDEPA, 1995-2004). Technology based projects are not exclusively targeted (less than 20%) although there has been a small number (less than ten) of spin-offs from the local PRTOs. In total, there is an annual firm creation rate of 20 to 30 new companies, of which around 50% are technology-based/innovative firms(IDEPA, 1995-2004). Only a couple of them moved into the Park space. Generally, the Park has benefited very little from this new firm creation process. While one of the objectives of the creation of the Centro Elena buildings was to accommodate projects that graduated from CEEI (Quintamobilis, 2007), there have been no such example so far (Mendendez,interview,2005). The CEEI incubation function remains disassociated from the Park and has not contributed to its renewal or acted as an extension of its activity.

5.7.3.2 Cartuja93

In Cartuja93 Park, the absence of an incubation scheme reflects the limited priority placed upon this function. Nevertheless, the Park's director referred to the presence of "many start-

[192] Questionnaire filled in electronically and no name was provided

ups" (Gill, interview, 2006). According to the 2005 study of IAT (2005), 28% of the total tenants (around 90 firms) were newly created firms. Of these 90 firms, 21 firms were in the basic services sectors. The remaining 69 businesses included start-up and spin-off firms, but also 24 subsidiary units of the larger companies operating in the Park.

This latter group does not represent genuine entrepreneurial activity. They can be classified as restructuring-driven corporate spin-offs (Antoncic and Hisrich, 2003) initiated by the parent companies in a top-down form, as a result of their organic growth, their diversification strategy or the reorganisation of their operational structure. In all cases, the parent companies have maintained full control. The entrepreneurial or even intrapreneurial element was rather limited.

The independent start-up firms are spread throughout the various Park offices and do not receive any incubation support. The only space with a more explicit focus on new technology-based firms is the central pavilion (Pabellon de Italia), with twelve of its 35 tenants being new firms in 2004 (Cartuja93, 2004). Among the start-ups, only a few fitted the definition of a technology based firm. They included three research spin-off firms from local public research organisations (AnaFocus, Ingeniatrics and Biomedal), one second generation spin-off, Neocotex, and one corporate spin-off/joint-venture (CASSFA). Initiated by researchers and academics, they all have a very high knowledge intensive character and are in the frontier of technology in their respective areas (see Table 5-21). They hold patents and have developed a series of new products, achieving positive growth rates and showing great dynamism. Anafocus was backed by a venture capital firm for its expansion and was included in the list of the 100 most innovative firms of Red Herring magazine (CORDIS, 2006). Biomedal, Ingeniatrics and Neocodex were created by the same team of researchers in the University of Seville and Pablo de Olavide and share R&D

facilities and personnel. Both Neocodex and Anafocus have already established new units in the United States. CASSFA is a joint venture of eleven firms of the ICT sector (three from inside the Park) that performs R&D, develops new products based on open source software and provides services and training.

Table 5-21: Spin-off companies operating in Cartuja93

Name	Activity	Created	Parent organization	Person. (2005)	Growth	R&D intensity	Results
Anafocus	Microelectronics – Develop analog and mixed signal circuits R&D	2000	Institute of Microele-ctronics of Seville	24	S: >40%	S:>40% E:>40%	New/impr. products/ processes Patents
Ingenia-trics	Biotechnology machinery and equipment R&D/Small scale production	2000	University of Seville	5	S:>40%	S:>40% E:>40%	New/impr. products/ processes Patents
Biomedal	Molecular/cellular tool development Consulting/testing[193]	2002	University of Seville	15	S:11-20%	S: 20-40% E: >40%	New/impr. products/ processes Patents
Neocodex	Biomedical research / DNA data banks R&D Testing/analysis	2002	Biomedal	11		S:>40% E:>40%	New/impr. products/ processes Patents
CASSFA	Open software development R&D and software development Testing/analysis	2002	11 firms (3 in the Park)	30	S:>30	S: >40% E:21-40%	New/impr. products/ processes

Source: survey and own elaboration

Despite these few exceptional cases, the overall record of Cartuja93 in entrepreneurship and NTBFs' creation is limited. The absence of the dedicated incubation support mechanisms is one of the main weaknesses of Cartuja93, according to the director of OTRI of the University of Seville (Delgado, interview 2006) and of AICIA (RC93-1)[194]. It is a missing element recognised by the Park management (Gil, interview, 2006) that plan to address it with the creation of a pre-incubation and incubation facility.

[193] Biomedal main R&D activity takes place in the university laboratory outside the park area.
[194] The engineering school has created 8 spin-offs, all of them operating outside the park area.

5.7.4 Linkages, cooperation and synergies development in the Parks

This section focuses on the linkages and synergies developed inside the Parks. It examines the presence and character of customer-supplier relationships, labour mobility and innovation linkages in order to assess the presence, character and intensity of interactions inside the Parks' space and identify the main sources of knowledge and technology for the Parks' tenants.

5.7.4.1 Market based relationships – focus on the regional market

For the great majority of respondents (>80%), the Park have limited weight on the location of their customer and supplier base (Table 5-22). The great majority of the firms focus on their respective regional markets, with over 75% preferring local customers and a similarly high number (over 70%) favouring local suppliers. This dominance of the local/regional markets is a result of the increased shares that services firms have in both STPs. The great majority of firms with consulting activity placed a (90%) moderate to very high weighting on the local markets. Proximity to customers has particular importance/relevance, but parameters such as firm size or innovative intensity did not appear to play any role[195].

The main difference between the two cases lies in the role of the non-local markets. Asturias firms are limited to the national boundaries. Around 60% of them suggested that their Spanish customers are important in terms of total sales, but only 16% referred to an important share of foreign markets. This is only the focus of a few manufacturing units which, according to the secondary sources, have a strong export orientation (over 50% of total production), but only limited use of the domestic input supply (IDEPA, 2002a; 2003). On the contrary, 33% of Cartuja93 tenants suggested an important/export orientation,

[195] None of them produced statistically significant results

including some of the most dynamic and technology oriented tenants, spin-offs such as Anafocus, Biomedal and Ingeniatrics or the large flagship tenants like Tecnologica, Inerco or MacPuarsa. The greatest part (77%) of these export-oriented firms also placed a high weight on international suppliers. They are firms with an evident international orientation.

Table 5-22: Location of STPs' tenants' customers and suppliers (% of STPs' firms stating medium to very high weight on their total sales and purchases)

	Cartuja93 (n=27)			
	Park	**Region**	**Spain**	**International**
Customers	22	77	48	33
Suppliers	15	70	74	45
	PTA (n=24)			
	Park	**Region**	**Spain**	**International**
Customers	16	84	60	16
Suppliers	16	76	72	24

Source: survey and own elaboration

5.7.4.2 Skilled labour sources and mobility

Human capital plays an important role in the firms' innovative activity. More than 60% of the survey respondents (56% in Cartuja93 and 62% in Asturias) considered that the hiring of personnel and/or training represent an important source for technology upgrade and innovation creation. However, the Parks' space contribution to the provision of this critical input appeared limited. Only four firms in Cartuja93 and one in Asturias Park referred to the hiring of a significant proportion (>25%) of the total number of new R&D and management employees as coming from the Park area (Table 5-23), meaning very limited labour mobility, while the overall added-value of the Parks in terms of access to qualified workforce was in both cases considered to be rather low (Table 5-24)[196].

This limited role of the Parks' environment did not seem to be a particular problem for the firms' access to skilled labour. The broader local environment was suggested as supportive for the identification of skilled employees. Both Asturias and Andalusia covered the largest

[196] 38% said that there was no added value at all and another 29% opined that it was very low.

share (>50%) of the recently hired employees in R&D and management positions and, although the quality of the regional education systems were considered average, the availability of labour was seen as satisfactory for the firms' operation.

Table 5-23: Source of R&D and management labour for STPs' tenants

	PTA		Cartuja93	
	No.	**%**	**No.**	**%**
Park	1	4	4	15
Region	12	50	19	70
Spain	5	21	7	26
Foreign	2	8	1	4
No response	4		0	
n	28		27	

Source: survey (Firms identifying location as origin for more than 25% of R&D and/or management personnel hired during the last three years)

Table 5-24: Assessment of skilled-labour sources (% of respondents stating)

	PTA		Cartuja93	
	Not apply/ No opinión	3-5	Not apply/ No opinión	3-5
Park as source of skilled-labour	45	21	38	27
Quality of regional education system	0	74	4	68
Availability of skilled labour in the region	0	91	0	80
No response	4		0	
n	28		27	

Source: survey (Firms responded from 1 – very low/weak to 5 – very high/strong or No opinion)

5.7.4.3 Linkages, knowledge flows and innovation cooperation

Turning to the analysis of the Parks' tenants' interactions, the researcher examined the formal and informal linkages of the tenants at various different spatial scales and also asked firms to identify the parameters that most affect or obstruct the development of linkages and partnerships.

5.7.4.3.1 Public research organisations and technology transfer

ITMA, the only technology organisation in the Asturias Park, appeared almost completely isolated from the remaining Park entities, with no reference to formal or informal cooperation with Park tenants during the last three years (see Table 5-25). The main reason suggested is the limited overlap of their activities with those of ITMA. Nevertheless, ITMA has strong linkages in the region and exchanges knowledge and participates in cooperation networks (e.g. Club Asturiano de Innovacion). It is connected with the University of Oviedo's relevant laboratories in both formal (joint R&D projects) and less formal ways (use of equipment, technology services or exchange of personnel) and also has some linkages with regional and Spanish firms. While, in many cases, cooperation flows in one direction via use of testing facilities and certifications, exchange of personnel (training) and other technology services for small and medium size enterprises, there are also interactive linkages in the form of joint R&D. At the international level, ITMA connections have been very limited, with no participation in European projects; they only recently started participating in a few European technology platform projects.

Table 5-25: Importance of different partners of ITMA in innovation cooperation according to location

	Park	Region	Spain	International
Universities	-	5	5	-
PRTOs	-	5	5	-
Clients	-	5	5	-
Providers	-	1	1	-
Experts/Consultants	-	1	1	-
Intermediary organisations	-	4	4	-

Source: survey (-: not exist, 1:very low importance, 5: very high importance)

With regards to Cartuja93, eight of the nine PRTOs that participated in the survey claimed that cooperation with other partners and participation in innovation networks represented an important source of knowledge creation and technological capacity building (see Table 5-26). Universities and research units were given a very high value/weight, while those for firms varied significantly. The four CSIC research institutes that give priority to basic research stated a limited role of contacts with industry, primarily at a national and international scale. Park based linkages were documented by two of them (IIQ and CNA), but they were of limited importance. Even more isolated was the IPTS. The direct reference to the EU commission and control for almost all contracts and cooperation activities is a barrier to significant local and park-based interaction (RC93-6). On the contrary, AICIA, the engineering school and (less so) CITAGRO referred to a strong partnership base inside the Park as part of their extensive regional connections. An AICIA representative suggested that the Park space has gradually assumed a more important weight in its partnership base as the number of tenants increases.

Overall, the Cartuja93 PRTOs have linkages inside the Park in parallel with their more developed external ones. R&D contracts with other PRTOs, and less so with firms, are the most common type (usually through participation in publicly funded R&D projects), followed by informal linkages such as personnel exchange, use of installations/equipment and provision of technology services.

Table 5-26: Linkages of Cartuja93's PRTOs by partner type, location and form (numbers represent type of linkage[197], - represent no linkages stated)

	Linkages with PRTOs				Linkages with firms			
	In park	In region	In Spain	Int'l	In park	In region	In Spain	Int'l
ICMS	1	1,4	1,3,4,5	1,3,5	1,4	1,6	1,6,7,8	1,3,6,7,8
CENTRE	1	1,5	1, 5	-	-	1	1	1
AICIA	1,3,4,5	1,3,5	1,3,5	1,3,5	1,3,4,5,6,7	1,5,7	1,5	1,5
IAT	4	1,2,3,4,5	1,4	4	4,5,8	1,3,4,8	4,5,8	5,6,8
IIQ	1,3,5	1,3,5	1,2,3,4,5	1,2,3,4,5	2,5	2,5	1,2,3,4,5,6	1,2,3,4,5
IPTS	4	3	1,3,	1,3	-	-	-	-
IBVF	1,4	1,3,4	1,3,4	1,3,4	2,4,6,8	1,2,8	-	-
CNA	1,5	1,3,4,5	1,3,4,5	1,5	-	-	1,4,7	-
CITAGRO	1,5	1,3,4,5	1	1	1,4,5,7,8	1,3,5,6,8	1	8

Source: survey

5.7.4.3.2 Firms' linkages

Concerning inter-firm cooperation (Table 5-27), a little more than half of Cartuja93's tenants stated the presence of important partnerships with universities and R&D centres, a level similar to that found in other STP studies (Phillimore, 1999; Vedovello, 2000), but 20% lower than the result reported in the IAT study for Cartuja93 (IAT, 2005). On the other hand, among the PTA tenants, less that 25% referred to PRTOs as important partners

[197] PRTOs linkages: 1 - Joint R&D projects, 2 - Joint Venture, 3 - Provision of tech.services, 4 --Exchange of R&D personnel, 5 - Use of facilities/equipment
Firm linkages: 1 - R&D contracts, 2 - Licensing of R&D results, 3 - Technology services, 4 - Use of equipment, 5 - Information on R&D activity, 6 - Exchange of researchers, 7 - Training of personnel, 8 - Personal/social relations

in innovation cooperation. Their innovation partners are more often firms (suppliers and occasionally customers), while subsidiary units refer to the linkages with other units of the firm. The role of firms' clients and of other firm units is also highlighted in Cartuja93 Park, although connections with suppliers are given a much more limited weighting.

Table 5-27: Innovation partners of Parks' firms– presence of cooperation and importance

	PTA			Cartuja93		
	YES	**Important**	**% of responses**	**YES**	**Important**	**% of responses**
Universities	10	6	24	18	13	52
R&D centres	8	6	24	15	14	56
Clients	12	7	32	19	13	52
Suppliers	13	9	41	13	5	20
Companies in same sector/competitors	11	6	27	9	5	20
Companies in same group	10	9	41	15	11	44
Experts/consultants	12	1	5	10	8	32
No response		6			2	
n		28			27	

Source: survey results (firms stating presence of cooperation and characterising partners as of medium, high or very high importance)

Firms were also asked to state the location of their important partners and the types of linkages and cooperation developed with PRTOs and other firms (clients, suppliers and competitors). The responses show that spatial scale and proximity play no apparent role in the development of innovation cooperation (see Table 5-28). In the PTA, as already recorded, there are no linkages with the PRTOs or ITMA; even among the firms, only two tenants referred to important linkages. The PTA space is clearly not a place of interaction or knowledge flows. All tenants' connections are directed outside the Park space. However, there are also a few firms that stated mainly informal linkages with local PRTOs such as training services and the hiring of students, and even fewer at the national scale (see Table 5-29), revealing a broader tendency of the PTA tenants.

Table 5-28: Location of important innovation partners (% of tenants stating)

	PTA	Cartuja93
n	28	27
Cooperation with PRTOs	%	%
- in Park	0%	33%
- in region	40%	52%
- in country	40%	38%
- foreign	0%	31%
No responses	3	0
Cooperation with other firms (clients, providers, competitors)		
- in Park	10%	19%
- in region	35%	44%
- in country	40%	54%
- foreign	70%	39%
No responses	3	0

Source: survey results

Table 5-29: Formal and informal linkages of Parks' firms (number of firms reporting)[198]

	With PRTOs		With firms	
	PTA	**Cartuja93**	**PTA**	**Cartuja93**
n	28	27	28	27
Formal linkages				
- in Park	-	5	1	7
- in region	-	12	5	6
- in country	2	9	3	10
No response				
Informal linkages				
- in Park	2	10	1	7
- in region	7	18	1	11
- in country	5	12	1	6
- foreign	2	10	2	4
No response	13	7	12	8

Source: survey

At the international scale, the responses do not reveal any particular intensity of linkages and connections. Some of the subsidiary units (Fluor, Phoenix, ECA) referred to joint R&D activity or joint production with the parent firms. Beyond that, secondary sources, i.e. the firms' websites, suggest the presence of "preferred partner" agreements with large/specialised national and multinational firms (e.g. Cisco, HP, Microsoft, Oracle,

198 Formal links with RO/HEIs include: research results licensing, R&D contracts, joint ventures, provision of technology services/consultancy Formal links with firms include: R&D contracts/projects, joint ventures, common production/subcontracting 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 Informal links with firms include: shared equipment, exchange of personnel, interpersonal relations

SAP). In this case, the PTA firms operate not only as distributors, but also as value added resellers or system integrators of the various technology platforms and business software applications.

In the case of Cartuja93, one out of three tenants reported the presence of an important partnership with one or more of the 34 PRTOs of the Park. These connections are present in parallel with those at the regional (the most common), national and international scale. Informal linkages, use of equipment, training or hiring of graduates, were mentioned by 50% of respondents, while formal linkages are less common, a result similar to that observed in other Park studies (Phillimore, 1999; Vedovello, 2000). Firm linkages were quite limited inside the Park area, only five firms mentioned them, but more (slightly less than 50%) referred to partners outside the Park space. At the regional scale, informal interactions, exchange of researchers, use of equipment, were quite common while, on the other hand, formal connections/linkages were more frequent at the national and international scale, based on participation in national and EU projects. Research spin-offs, large firms such as Inerco and Tecnologica and some of the foreign subsidiaries were the most active in these extra-regional cooperation linkages. The firms' websites also confirmed the presence of "preferred partner status" connections among ICT and engineering services firms, similar to those recorded in the PTA.

The above results suggest that, for the majority of firms, spatial proximity is not a critical element in the development of partnerships. The firms' responses on the factors inhibiting cooperation (Table 5-30) support this argument. Geographical distance was not seen as an important obstacle in the development of partnerships, as only two firms in both Parks referred to it. Nor did the respondents refer to the absence of own interest or competent/relevant firms. The focus was more on the cost of cooperation coordination, a parameter expected to be particularly important for smaller firms[199]. For the Cartuja93 tenants, the more important aspects were the absence of a cooperation culture and what the tenants' association director identified as a "lack of trust" (Gonzalez, J., interview, 2006).

Table 5-30: Obstacles in developing cooperation in R&D activities - % of respondents stating as important

	PTA		Cartuja93	
	No.	%	No.	%
Costs of coordination/cooperation	11	61%	10	43%
Absence of cooperation culture	7	39%	13	57%
No scheme to support cooperation	5	28%	5	24%
No interest from own firm	3	17%	2	9%
No interest from other firms	3	17%	3	13%
Absence of competent/possible partners	3	17%	3	13%
Geographical distance	0	0%	2	9%
No response	10		4	
n	28		27	

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

To conclude, while there is absence of almost any linkage, interaction and knowledge flow among the PTA tenants, there are a number of Cartuja93 tenants with developed linkages and connections. With more R&D intensive firms and a strong knowledge base, flows and synergies are present among some Cartuja93 tenants, even if these are far from being strongly developed. It is still clear that Park location and physical proximity do not have any particular role in building these connections. Broader scales inside the region or, in many cases, further beyond are usually of greater weight, especially for the most technology-oriented firms.

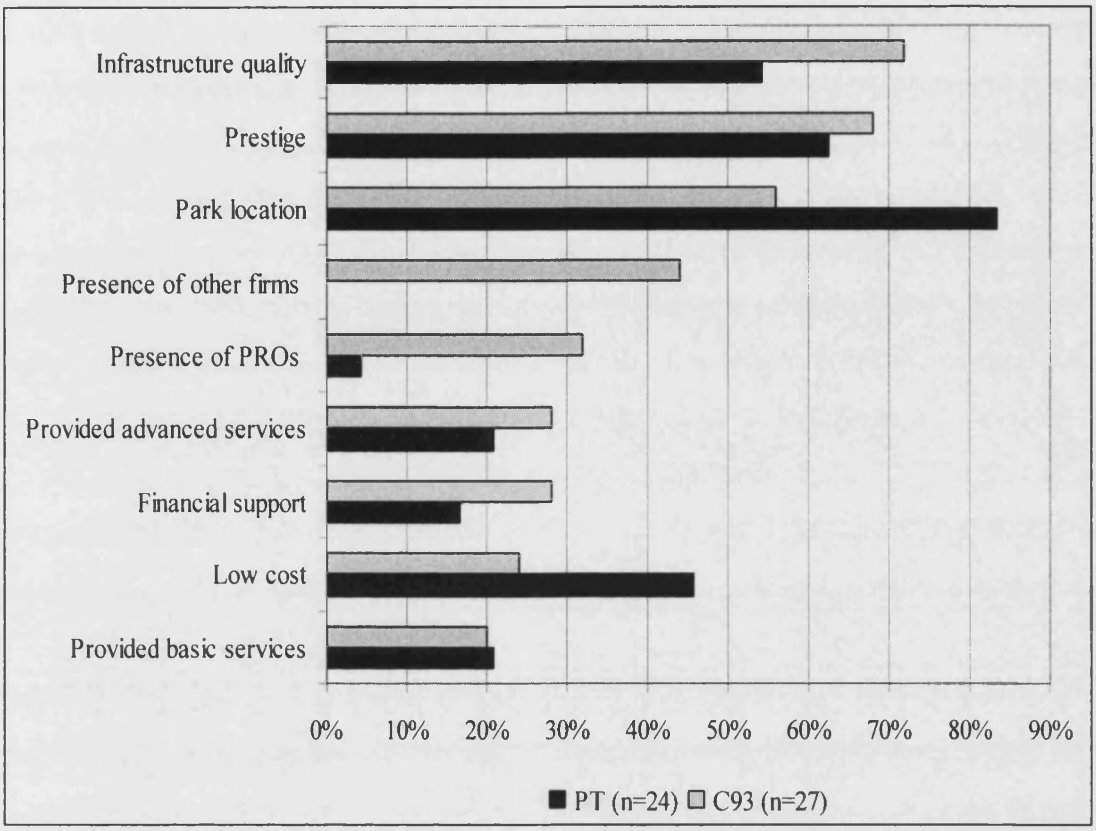
5.7.5 The role of STPs' tangible and intangible mechanisms

Turning to the role of the Parks' mechanisms, the tenants' responses concerning the reason for moving inside the Parks and the attraction elements for new and established companies are illuminating (see Figure 5-8). Similar to other studies in Spain (Guillermo, 2003) and

[199] The data are not as supportive. The responses from both Parks show that costs are an important constraint for 50% of firms with less than 25 employees and for 33% of firms with more than 25 employees.

elsewhere (e.g. Monck et al., 1988; Massey et al., 1992; Bakouros et al., 2002), the responses reveal that the Parks' tangible elements and the STP label/image are by far the most important drivers. More than 60% referred to the importance of the Parks' image and as much as 85% of PTA tenants mentioned the role of the Parks' central location. Quality infrastructure and low cost were mentioned by around half the respondents. Against this, intangible support parameters, including advanced services or even financing, were mentioned by no more than 20% of respondents in both cases.

The difference between the two Parks concerns the elements of potential cooperation and networking. In Cartuja93, 44% of respondents referred to the cooperation opportunities with other firms as an important reason for their location in the Park space, while around 33% mentioned the positive role of research organisations. The presence of other organisations also increases the attractiveness of Cartuja93. More than half (7/13) of the more recent entries (after 2001) referred to their expectation of cooperation, in comparison to 33% (4/14) of the older firms (before 2001). In contrast, cooperation or potential spillovers have been absent among both the older and the more recently entered firms in the PTA.



Source: survey results (firms could state a maximum of 5 reasons)

Figure 5-6: Main reasons for location in the Spanish Parks (% of respondents stating)

The assessment of the actual experience of the operation inside the Park verifies to only some extent the initially expected role of the infrastructure and prestige elements (see Table 5-31); 25% of the PTA tenants questioned the prestigious element of the Park label, while in both cases there were complaints concerning the quality of infrastructure and basic support services. In Cartuja93, the absence of parking space is a critical problem now that the Park attracts more than 25,000 employees, students and other visitors on a daily basis. In PTA, some firms complained about the absence of a reliable and frequent transport service.

Where the important differences lie is in the presence of partners (firms and PRTOs) and the development of a synergetic environment. Despite the few linkages recorded, a number of Cartuja93 tenants attached a positive role to this part of the Park's operation. Even firms that stated no cooperation referred to positive added-value, possibly linked to the easier access to supportive services. In the PTA, on the other hand, most tenants did not see any positive externalities derived from the presence of other firms or the ITMA in the Park.

Table 5-31: Added value received from different elements of the Park

	PTA				Cartuja93			
	N.A.	1-2	3	4-5	N.A.	1-2	3	3-5
Quality of infrastructure	2	6	7	9	2	6	7	11
Access to basic support services	3	7	5	9	5	8	9	4
Prestige of the Park	6	4	6	8	1	1	4	20
Financial support	6	9	5	4	9	10	2	5
Advanced business and technology services	8	11	2	3	6	10	6	4
Presence of synergetic atmosphere	6	10	7	1	8	4	4	10
Presence of research centres for cooperation	11	12	0	1	6	7	5	8
Presence of relevant firms for cooperation	9	12	3	0	5	8	10	3
Access to skilled personnel	7	12	5	0	11	8	3	4
No response		4				1		
n		28				27		

Source: survey (tenants were asked to assess the Parks' location and added-value, given a choice of 6 options: (not applicable, 1-very low, 2-low, 3-medium, 4-high, 5-very high)

Table 5-31 also reveals the common negative assessment of the advanced support services available to the Parks' tenants. A more detailed break-down of these services (see Table 5-32) shows that the majority of tenants give a negative or very negative assessment to almost all of them. With the exception of information provision/diffusion mechanisms, none of the other services appears to be effectively provided to the Parks' tenants. That includes support in business and management activities, the provision of the various types of technology transfer support or, even more critically, the promotion of partnerships and cooperation. However, a number of respondents (up to 33% in the PTA) have not used any of the above mechanisms either due to a lack of interest or reliance on other external mechanisms. The differences between the two cases are rather minor. In neither of the two Park spaces do the intangible elements of support and coordination play the role that the STP model describes.

Table 5-32: Level of satisfaction with support services offered in the Park

	PTA				Cartuja93			
	N.U.	1-2	3	4-5	N.U.	1-2	3	3-5
Information provision services	6	6	8	4	5	5	4	11
Business/management/marketing support	12	6	2	5	9	6	7	2
Support in participation in R&D projects	10	6	6	2	12	4	4	5
Technology transfer support	12	8	4	0	9	9	1	6
Support in innovation partnerships	12	7	4	1	9	9	2	5
No response		4				2		
n		28				27		

Source: survey (tenants had a choice among 7 options: not known, not used, 1-very low, 2-low, 3-medium, 4-high, 5-very high)

The above results are also similar in relation to the promotion of entrepreneurship and support, a function given a much greater priority in the PTA through the CEEI incubator. The responses of the Parks' NTBFs[200] (see Table 5-33) show few positive assessments beyond the infrastructure element, the basic office services and the Parks' prestigious label/address. The rent scheme applied in CEEI was recognised as a positive mechanism by the majority of respondents, but only a small number positively assessed the management/business support and networking that was the focus of CEEI managers or the technology transfer support. The positive comments documented[201] in a few cases were not unanimous. Similarly, while some of the Cartuja93 spin-offs provided a rather positive assessment to technology transfer mechanisms such as Citandalusia, other start-ups from Cartuja93 did not consider their Park location to offer opportunities for networking and partnership development (see Table 5-34).

[200] Responses from PTA are limited to the CEEI incubator. Responses in Cartuja93 include all NTBFs operating in the Park. Clearly, the comparability of the results is limited. Still they give a picture of the different level of NTBF support available in the two STPs at the time of the survey.

[201] "*In October 2005 I started the [firm] activity and I am very satisfied: I have developed many contacts and had conversations with many people*"[201] (Menendez, interview in Plaza, 2007). "*The support is fundamental, without initial financing there will be many that will think twice before taking the decision [to start a new company]*"[201] (Iglesias, interview to n.a.).

Table 5-33: Realised added-value for the Parks' NTBFs by the Park location (# of firms stating)

	PTA				C93			
	Not apply	1-2	3	4-5	Not apply	1-2	3	4-5
Cost/rent	-	2	-	5	2	7	1	-
Infrastructure	1	1	2	3	1	1	3	5
Park prestige	2	2	-	3	-	-	2	8
Basic services	1	2	2	2	1	4	5	-
PRTOs presence	4	3	-	-	2	3	3	2
Firms presence	4	3	-	-	1	5	3	1
n		7				10		

Source: survey

Table 5-34: Use of and satisfaction of Parks' NTBFs with the support services and mechanisms provided in the Park

	PTA				C93			
	No use	1-2	3	4-5	No use	1-2	3	4-5
Information	-	2	2	3	1	2	3	4
Access to finance	1	1	3	2	2	7	-	1
Management support	-	2	3	2	4	2	2	2
Participation in R&D projects	2	2	2	1	5	3	1	1
Cooperation /networking	2	2	2	1	3	4	2	1
Technology transfer support	2	4	1	-	2	5	-	3
n		7				10		

Source: survey

5.8 STPs' role in the broader region

5.8.1 The Parks as growth poles – the impact on income and employment

The difference in the activity of the two Parks also means they are given rather different weights in the respective regional/local economies (Table 5-35). In 2005, 1,700 PTA employees represented only 0.4% of the total regional employment and less than 0.5% of Asturian firms' total activity turnover[202]. In comparison, in 2005 the 11,500 employees of Cartuja93 represented 1.6% of the total employment in the province of Seville and around 5.6% of the provincial GDP (INE, 2006b).

[202] This estimate is based on the Amadeus firm's database using data for 2005. It includes 42 of the 102 (41%) firms operating in the Park (in 2005) and 16,550 of the 106,210 (15%) Asturian firms.

Table 5-35: Weights of STPs in regional total employment and high-technology sectors[203] activity (estimates)

	Asturias/PTA	Seville/C93
Total employment in region/province (2005)	425.500	709000
STP employment (2005)	1700	11500
% of Park in total	0.4	1.6
KIHTS employment in region/province (2005)	7693	28900[204]
% of Park in KIHTS employment (2005)[205]	< 5%	16%

Source: EUROSTAT (2005b) INE,(2006e),(IAT, 2005) and own elaboration

However, given the turn towards local firms, these employment and economic activity levels do not reflect the net contribution level in either the total or the high-tech sector employment of the two regions. Around 50% of Cartuja93 tenants and 32% of Asturias Park are units that pre-existed and moved from different locations inside the region (Table 5-36). Most of the examined firms in the sample stated an increase of activities, but a low level of satisfaction from the Park mechanisms. The opinion of Cartuja93 tenants' association director is that most firms grow, irrespective of their Park location (Gonzalez, J., interview, 2006) which suggests that the Park's role in their growth is probably limited.

Table 5-36: Origin of Parks' tenants

	Cartuja93	PTA
N	**311**	**104**
Firm relocated from inside the region	46%	23%
New company created in the Park	29%	28%
Subsidiary unit of firm from outside the region	13%	28%[206]
Firm relocated from outside the region	5%	-
Subsidiary unit of firm from inside the region	4%	9%
Other/No info	3%	11%

Source: IAT(2005), IDEPA (2006b), survey results and own elaboration

Independent of origin, the above concentration of firms, local or non-local, could serve as the base for growth pole based economic and employment effects. In reality, though, the growth pole mechanisms are absent. There are no indications linking the Park to the establishment of additional activities in the region, motivated by the agglomeration

[203] Include telecommunications (K-64.2), informatics (K-72) and R&D (K-73) sectors according to NACE classification.
[204] This is derived from the total of 61,415 of Andalusia and the share of KIHTS employment of the province of Seville (47%) in the total in 1999.
[205] This is an upper level estimate if all Parks' activities are classified in knowledge intensive sectors.
[206] 17% of these units were just sales/distribution or regional delegations (survey).

economies created by the Park activity. While an extensive survey at a regional/provincial level was not conducted, the interviews with the Park managers and external players or experts did not bring about any such example. Only the university representative saw that Cartuja93 Park might play a limited positive role in the attraction of high-tech firms (Table 5-37) to the region.

Linkages and multipliers from the Parks' firms' activity are also limited. The dominance of knowledge intensive services firms, where the main input is skilled labour and material linkages are less important[207], means that backward linkages are greatly reduced. Moreover, the questionnaire responses show that over 66% of both Parks' tenants had high shares of input from the local market, but that these linkages are, in a few cases, related to advanced technological inputs.

In conclusion, neither Park has so far developed any of the expected growth pole mechanisms. Economic and employment impacts are driven primarily by induced growth through the earning multipliers of the Parks' employees. Backward and forward linkages are limited and there are important leakages outside the region when it comes to more technologically advanced input. From the possible expected mechanisms of the growth pole doctrine, the Parks have so far brought along very little.

5.8.2 Supporting endogenous capacity and the operation of the regional innovation systems

Turning to the endogenous support role of the Parks' operation, the focus is on the creation of new technology based firms, the promotion of entrepreneurship and the strengthening of local industry competitiveness through technology transfer and the provision of support

[207] According to the IEA study for the advanced services sector firms of Andalusia, material input in 1999 represented less than 20%, with labour costs close to 50% (IEA, 1999).

services. In this respect, Asturias Park has, through the CEEI operation, a positive role in new firms' creation that goes beyond the 100-130 new firms, most of them characterised as innovative and 50% of them as new technology based firms. CEEI has contributed to an active promotion of entrepreneurial culture among the university and PRTOs researchers and students, as indicated by the 300 new firm projects supported annually, over 50% of which are in knowledge intensive sectors. CEEI clearly represents the greatest contribution from the Park space (see also Table 5-37). In comparison, Cartuja93 so far has made a limited contribution in this direction. The total of no more than 70 firms, with only a handful of spin-offs, is still a very small contribution to the regional NTBFs creation record.

In relation to the transfer and diffusion of technology and the strengthening of local industry productivity, the Parks do play a role through the activity of many of their services tenants. The knowledge-intensive firms, local or not, offer business support to the local firms integrating advanced ICT and other technology systems by implementing new management and organisation systems and optimising or redesigning production systems, all to enhance the productivity of local clients. In both cases, 60% of them stated that local markets are very important to their total turnover, while still referring to linkages with regional and extra-regional research and technology organisations. Even more directly, this type of support comes from the technology and innovation support services of AICIA, IAT and the other technology centres of Cartuja93 or from the smaller ITMA technology centre in Asturias Park. The difference between the two Parks is related to size and the fact that Cartuja93 had a faster and more dynamic evolution in these types of activities, both public and private.

Table 5-37: STPS role in the region - Assessment of regional players' representatives

	PTA				Cartuja93			
	Industry	Regional gov't	HEI	Intermediary organisation[208]	Industry[209]	Regional gov't	HEI	Intermediary Organisation[210]
Knowledge creation	-	n.a.	-	-	+	0	-	+
Attract high-tech firms	-	n.a.	-	-	-	-	+	+
New firm creation	0	n.a.	+	+	0	-	- -	-
Technology transfer	-	n.a.	- -	-	0	-	-	0
Innovation cooperation	-	n.a.	-	- -	-	0	-	+

Source: survey respondents graded from very weak(--) to very strong (++)

The difference between the two Parks is more evident in the respective contribution of the regional innovation systems and the promotion of regional cooperation. By giving priority to the attraction of production activities and limited weight to the knowledge creation element, the PTA promoters have not supported the potential role of the Park as an interface between science and technology. IDEPA, ITMA and CEEI are recognised individually for their contribution, but the Park has not become a point of reference for the development and exchange of technology information or the promotion of innovation cooperation (see Table 5-37). As suggested by the FICYT representative, the Park is far from being the centre of reference in relation to technological development and innovation (Suarez, E., interview, 2005). Nor has the single shareholder management structure played any role in the development of partnerships among the local players.

Based on the responses of the industry and the University of Seville representatives, Cartuja93's role in the promotion of regional innovation cooperation appears marginally more positive. Both the industry and the university representatives, the two main pillars of

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[208] FICYT
[209] Tenants association director
[210] Citandalucia

the regional system, had negative views concerning its interface role, largely reflecting the weaknesses already described. It was considered to be rather more positive for the regional government and the intermediation entities, possibly reflecting their own effort to strengthen the Park's role though the location of technology transfer organisations such as Citandalucia, IAT or CITAGRO. Cartuja93, along with the Park of Malaga, is characterised by the regional authorities as a "technology agent" of Andalusia (Rodríguez, 2005, p.3). Newly created structures such as the Corporacion Tecnologica de Andalucia (CTA) and RETA network include an important number of Park tenants and directly target `the development of linkages between the regional industry and Cartuja93.

The role of the Cartuja93 is still unclear as a potential cooperation platform. The regional and local authorities dominate the Park management and there has been limited space for other players. Other partnerships such as the CTA represent more explicit partnership platforms. Still, in a rather informal way, the endogenous turn was based on a common action framework between the public and the private sector and targeting a set of strategic planning initiatives (Vazquez-Barquero and Carrillo, 2004). The recent decision of a private bank to acquire a small share in the Park's operation and the very small participation of the university can reflect the increasing role and importance of the Park inside the regional innovation system.

5.9 Synopsis

The two property-led Spanish Parks under discussion had important differences in their initial structure and design. Cartuja93 was a high profile project which targeted the creation of a high-tech innovative milieu of international reference. The PTA of Asturias was a much less grandiose project aiming at the diversification and upgrading of a strong but declining industrial base.

The analysis of their activity and growth pointed to rather similar difficulties in attracting activities and building a high-tech environment. Costs, limited patience and an absence of real interest from non-local organisations led both cases to adopt flexible admission criteria that jeopardised their high tech character. However, Cartuja93 was endowed with public research organisations and education institutions and gradually attracted a number of local-origin, dynamic and innovation-oriented firms. Partly as a result of its promoters' priorities, Asturias was left with a weak institutional and R&D base, but was also unable to attract local-origin firms. The Parks have thus deviated significantly. Cartuja93 has become one of the larger STPs in Spain, while the Asturias Park is still struggling to fill the already decreased initial space.

Moreover, the differences in the level of linkages, interactions and synergies identified in the two Parks are even more evident. Neither case represents a synergy intensive environment. However, the dynamic and innovation-oriented firms of Cartuja93, along with some entrepreneurial research organisations/entities, are the basis for some interactions and partnerships among PRTOS and firms. With no real PRTO base, few firms with internal R&D activity and a focus on production, the Asturias Park linkages and knowledge spillovers are non-existent. Only its incubation function appears to have a positive performance, but is still disconnected from the remaining Park activities. As for the Parks' role in the region, their contribution comes primarily from the presence of advanced business and technology adoption services/functions for the regional industry. The growth pole linkages and agglomeration forces are largely absent and, subsequently, they have so far played a limited role in the diversification and upgrading of the regional economies towards higher technology production activities.

Nevertheless, at the same time (in contrast to the Greek cases) the analysis reveals a gradual evolution of the Parks' mechanisms, attempts to address omissions and weaknesses and a movement for initial consolidation towards the "maturity" phase as described by Luger and Goldstein (Luger and Goldstein,1991). This is clearer in Cartuja93, which has a supportive and active regional government, a dedicated management team and an active tenants' association. It is less evident in the Asturias Park. Cartuja93 is not only a larger Park, but is also in a better position towards becoming an STP with all the expected functions and operations.

6 Chapter 6 – high-tech Parks or high-tech fantasies?

6.1 Introduction

The objective of this study was to examine the feasibility of developing successful Science and Technology Parks in peripheral regions of Southern Europe. Set against the non-supportive environment of their regions, the aim is to evaluate whether, and to what extent, they abide by the STP definition, including the elements, functions and processes that are characteristic of the STP operation model. The aim is also to identify the parameters that play a role in their success or failure.

The review of a large number of existing STP labelled projects in the periphery of Southern Europe reveals their significant variation in design, operation and priorities. This variation is reflected in the four selected cases. The Spanish and the Greek Parks represent the two approaches in the design of STPs, the property-led versus the technology-led model. Furthermore, the two Spanish cases represent the two different versions of STPs in Spain. Asturias focuses on production functions and the application of technology, characterised as a Technology Park, while Cartuja93 gives greater weight/role to R&D activity, the presence of public research and the interaction between the public and the private sector, what Spanish practitioners (Rubiralta and Vendrell, 2004) call a Science and Technology Park.

All four STPs were created in regions with weak regional systems, characterised by the absence of a relevant critical mass of knowledge and innovation creation activities, as well as by the absence of developed linkages between technology supply and demand. There are, at the same time, distinct differences between the Greek and the Spanish cases concerning the capacity of regional authorities and their role in research and innovation policy. In contrast to the centralised character of the Greek system, where innovation policy is defined at a national level and regions are largely absent, the Spanish regional administrations have seen an increase in their powers and their capacity in the design and implementation of regional innovation strategies and projects such as the STPs.

The previous two chapters analysed the STPs' operation and assessed their performance. The results reveal common elements and variations among the examined cases, point to strengths and weaknesses and highlight critical elements of the internal and external environment. This chapter brings together the four cases to provide a common picture concerning the development of STP projects in the context of a lagging European region. The analysis is developed around the three expected functions of the STP operation:

- Their development into knowledge and innovation-intensive spaces
- The creation of knowledge/technology linkages, innovation cooperation and synergies
- The creation and growth of new technology based firms

The chapter examines which part has worked, which has not, and why for each STP. Based on the comparison between the four cases, the analysis identifies the role that the regional context has played in the STPs' operation development, leading to an answer to the main question of this study, the feasibility of creating successful STPs in lagging regions. The comparison of the different structures and the alternative evolution paths of the four STPs shed light on the role that internal factors assume in the Parks' operation and performance. With the answer to the above question taken as given, the last section of the chapter assesses the actual role of the Parks in the region and the functioning of their innovation systems.

6.2 Building the STPs' high-tech space

Has the creation of STP-labelled spaces and the provision of quality infrastructure in the southern periphery of Europe led to the development of high-technology and innovation intensive spaces? Following Benko (2000), the prime criterion for the identification of the "real technopole" is the presence of knowledge intensive firms and activities that differentiate them from simple industrial and/or business parks. Parks can be built based on exogenous sources, i.e. non-local origin multinational firms with an advanced innovative and technology content, or on endogenous sources, including existing local-origin high-tech firms or newly created technology-based firms (start-ups and spin-offs) (Tsipouri, 1998b).

The cases examined gave different weights to the each of the above factors. In the Greek Parks, the priority was towards local-origin technology-based firms, start-ups and spin-offs of the public research organisations. On the other hand, the Spanish Parks' promoters gave higher priority to the attraction of non-local firms, although local knowledge-intensive firms were also targeted at different levels. The Seville Park aimed more explicitly at knowledge creation though R&D and product development, giving priority to firms' knowledge-intensive functions. In comparison, Asturias promoters targeted more production activities and the use and integration of technology and innovation.

6.2.1 Non-local origin firms' decreased presence and limited role

In an attempt to attract high-tech firms, Spanish Parks' promoters used a series of fiscal instruments such as tax cuts and establishment subsidies, together with quality infrastructure, a central/convenient location and the promotion of the quality life-style of the two regions. Aggressive marketing strategies before and after the inauguration of the

Parks were also followed and Cartuja93 could also count on their global reputation after Expo92 and the political support of the Spanish national government.

Despite these positive conditions, the analysis points to a failure of the exogenous strategy. Foreign-origin firms have played a minor role in the Parks' development and growth (not more than 30% in terms of the units and much less in terms of economic activity) and have had a limited role in building their technology-base. Asturias 4 foreign production units are small plants that did not bring along advanced knowledge intensive and development functions. With small variations, their innovative character is limited to the use of advanced technology equipment (automation systems) and to the application of production quality systems, but R&D and knowledge creation remained anchored in the firms' headquarters. Even if the objective was the attraction of "performance branch plants" (Amin and Tomaney, 1998), characterised by increased autonomy and advanced local supply-chain linkages, this is only partly evident among the few Park units. Autotex was probably the most negative example, as it had no development activities/functions, focused on the low cost of the local labour force and did not offer much to the Park's knowledge base. Its footloose character was proven five years following its establishment with the plant closure as a result of increased cost-competition from East Europe (Fuente and Rubio, 2006). Other examples (STRE or ERVISA) are probably more positive, with some form of process engineering/development activity and gradual expansion of activities, but again their contribution to the development of the PTA as a high-technology space has been limited. As suggested by the regional industry representative "...these companies are interesting for the economy of Asturias but they neither have a real high-technology content, nor do they conduct any important R&D activity" (Gonzalez, A.M., interview, 2005).

From the firms' perspective, the choice of locating in the Park had very little to do with access to knowledge and technology, agglomeration forces or any expectation of the support of their innovative capacity by the Park model. Their location decisions seem to have been governed by typical branch plant costs reduction and infrastructure quality parameters (Amin and Tomaney, 1998). For ERVISA:

> "...the regional incentives offered by the regional community were decisive for the decision to opt for Asturias as the location of their new plant. In addition, great role played the proximity of the new location (the park) to major ports, selected route to provide access to the production oriented towards the foreign markets of the European Union and US" (IDEPA, 2003, p.9).

The CEO of STRE agreed:

> "We wanted to be in the EU, we wanted the business currency to be euros, and we wanted the value equation to balance labour cost, skill level, ready infrastructure, and ease of doing business—including working with the local authorities in the construction phase right up through the production phase". (Yorgensen R. STRE COO, interview to McCandless, 2004).

The failure of Cartuja93 is even greater, given the scale of the initial ambitions for the creation of "an innovation space of international reference" (Cartuja93 S.A., 1994, p.20). Not one of the eight[211] international firms that initially agreed to come to the Park is currently present. Exogenous elements such as the global economic crisis after 1992 have been suggested as providing part of the explanation (Benjumea Pino, 2003), but even those few units that initially moved in (XEROX and Siemens) left the Park after few years and forced the Park managers towards a change of strategy. The initial objective of attracting

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[211] IBM, Fujitsu, Alcatel, Phillips, Siemens, Sony, Panasonic, EPSON (Castells and Hall, 1994)

R&D facilities of large multinational firms was not achieved and was gradually abandoned. The non-local tenants are nowadays sales and/or administration branches of international or Spanish firms or regional offices of advanced business services firms.

This last group of business services firms, including ICT, engineering/technical services and other producer services, nowadays represents the only type of non-local origin firm with a knowledge intensive character. Firms like Sky-Cross in aeronautic engineering services, Oracle Iberica, GMV-SGI, GFI and Applus+/Soluziona (ICT), or the local branches of international consulting firms such as Deloitte and Accenture in Cartuja93 do indeed have a knowledge-intensive profile and high levels (>50%) of skilled personnel. The US-headquartered Fluor Daniel[212] and the Spanish ECO, Satec, are similar types of firms in Asturias Park. The nature of their activities - customised applications, systems integration, turn-key projects- requires high levels of local product development and design activity. While still largely dependent and determined by the activity taking place in the headquarters (Asian, 2004) R&D, software development or product design activities are present on site for four out of six of the survey respondents[213], adding to the knowledge and innovation creation activity of the Parks' space.

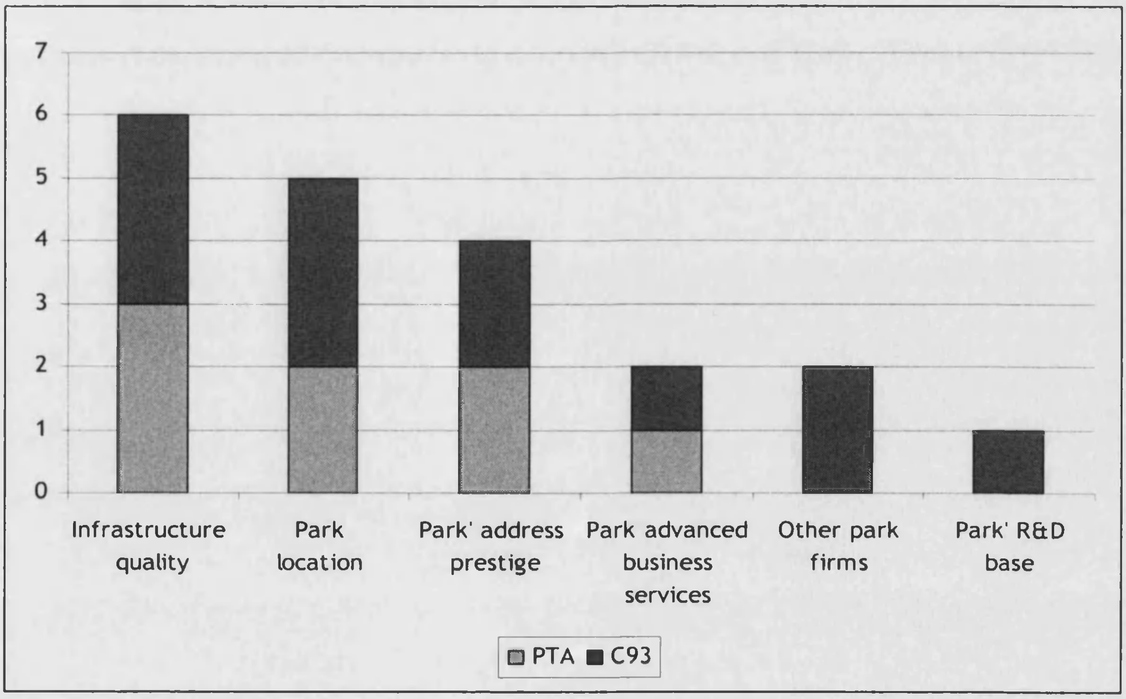
The reasons behind their location in the Parks are, however, rarely linked with any interest in accessing and exploiting technology resources. Some come to the region as a result of a gradually increasing demand for advanced business services, an area where the regional governments' own investment programs play an important role. According to the GMV-SGI regional director:

[212] US subsidiary, with the Asturias unit being the head office in Spain

[213] These include the French GFI, Spanish Oracle Iberica and SGI in C93 and US Fluor, Spanish SATEC and ECO in Asturias.

"…first of all we should note the capacity of the region [of Andalusia] to grow in the area of IT and that it is one of the regions in the country that makes the greatest effort to situate itself among the most technologically advanced autonomous communities in the country. In second place, the Andalusian administration is supporting decisively the activity areas that GMV-SGI is working and it is the leader at the national level, we believe that this is a sufficient motive for GMV-SGI to be here."(GMV Seville regional director, interview in GMV, n.d.).

Others are attracted by the presence of a single large and important client – such as Airbus/CADSA plant for SkyCross in Seville or the DuPont chemical plant for Fluor in Asturias. Given the choice of the region, infrastructure, central location and the prestigious park address are the key factors that lead to parks' site selection (see Figure 6-1). Connections, interactions or the parks' R&D base are not cited as important reasons to locate there.



Source: survey results

Figure 6-1: Reasons given by non-local origin producer services firms for locating in the STPs' space (number of firms stating: 7. 4 in C93, 3 in PTA)

The Greek STPs were not designed with the intention of attracting multinational firms, as they had limited space available and no incentives. Even so, in the initial stages STEP-C promoters attempted to bring the R&D units of a few national firms to the Park using the attractiveness of FORTH's R&D activity as bait. The efforts proved unsuccessful, however, and the assessment of this failure is illustrative of the limitations that the Greek context more generally suffers with regards to the operation of the STPs. According to a FORTH representative:

"Greek firms are not interested seriously in R&D activity. The sole expectation from their park presence was to secure access to public R&D programs. When they realized that this was not the case they left the park" (Stratigis, interview, 2006).

This apparent failure to attract non-local firms in order to build the STPs' knowledge base is not an exception. After analysing eight Spanish Parks, Gonzalez and Diaz (1995) report that non-local firms represented less than 30% of the total tenants and Hermosa (1998) found that in 1995 international firms in Spanish technology Parks represented only a small share of the total number of tenants. They included production activities that would not have been accepted in STPs in the UK. Moreover, 19 of the 22 multinationals were concentrated in the Technology Park of Vallés in Catalonia, one of the most advanced regions in Spain. It is a picture that follows the distribution of high-technology FDI, where Madrid and Catalonia concentrate over 90% of the total for the period 1993-2006, while Asturias and Andalusia (the latter being the largest and most populous region of Spain) have each attracted no more than 0.5% of the total (DataInvex, 2007). Even more so, in Greece there is only one example of an international firm in a STP (Atmel in Patras

Science Park (PSP, 2007))[214] and FDI in high-tech sectors has more generally been extremely limited, very much below the country's theoretical potential (UNCTAD, 2007)[215].

What the above reflects is the fact that the location choice of advanced knowledge-based activities of multinational firms is not driven by quality facilities or financial incentives and cost considerations do not seem to play an important role (Cantwell and Iammarino, 2003). It is driven by access to important markets (including the element of quality demand) and/or the specific capabilities and knowledge developed in any single location (Lazaric et al., 2004; EC, 2006a) including high quality research, access to centres of excellence with specialised R&D knowledge and important cooperation opportunities with a strong private technology base. All these were elements absent from the four regions and the STPs' creation could not by itself change that. The Universities of Oviedo or Seville and the other regional PRTOs, and in a similar way their Greek counterparts, may have some researchers or research units recognised at international levels, but the regional level of R&D activity is limited in size to create strong knowledge spillovers and cooperation opportunities for multinational firms to tap into.

For the regional or national authorities in lagging regions, the STP projects may be seen as a signal of their intention to pursue technology-led development, but for the foreign firms the STPs' presence does not change the fundamental and important issues. As suggested by Tsipouri (1998b, p. 41) "...the proliferation of parks has increased competition and only the greatest success cases are considered by research intensive multinationals". The STPs

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[214] This firm design unit closed in 2006 (Atmel annual report 2007).

[215] According to UN World investment report for 2007, Greece was ranked in the 114th position among 141 countries based on the real inward FDI performance while it is ranked in the 36th position based on its inward FDI potential – determined from a range of factors that affect a county's attractiveness(UNCTAD, 2007).

examined here and in other similar environments are a-priori in a disadvantaged position against other, more central/advanced locations. Successful examples such as Sophia-Antipolis in France (Castells and Hall, 1994), the Research Triangle Park (Luger and Goldstein, 1991) or Oulu Technopolis Science park in Finland (Ylinenpaa, 2001),that catch the imagination of the Parks' promoters tend to be the exception rather than the rule. They are exceptional cases that benefited from favourable national contexts, strong political support and an element of luck. In all three cases, significant time (over 15 years) passed before the STPs managed to attract foreign companies to the Park. Neither of the two Spanish Parks' promoters showed the same long-term view and patience.

6.2.2 Building the high-tech space on local sources

Deliberately or not, the inability to attract external firms has led to a dominant local content in all 4 cases as in most STPs in lagging regions. Local-origin firms have been the prime force behind the activity growth in Cartuja93 and, similarly, they have supported the more recent growth in the PTA. The Greek incubation oriented STPs focused more explicitly on exploiting the given local/endogenous entrepreneurial potential. Following Luger and Goldstein (1991), there was no a-priori reason that the STPs high-tech space could not be based on local firms. However, this requires the presence in the region and the actual attraction to the Park of local firms with the capacity and interest to innovate and develop network interactions and cooperation (Landabaso, 1997).

Against these requirements, the reality of the four examined cases was very mixed. On the one hand, there are indeed STP firms that belong to the group of most dynamic and/or technology-oriented firms in their regions. The Spanish Parks' managers report R&D

employment shares[216] higher than the respective regional averages. More than half of the Cartuja93 firms in the technology sectors reported the presence of R&D activities. The Cartuja93 "endogenous" turn was driven by a number of dynamic local-origin and technology-based firms such as Sadiel, Tecnologica, Group MacPuarsa or Inerco, then along came a few university and research spin-offs. Even if not global players in terms of innovation and technology,[217] their R&D investment (from 2% to up to 20% of turnover depending on size and sector) and the on-going cooperation with the engineering school means that they fulfil the expected dynamic profile that Parks' tenant should have according to Landabaso (1997) . Similar types of firms are present in Asturias (Ingenieros Asesores, Normalux, Felguera), but in smaller numbers, size and dynamism. The Greek Parks include some start-ups or subsidiary units with a knowledge intensive and innovation orientation. They are among the few local firms with high knowledge-intensity levels. Even though very few of them produce leading edge products or services at an international scale, they are still tenants of a high-technology character, with high levels of skilled personnel and with important weight given to the production, use and integration of innovation as a driver of competitiveness.

At the same time, however, in all four cases there has been a documented presence of firms and units with unclear knowledge intensity and limited, if any, innovation related activities. Travel agents, administration units, construction firms' offices or storage facilities dominate the Greek STPs' limited space. Cartuja93 includes a strong share of public sector organisations/agencies and media/broadcasting units, while Asturias' Park hosts an apparel production unit, a lab equipment retail firm and many other non-KIBS services firms. They

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[216] Although there is no definition of the R&D personnel and whether they also include the PRTOs' personnel.
[217] None of them belongs to the list of the 1,000 most R&D intensive firms in Europe (EC, 2006b)

are tenants that confirm the idea that many STPs are not much more than high-prestige industrial or business parks (Benito del Pozo, 2000; Aernouldt, 2004).

The differences in the relative weight of the high-tech activities appear to be the result of external contextual limitations, but are also linked to internal design constraints, manifesting themselves at different intensity levels in each case. For the Greek STPs that targeted NTBFs and high-tech start-ups, the low levels of entrepreneurial capital represented an important obstacle. The supply of projects and start-up firms fitting the demanding STP criteria was not seen as adequate to support the operation of the Park space and led to the use of more flexible criteria and longer term occupancy periods (Tramantzas, interview,12/06/2005). TTP could also not count on its promoter's (CERTH) own spin-off creation capacity, which was absent until 2005, and STEP-C not that much more.

The Spanish cases showed greater capacity to attract the few dynamic and innovation oriented local firms. Cartuja93 could count on a number of positive elements including its location in the administration centre of the region, the quality infrastructure and, to a lesser extent, the presence of the research and training entities that made it "an interesting proposition" (Gonzalez, J., interview, 20/02/2006) to some of the local dynamic firms. On the negative side were the high maintenance costs of the Park and the parallel interest of firms in mainstream areas for a site that concentrated 33% of the total office space available in Seville (Knight Frank, 2007). The negative forces were much more dominant in the initial periods; however, as the pressure to cover the infrastructure costs decreased, having in the meantime sacrificed part of that infrastructure, Cartuja93 managers were able to be more selective and to attract more appropriate tenants. The Asturias Park not only did not benefit from a similar number of large and dynamic firms; at the same time, the existing ones showed much less interest in the Park's space. The location of the Park in the centre of the region, but outside the main urban centres, has been attractive for production units, but was not convenient for the majority of the regional knowledge intensive services firms that are primarily located in one of the three main urban centres[218]. The absence of smaller offices for rent or sale, again reflecting the priority towards larger production units and firms, also meant limited ability to attract small firms dominant in the region. This was addressed only after 2001 and, again, had very flexible criteria applied. The negative economic conditions and the very small number of genuinely innovative firms, combined with an inappropriate design left the Park managers struggling to bring along high-tech activities.

6.2.3 **Conclusion**

In all four cases, the targeted high technology and innovation intensive environments have been only partially developed. The limitations of the lagging regions' context were not addressed by investment on the STPs' infrastructure, the provision of location incentives or the presence of high-profile research organisations. The Park managers have been, to different degrees, forced to apply flexible/relaxed admission policies. In Asturias Park, this was done in a formal way; in the other three, less explicitly. The infrastructure and cost pressures were evident both in the small incubation led Greek Parks that could not bring ten or fifteen high-tech firms to fill the Parks' offices, as well as in the large property-led Parks of Spain. Next to the high-technology and innovation-driven tenants, traditional and much less innovative firms dominate and the definition of high-tech assumes a relative value, linked to the broader lagging context. While high-tech and knowledge intensive firms are not absent from the examined STPs, the basis for the development of knowledge based linkages and interactions is, to date, reduced.

[218] Oviedo and Gijon concentrate more than 75% of KIBS firms of Asturias (IDEPA, 2002b)

6.3 STPs and the development of linkages, knowledge flows and synergies

If the presence of knowledge-intensive functions and activities is a prerequisite for the development of the Parks' innovation intensive environment, the essence of an STP operation relies on its capacity to stir/create knowledge flows linkages, interactions and synergies that should lead to the cross-fertilisation and innovation creation (Komninos, 2002). The linear view focused on STPs' potential role in knowledge and technology transfer and the facilitation of linkages between public research organisations and firms (R-I linkages). The interactive view of the innovation process extends this to the development of linkages among firms that provide complementary and specialised knowledge and resources and support innovation creation. In its ultimate form, it refers to the formation of the innovation networks and the collective learning processes present in technology districts and innovative milieux (Komninos, 2002; Capello and Fagian, 2005).

STPs rely on two main mechanisms to achieve the above objectives. Firstly, the physical proximity and the concentration of high technology activities that should support face-to-face interactions, reduce communication and transactions costs, and act as a stimulus for communication, collaboration and knowledge exchange. Secondly, the coordination, organisation and support functions of the management teams that facilitate the flow of knowledge and technology and build the Parks' technopolitan culture.

The Spanish and the Greek Park models differ in the relative weight given to these two described mechanisms. The Spanish Parks "look" inside (Komninos, 1993) giving priority to the physical concentration of a large number of firms that should serve for the creation of automatic flows and technology transfer relationships inside the Park. The Greek Parks, considered to be "looking outside" the Park space, focus more on cooperation and knowledge transfer mechanisms with a greater reference to the broader regional scale. Furthermore, different priorities were placed on the various types of linkages. PTA focused more on the inter-firm connections that would support the firms' innovative capacity, even though there were still claims of a "close relationship with the region's university and technology centres" (IDEPA, 2007). The Greek Parks focused more on the university-industry technology transfer both inside and outside the Park. In Cartuja93, both types of linkages and synergies and the creation of the innovative milieu were equally targeted. These two types of linkages and priorities and the role of the Parks mechanisms in facilitating are examined in sequence, although it is still clear that they are, in many cases, interconnected.

6.3.1 Supporting Research -Industry linkages

The picture from the examined cases concerning the development of the PRTOs' connection with industry appears clearly problematic, questioning the STPs' alleged role. The survey results confirm the idea of some type of spatial boundary in the development of R-I linkages and the importance of proximity in their development (Phillimore, 1999; Fritsch, 2001). Among the 65 respondents from all four Parks, over 60% referred to region-wide linkages with PRTOs against 37.5% at a national level and 19% at international. However, inside the Parks less than 35% referred to any type of connection, formal or informal, with a Park-based research and technology organisation.

These linkages were, however, unevenly distributed between the four examined cases, as a consequence of the presence of competent organisations and firms with pre-existing connections in Cartuja93 and STEP-C. The engineering school of the University of Seville (ESI) in Cartuja93 probably provides the most positive example of such a tenant. At the time of its transfer into the Park (1997), ESI had significant research and technology activity that overlapped with a number of Park firms in the ICT and engineering services sectors. These partnerships were already formalised through a public-private partnership scheme with industry (AICIA) that had been developed since 1982 and had focused on "...the establishment of cooperative relationships with public or private entities" (AICIA, 2007). In the Cartuja93 Park, ESI combines advanced level knowledge creation, training and provision of skilled students with an already developed entrepreneurial character. It fulfils the criteria Castells and Hall (1994) suggest as being critical for any PRTO to contribute to the development of the Parks' synergies. At the same time, there were the dynamic, large and local-origin technology-intensive firms (e.g. Tecnologica, Inerco, MacPuarsa, Sadiel) or the few university spin-offs (e.g. Ingeniatrics, Biomedal), all with their own R&D activity (i.e. absorptive capacity (Cohen and Levinthal, 1990)) and pre-existing personal and professional connections (i.e. relational proximity(Gertler, 2003)) with ESI and other R&D units' researchers. The joint R&D projects, licensing agreements, technical services, use of researchers and hiring of personnel were part of their broader connections with PRTOs, inside and outside the region.

The examples of R-I interactions observed inside STEP-C are similar in nature, even if at a much smaller scale and with less intensity. They are based on the presence of a few FORTH spin-offs or the start-ups of the University of Crete's graduates that often had prior working/research experience in FORTH institutes. Personal connections and prior interaction experiences ease access to the FORTH knowledge base, the use of FORTH facilities and, even more critical for the financing of these small firms' R&D activity, joint participation in public programmes.

In neither of the described cases was proximity the critical supportive element for the development of these linkages. Closeness to ESI or FORTH is only important to the extent that it allows easier access to specific facilities and equipment and it may be an extra convenience element for the few researchers in the spin-offs of STEP-C. However, in most cases they are linkages that pre-existed and grew and strengthened over time as the firms and organisations grew themselves and increased their activities. The social interactions are equally as present inside the Parks' space as outside. So far, it is the Parks' environment that benefits from their presence and not the other way around.

These positive cases can be contrasted with many more examples of limited or no connections. The CSIC national research institutes of Cartuja93 focus on basic research and have a much less entrepreneurial character. Their transfer inside the Park supported Cartuja93 in the initial period and strengthened its R&D and knowledge base, but after 12 years of operation, knowledge transfer takes place only through training. Most of their interactions remain primarily in the academic sphere. Similarly, Cartuja93 has a large share (over 60%) of tenants that stated they have had no interaction with the park PRTOs. Subsidiary units of non-local firms where R&D takes place in the company headquarters, or producer services firms with no own R&D activity, focus on the connections with their local clients and have no interest in a link with PRTOs. The Park location, selected for reasons related to its central position, quality infrastructure and prestige, has not increased their interest in R&D cooperation.

This is more evident in the cases of Asturias or Thessaloniki, where physical proximity has remained so far rather irrelevant. In the first, the development of the R-I linkages was a-priori limited. The materials institute (ITMA) has strong reference to the traditional industrial base, but limited overlap with the great majority of the Park tenants. Far from representing firms with a propensity towards cooperation with PRTOs, the majority of the PTA firms (>75%) stated no use of external R&D and did not consider public research organisations to be important sources/partners. As stated by the University of Oviedo representative:

> "...there are few firms in the park with which we have cooperation, but in total it [the park] does not represent a space with particular interest/weight for the university research" (Roqueni, interview, 2007).

Similarly, while dedicated to technology transfer, the conditions for R-I linkages inside Thessaloniki Park were not supportive. With no spin-offs, no pre-existing connections and, in most cases, no relevance to CERTH research activity, linkages are again absent, whether formal or informal. The initially stated attractive role of CERTH institutes reflected the expectation of easier access to public R&D programmes rather than concrete interest in cooperation. For CERTH researchers, focusing on publications and access to European programmes, the presence of the firms was equally indifferent and most of them were even unaware of their activities. Again physical proximity appeared irrelevant.

The absence of relevant activities, absorptive and relational capacity inside the Greek STPs is the main limiting factor for the connection of the Greek institutes with the broader economy and local industry. Knowledge transfer from CERTH institutes towards Central Macedonia firms and public sector/organisations takes place either through specialised consulting services from some units/departments, or more often through the training of students and the creation of highly skilled personnel. However, overall it is limited and has a marginal role for the institutes. A CERTH director summarised:

> "We have decided that technology transfer in the region should be a strategic goal for CERTH, although we do not expect any significant return from that. The great majority of firms in the region, and in Greece more generally, have limited interest in R&D and technology development. They look towards the PRTOs only in order

to get access to finance through the government R&D programs" (Vasalos, interview, 2005).

Even less supportive is the environment in Crete's smaller economy, where the few firms "...do not have interest for R&D [and] FORTH does not know the [regional] market" (Katharakis, interview, 2006).

The above description of an absence of R-I linkages and knowledge transfer is in accordance with the more negative views expressed in the literature that question the role of the STP and the proximity thesis (Van Dierdonck et al., 1991; Massey et al., 1992; Vedovello, 2000). It confirms the idea that STPs are relevant only to those tenants, firms and researchers with their own capacity, personal/professional connections and pre-existing partnerships (Massey et al., 1992; Felsenstein, 1994) for which the Parks provide only a convenient location. For most others, the Parks' space remained irrelevant and did not seem to play a role in their behaviour and access to knowledge. Limited by a weak regional base and ineffective admission policies, the development of linkages clearly needed more than simple physical proximity. It points to the role of the intangible mechanisms elements, the active support and coordination, which will be analysed later.

6.3.2 STPs and the development of intra-firm linkages and innovation networks

If Park related R-I connections and technology transfer have been limited, the inter-firm interactions and knowledge flows were even less developed and the identified social networking and communication processes inside the Parks were close to zero. The results again follow the propositions of part of the literature concerning the limited role of space and proximity in inter-firm connections and the importance and priority of access to global/international linkages and networks (Freel, 2000; Wolfe and Gertler, 2004), particularly for high-tech sector firms in backward environments (Tsipouri, 1998b; Fontes, 2005). While only 17% of the 65 responding firms in all Parks referred to some form of interaction with other Park firms and 37% to the presence of linkages at the regional scale, more than half (53%) gave high priority to linkages with firms at broader national and/or international levels (see also Table 6-1).

The picture is also much more uniform among the four parks, even if design and attraction policies still play their role. With a limited number of firms and no sector specialisation, the Greek STPs provided a limited base for the development of inter-firm linkages. Proximity played no role among the few firms of TTP, which essentially operate behind closed doors and do not even hold information on their neighbours' activities. STEP-C's more positive picture is due to a small group of four or five ICT firms with complementary activity, but also with some form of prior connection through their common working experience in FORTH. R&D cooperation, as well as a couple of joint product developments projects (examples of the expected cross-fertilisation and innovation creation role of the STP space (Benko, 2000)) led to a conclusion that "*there is networking inside the park*" (Ignatiadis, interview, 2006). Nevertheless, it appears to be still ad-hoc with none of the advanced self-sustainable communication and collective learning processes that would imply the formation of an innovative milieu.

If the small Greek STPs were a-priori not seen as supportive of the development of intra-firm linkages (Komninos, 1993), the linkages and interactions appeared limited even in the Spanish Parks with more firms in related sectors. The majority (>80%) referred to market-based interaction and showed no interest in cooperation. Asturias production units were almost exclusively directed towards partners outside the region for technology inputs/equipment, while even the knowledge intensive business services firms (the most dynamic element) did not refer to almost any linkage in the Park. There is "distance" from the other tenants and, with few exceptions, limited information on their activity.

Cartuja93 appears to be the most positive case among those studied, based on the presence of large and dynamic firms with R&D intensity or the very few innovative research spin-offs with formal and informal linkages; both types are firms with increased absorptive capacity. The results show that, with the passage of time, the frequency of these connections is increasing[219] and technology joint ventures (i.e. CASSFA and Bluenet) are indeed examples of cross-fertilisation; but these few connections should not be overstated. They concern only a small share of firms, when the remaining are either isolated or limited to the customer-supplier relationships that any such concentration of economic activity allows. As the tenants association suggested, they are "...anecdotal and do not have a critical role for the firms, that will develop and succeed irrespective" (Gonzalez, J., interview, 2006). Sustainable communication processes and social networks are not present as "...there is limited knowledge/information concerning the activities of others. There is absence of confidence and trust for cooperation" (ibid.). Similar to any other industrial or business park, the STPs' benefits for most firms come from reduced costs for the common use of basic infrastructure and services, but include neither the skilled labour mobility, information and ideas flow of the pure agglomeration model, nor (to an even greater extent) the trust relationships of the social-network model (Gordon and McCann, 2000).

The limited role of the Parks' space and physical proximity contrasts with the greater focus and intensity of the external connections. In some cases, primarily for the Spanish firms, they involve other firms at the regional scale with formal and, more often, informal

[219] The comparison of IAT surveys of 2004 and 2006 reveal also increase in the share of firms cooperating in R&D projects with other park entities.

interaction present. Participation in regional R&D programmes and the provision of technical services to the local customer base of some KIBS represent the most common forms, while the most dynamic are all integrated in various regional clubs, partnerships and technology cluster schemes promoted by the regional authorities.

However, in accordance with the literature on the connections of high-tech firms in lagging regions (Fontes, 2005), most look outside the region for partnerships. Depending on the sector and the firm's capacity, the knowledge intensity and character varies. For the more advanced cases such as Tecnologica, Inerco or Sadiel, or the spin-offs of Cartuja93, linkages with foreign firms are broad and intensive (R&D contracts, joint ventures, technology platforms and national or EU funded projects), giving access to critical knowledge and resources to compete in national and international markets. For the Asturias Park's production units, international connections refer primarily to their access to inputs and business and technology partnerships at national and international levels. For the ICT and engineering services firms, business type linkages in the form of value added resellers, system integrators or independent software vendors provide access to resources, but also essential mechanisms to strengthen their position in the local market. Similarly, it is the external linkages, national or international, that are given the most important role, especially for the most dynamic of the Greek STP firms (e.g. FORTHnet, Virtual Trip, Helletel). They are closely linked with the need to access broader markets, especially as part of their participation in national and European public R&D programmes.

In all the above external connections and linkages, spatial constraints and proximity do not play a role. Firms looked for complementary technology resources and seek to integrate them into sectoral networks that cross spatial boundaries (Carlsson and Jacobsson, 1997). What determines their ability to participate in the above networks are the firms' own knowledge base and their innovative and absorptive capacity. The role of the Park is, in most cases, limited to its reputation and prestigious label/address or possible positive signals in the initial stages of the partnership promotion/creation.

Table 6-1: The intensity of firms and PRTOs' linkages inside and outside the Parks ares - summary table[220]

	STEP-C	TTP	PTA	C93
Firms – PRTOs' linkages				
Inside park	Moderate/High	Very limited	Absent	Moderate
In Region	Moderate/High	Limited	Limited	Moderate
Outside	Moderate/High	Moderate	Absent	Moderate
Inter-firm linkages				
Inside park	Among small ICT group	Absent	Absent	Limited
In Region	Limited – one direction	Limited	Moderate	Moderate
Outside	Moderate/High	Moderate	Moderate/High	Moderate/High
Park PRTOs' linkages				
In Region	Very limited – one direction	Limited – one direction	High but services oriented	Moderate
Outside	High	High	Low	High

Source: survey and own elaboration

6.3.3 Form, role and evolution of the STPs' coordination and support mechanisms

The absence of Park based linkages is, however, not only a confirmation that spatial proximity cannot by itself support interactions among entities (PRTOS and firms) with limited capacity. It is also reference to the absence of the intangible mechanisms that could promote and coordinate the Parks' knowledge flows and synergies.

On the positive side, as a response to an initial absence of relevant technological information at the time of their creation and with the objective of strengthening the latent demand for innovation and technology, the STPs' management teams gave priority to the dissemination of technology information (organisation of events, electronic and/or paper journal, databases and patent information, information on new public programmes) and the

[220] The characterisations are indicative and refer to each Park separately, they are not directly comparable across the cases

codification of the existing available knowledge base of the PRTOs (e.g. technology services available, technology watch services). The Parks' mechanisms appear to have a positive role, but this primarily concerns the information for external (non-park) support programmes and mechanisms. It has not served the diffusion of information about the activity of firms and PRTOs inside the Park. The Cartuja93 tenants' association director referred to the limited knowledge of other firms' activities, while one Thessaloniki Park tenant stated that there is "no information on the activities of other firms inside the incubator" (FT-3). To the extent that the firms are not actively searching for partnerships inside the Park, the above information mechanisms appear of very limited use.

Even more, awareness raising and the partner-search costs reduction are only one part of the expected cooperation support function. They do not address the obstacles to cooperation that, following the survey results, include the high costs of coordination (47% of respondents), absence of the necessary supportive mechanisms (33%) and limited cooperative culture (38%)[221]. The small firms that dominate the Parks' space especially "...have limited own resources and cooperation capacity and are those that need help. Large firms have their own mechanisms of developing partnerships and do not need external services" (Escasena, interview, 22/02/2006). Formal and informal networking actions go beyond the matchmaking stage. They require pro-active structures that help firms to define their technical and related financial, marketing and organisational needs (Hassink, 1996). They enhance the absorptive and cooperative capacity of the firms and induce cooperation and interaction through schemes that address the cost constraints (Howells, 2006). Such activities have not been entirely absent from the Parks' service list, they were not given priority by the Park promoters and managers and were rarely

[221] Other reasons mentioned were absence of partners (21%), no interest of other firms (19%), geographical distance (14%), no interest of the firm (12%). Distance was considered particularly important in Crete, though (50% of respondents) (Survey results).

sufficiently developed. In all four cases, few firms use them and the great majority stated a low level of satisfaction (see Table 6-2).

Table 6-2: STPs' coordination and cooperation support mechanisms (number of firms stating use and level of satisfaction from 1-very low to 5-very high)

	TTP		STEP-C		PTA		C93	
Service type	**Use**	**4-5**	**Use**	**4-5**	**Use**	**4-5**	**Use**	**4-5**
Information provision	3	2	9	2	18	4	20	11
Support in participation in R&D projects	2	0	9	1	14	2	13	5
Technology transfer	0	0	5	0	12	0	16	6
Cooperation /networking	2	0	8	1	12	1	16	5
N	5		10		24		25	

Source: survey

In practice, the Greek Parks never really fulfilled their liaison function and the management team staff had limited, if any, experience in technology transfer. CERTH researchers do not, in practice, consider using the Park's limited mechanisms and the picture in STEP-C was only marginally better due to the presence of the PRAXI network. In practice, the only mechanism inducing cooperation is the government R&D cooperation support programmes. Even if they are given a negative tone[222], and in many cases they are primarily seen as a cash support scheme, both sides confirm their contribution.

The Greek STP managers recognise the existing weaknesses and limitations of an underdeveloped support structure; but they claim that the re-active broker focus and the absence of clear Park-reference are dictated by the negative environment and a problematic operational model. Above all is the limited demand for the use of technology transfer services, both inside the Park and the region: "firms and researchers do not want to pay for such services. They are only interested if they are offered for free" (Tramantzas, interview,

[222] A FORTH representative, "*firms are only interested in cooperating with PRTOs to get access to the public subsidies*" (Stratigis, interview, 04/05/2006) while from the firms' side "*FORTH looks for business partners in Crete only when it wants to access the public programs*"(Katharakis, 04/05/2006).

12/06/2005). External financial support was necessary, but neither the Park sponsors nor the national government (that soon after stopped supporting the STP experiment) provided it. The management teams' viability is linked to their success in bidding and participating in public projects, which only rarely have any relevance to the promotion of Park coordination activities. The Park teams operated from the beginning in an "uncomfortable position", as suggested in Souitaris and Daskalopoulos (2000), of limited support and resources, not being allowed to address their weaknesses and develop a "thicker" support environment.

The responses of the Spanish firms did not reveal a different picture. Low levels of use, focus on information diffusion and low satisfaction from services related to technology transfer or cooperation are again present, even if they are somewhat better in Cartuja93. Where the difference with the Greek STPs lies, however, is in the documented gradual upgrading and thickening of the Park support and coordination structures, more evident in Cartuja93 and much less so in Asturias Park.

Initially, the Spanish Parks' promoters focused on the real-estate element, leaving the coordination activities and networking promotion mechanisms underdeveloped. However, following the maturity thesis of Luger and Goldstein (1991), this appeared to change gradually. As suggested by the Cartuja93 director:

> "once the process of filling the [park] spaces is completed, with more demands on the skills of the companies in the last three years, they are now sufficient to be considered as a technology park and not an urban space of a tower of Babel type. Now is the time for Cartuja93 to convert to a technology agent. It has to bring together the innovation efforts that are present in the park" (Jose Antonio Viera, interview to Bolanos, 2003).

It involves internal networking activities developed by the management team, technology transfer and business support services through contracts with third parties (Citandalucia)[223], linkages with networking organisations in the region, in Spain and outside, but also an active tenants' association. The regional government technology services units (Citandalucia, IAT, AENOR), the technology partnerships (CTA) and joint venture financing schemes (Bluenet) are an addition to that. Being a fully developed Park, Cartuja93 tenants have access to a wider range of mechanisms than in 2000 in order to seek to address the communication gaps and the absence of trust that proximity by itself cannot address. In the Asturian Park, the respective support mechanisms are much less developed. The absence of a single coordination unit and a more Park-focused approach from its promoters is also an obstacle. Still, IDEPA and its subsidiary organisations (CEEI, SRP) provide an important part of the necessary financing for access to specialised and technological services. Irrespective of the effectiveness of these mechanisms, for the Parks' operation it is important that the Spanish regional governments, as main stakeholders and promoters of the Parks, appear willing at different levels to address parts of the constraints of limited demand for advanced services and provide the support necessary in the attempt to induce firms and researchers towards cooperation and interaction.

6.3.4 **Conclusion**

If the high-tech environment of the Parks was only partially developed, the Parks have been even less successful in their role as mechanisms for promoting knowledge flows, linkages and synergies. The results of this investigation corroborate the findings of most other studies. STPs are not particularly linked with knowledge interaction, although a few high-tech and already networked firms and researchers do transfer their preexisting connections and use the Parks to exploit further pre-existing partnerships. Overall, when it comes to

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[223] Agreement for technology transfer services for Park firms with Citandalucia.

access to knowledge, much greater weight is given to external non-local linkages. The limited capacity of the regional context means that the focus of the Parks' innovative firms and of the research organisations is to link with national and international knowledge sources. They seek to integrate in functional cross-regional networks, rather than in weak territorial systems (Isaksen, 2001).

Following Capello and Morrison (2005, p.10) "in areas where this attitude [of cooperation] is absent the chance that a Science park will develop local cooperation is limited. The more backward the regional base, the harder will be this process, the more time necessary for the links to develop". This harder and longer process also reflects the critical role of pro-active and effective intangible mechanisms of coordination and cooperation. In the absence of genuine demand from the regional market, their efficient development has relied on sponsors and/or public support. It is here that the Spanish and the Greek Parks appear to deviate and where the increasing capacity and the dedication of Spanish regional authorities, compared to the experimental approach of the central government's regional policies, provide a much more supportive base for the Parks' operation.

6.4 STPs' role in the creation of NTBFs

STPs' third function, and one strongly connected with technology transfer, synergies and the provision of advanced services, has been the incubation of NTBFs. In the face of the regions' risk-averse attitude, commerce-oriented firm creation and non-supportive market conditions, their incubation-function involved both the creation of the necessary pool of ideas, as well as the provision of the necessary support services (Löfsten and Lindelöf, 2003). The first refers to the general promotion of entrepreneurial culture, the raising of interest among academics/researchers, students and the broader community towards knowledge-based entrepreneurship. The main objective is to increase the number of risk-taking individuals deciding to create a new firm, namely to raise the regional entrepreneurial capital (Audretsch and Keilback, 2004). The second concerns the supportive environment of the STPs helping the transformation of the new technology-based projects towards viable and growth-oriented ventures. It should address the limitations of newly created ventures in skills and capacity, as well as the potential market failures concerning the access to the necessary resources that hinder their viability and potential for growth (Colombo and Delmastro, 2002).

The examined STPs had some important differences in terms of the focus and priority given to the incubation function. The Greek Parks were explicitly linked with the creation of spin-offs from their promoting research centres, in parallel with other technology-based start-ups. The CEEI incubator in the Asturias Park had, in contrast, a less clear technology-orientation, linked more generally to the promotion of "forward looking"(CEEI, 2005) new firms. Technology-based start-ups and spin-offs were an important, but not exclusive target. In Cartuja93, the creation of NTBFs and the incubation function were not given priority in the initial stages. This only changed partly after 2000, with the creation of a dedicated space for small technology based firms, and it is only expected to be given a clearer focus in the future following the plans for the creation of a dedicated incubation structure.

6.4.1 STPs' incubation function results

Comparing the four STPs against themselves and the EU benchmark, only the PTA incubator achieved a really positive performance (see Table 6-3). With more than 100 new firms created in the period leading up to 2005 and over ten firms graduating annually, it is well positioned among similar European structures. The similar sized Greek Parks have had low creation and graduation rates and, especially TTP, are currently occupied by firms that have been operating seven or more years. Moreover, with an increasing presence of subsidiary units, which represent almost half of STEP-C's space and even more of TTP, their incubation function is in question. As for Cartuja93, the "large number of start-ups" operating in the Park (Gil, interview, 2006) (around 90 in 2006 (IAT, 2006)) involves at least 20 basic services firms and more than 25 subsidiaries units/entities of the larger firms, with little entrepreneurial or intrapreneurial characteristics (Antoncic and Hisrich, 2003).

Moreover, the technology character of many of the STPs' tenants is not always clear. On the positive side, and similar to other Park studies (Colombo and Delmastro, 2002), the majority of start-ups are ventures formed by individuals such as researchers, professional and graduate students with advanced education backgrounds driven by an interest in exploiting new ideas and their own skills base. They represent opportunity and knowledge-based entrepreneurs which are different from the necessity-driven and customer-oriented new firms dominant in both countries (GEM, 2005a; 2005b; IOBE, 2007), but their technological intensity is in many cases less clear. Operation in knowledge intensive sectors was enough for CEEI managers to characterise them as innovative firms and only 25% of CEEI are reported as being technology based firms. In the other three Parks, more advanced technology-based firms came along with new firms in more mainstream activities. An internet travel agent "developing internet-related products" was considered innovative enough to be admitted into the STEP-C incubator. Research spin-offs, the focus of the Greek STPs, are few, present in Cartuja93 and Crete but absent until recently in Thessaloniki park or in the Asturias incubator.

Table 6-3: Parks NTBFs' creation record – summary table

	EU benchmark	TTP	STEP-C	PTA	Cartuja93
Incubator space available (m^2)	5860	1200	4000(600)	900	14000*
Number of firms created (until 2005)	-	21	45-50	>100	≈90
Graduation record (firms/year)	6.6	1.4	2.5-3	10	No data
Average graduation period	2.9 years	6.5	>5	3 years	No data
Survival rates	85%	>75%	No data	65%	No data
Share of innovative firms	50-70%	65%	≈ 2/3rds	50-60%	75%
Research spin-offs created	11%[224]	2	10[225]	-	5

Source: survey, EC (2002)

The role of the STPs in firms' growth is even weaker. Against the prototype growth oriented start-up[226] of the technology incubator model (Aernouldt, 2004), the majority of the firms reported low or close to zero employment growth rates. High growth examples have been limited to one or two exceptional cases in STEP-C (FORTHnet earlier and Virtual Trip more recently), a similar number in CEEI and three more in Cartuja93. High growth performance does depend on a number of external and internal parameters such as the type of technology, market reference (local, national, international) and the technology/idea maturity at the time (Pirnay et al., 2003). Assessing firms and projects on the base of such criteria is common among incubators that follow a "picking winners" approach (Bergek and Norrman, 2007). In the examined cases they were never properly applied. The weak environment and the limited local pool did not allow such selective approaches.

Even more negative, however, are the low graduation rates and the absence of the necessary mechanisms that would push firms towards graduation. Despite the limited interest or capacity of many of the examined tenants in pursuing a growth-oriented strategy, they are still allowed to stay inside the Parks' incubator well beyond five or even seven years of

[224] This refers to the share of the total from a sample of 2,228 firms in incubators
[225] Three of the spin-offs of FORTH institutes moved outside Crete
[226] According to Autio (2007), the definition of high-growth entrepreneurship refers to a firm that reaches more than 20 employees after five years

operation. Instead of promoting growth oriented new ventures(Aernouldt, 2004), the Greek STPs' incubation function has been transformed to a survival support service, based on low rents and quality infrastructure provisions.

6.4.2 Stirring entrepreneurship

Given the limited entrepreneurial capital and their dominant risk-averse culture, the capacity to stir entrepreneurship had an important role in the Parks' incubation function, contributing to the region in general, but also to the creation of the Parks' own client base. Raising awareness and promoting entrepreneurial activity was part of all STPs' activity. Business plan guides, information concerning the role of intellectual property and organisation of events and other relevant seminars have been present in all four cases.

However, there are clear differences in the intensity and pro-activeness of the support activities. With a clear mandate from the regional government and continuous support from IDEPA, CEEI has been very active in ideas generation, entrepreneurship training provision and pre-incubation support for professionals, researchers and highly-skilled students. More than 300 entrepreneurship projects annually are indicative of this dedicated effort in attempting to address the initial obstacles that entrepreneurs face. According to one recent Park entrant:

> "...[this support] is very good. It open [peoples] minds and it is very good that the speak to young people that they should not only focus on the idea of finding a job, but also to develop synergies and to take the initiative to create companies" (Menéndez,C.- founder of Selegna Design, interview to Plaza, 2007)[227].

[227] Translated from «...está muy bien. Abre mentes y está muy bien que se le hable a los jóvenes de que no sólo deben centrarse en la idea de dónde busco trabajo, sino también establecer sinergias, que la gente coja la iniciativa para crear empresas».

This pro-active approach has not only created new firms in the region, but has also brought some new tenants into CEEI, even if these did not include any of the university linked spin-offs.

Against this dynamic approach, the Greek Parks have been limited to the implementation of a few projects such as Unistep[228] and some seminars and conferences, which again replicate their dependence on regional programmes and their limited capacity. Even inside the Parks' space, there is only a reactive approach to the identification of potential business ideas by the PRTOs' activity, which is very different from the technology opportunity search followed in other European research institutions (Clarysse et al., 2005). In many cases, this is seen as the result of the researchers' own limited willingness to become involved in such activity, as most are concentrated on publications (Saitakis, interview, 2006). For the current CERTH director, it is also due to the limited size of research activity and the subsequent small number of potential ideas for spin-offs that made the incubation function a premature idea (Kiparisidis, interview, 2007). However, as suggested by Oikonomidou (2005:3), the main problem is that "...there is no developed mechanism supporting the researchers to identify ways to exploit the technology they have developed". In both cases, the limited existing pool of ideas and negative attitudes are matched by mechanisms that do not support the change of attitude and the increase of potential projects.

As for Cartuja93, with no dedicated structure the Park has so far not played any role in stirring new ideas and increasing the local pool of potential entrepreneurial projects. It has thus operated as a passive recipient of some of the projects and ventures created externally. However, the sponsorship for the creation of a new department for entrepreneurship in the

[228] STEP-C participated in 2004-2005 in the UNISTEP project initiated by the Technical University in Chania promoting entrepreneurship among 80 university students, leading to 20 prototype developments and two new start-ups in STEP-C in 2006 (IRE, n.a.)

University of Seville and the agreement with CSIC research institutes in 2006 for the promotion of spin-off creations (Cartuja93, 2007) are indications of increasing focus. The pre-incubator and incubator structures (Gil, interview, 2006) should formalise this interest and increase the capacity to capture part of expressed increasing interest of PRTOs inside and outside the Park space.

Overall, in this crucial part of the incubation function, only CEEI adopted a pro-active approach, a direct result of a clear and strong mandate from its promoters. The other three cases have been limited to a Park label signalling role, awareness raising and general information that does not address limitations and hesitations identified in the majority of the research institutes and by the broader regional environment.

6.4.3 Supporting NTBFs' creation and growth

Even among the existing NTBFs[229], the study showed that, for the majority, the incubation function was limited to the quality infrastructure, basic services and a prestigious label/address (see Table 6-4). They did not include critical elements such as business guidance, networking and partnership promotion or access to external financial resources. They did not address the inherent limitations and weaknesses of the newly formed ventures, supporting their viability and enhancing their growth prospects. Some of them performed better than others and showed positive prospects, but this can hardly be linked with their Park location and mechanisms.

The positive assessment of the real-estate elements closely follows the results of both less and more advanced environments (Westhead and Batstone, 1998; Bakouros et al., 2002;

229 There are important limitations in this analysis as in many cases; especially in CEEI, the firms have been established very recently (last two years). Despite communication with former tenants,the researcher did not manage to receive any response. While the very small numbers of responses reflect to some extent the reality of the Parks, it does not allow for proper statistical analysis along the lines followed in the relevant literature.

Colombo and Delmastro, 2002). Quality space and basic facilities, along with the provided basic services, can support the NTBFs' operation, saving time and costs for their founders and allowing them to focus on the core of their firms' activity. Primarily in Crete but also in the other three regions, they addressed the absence of quality spaces at the time of their creation.

Table 6-4: Realised added-value for the NTBFs[230] from the Park (# of firms stating)

	TTP (n=4)			STEP-C (n=6)			PTA (n=7)			Cartuja93 (n=10)		
	nu	1-2	3-5	nu	1-2	3-5	nu	1-2	3-5	nu	1-2	3-5
Basic services	-	-	4	-	2	4	1	2	4	1	4	5
Park prestige	-	-	4	1	2	3	2	2	3	-	-	10
Cost/rent	-	3	1	2	4	-	-	2	5	2	7	1
PRTOs presence	3	-	1	1	-	5	4	3	-	2	3	5
Firms presence	4	-	-	1	2	3	4	3	-	1	5	4
n		4			6			7			10	

Source: survey (nu: no use, 1:very low, 5: very high)

Most of them place a high value on the prestigious label/address of the STP space, very similar to other cases documented in the literature (Westhead et al., 1994; Westhead and Batstone, 1998; Bakouros et al., 2002; Ferguson and Olofsson, 2004). It is connected to the assumed technological character of the tenant firm (Westhead and Batstone, 1998), a marketing tool and a positive signal for potential partners and customers, thus decreasing the "newness liability" related either to the firms' age or technology (Ferguson and Olofsson, 2004). While positive in all contexts, in a lagging region the prestigious STP address can be seen as further amplifying the above benefits, especially when it comes to building of linkages with foreign partners.

Beyond those factors, however, and more or less common to all four cases, the incubation function appeared less developed and not particularly effective. Networking and interaction among the Park tenants has been limited in the Spanish Parks, but almost completely absent in the Greek cases. In most respects, the examined cases are far from the networked

[230] Responses are based on the newly created and independent (non-subsidiary) firms.

incubator type of multiple formal and informal linkages described by Bollingtoft and Ulhoi (2005).

Business and management support critical for the creation of viable and growth oriented NTBFs has been made available, either internally or through external partners, and in all four cases there are some examples of success. However, only CEEI of Asturias presents a positive picture. An experienced internal team and continuous public financing supported the creation of mechanisms targeting the transformation of new firms into viable projects. The focus on business support and not on the technology transfer is in agreement with the recognised greater need that entrepreneurs with technical/scientific backgrounds have for business/market support and training (Ferguson and Olofsson, 2004). With no dedicated mechanism, the few research spin-offs of Cartuja93 were referred to the support of public technology transfer agencies like Citandalucia, but for most other new firms the above mechanisms were not used and were not seen as relevant.

In comparison, the priority of Greek STPs towards public programmes unrelated to the Park tenants' needs and activities and the limited experience of the STP management teams was translated to ad-hoc support in the initial stages of the firms' creation that was positively assessed in very few cases. Furthermore, as a result of loosely applied graduation policies, the initial support became rather irrelevant for firms after the fifth or seventh year of operation. Expressions such as "we have been completely abandoned since our relocation to the park's premises" documented in Souitaris and Daskalopoulos' (2000) study were replicated five years later with no response from the Parks' management.
The Spanish Parks also appeared more able to address the weaknesses of the small firms in identifying new partners and developing external linkages. While again with limitations,

CEEI had a pro-active approach towards the promotion of regional and external connections (see Table 6-5).

Table 6-5: Stated use and satisfaction of Park NTBFs regarding selected support services

	TTP			STEP-C			PTA			Cartuja93		
	NU*	1-2	3-5	NU	1-2	3-5	NU	1-2	3-5	NU	1-2	3-5
Information provision	2	-	2	-	4	2	-	2	5	1	2	7
Management support	2	1	1	2	4	-	-	2	5	4	2	4
Technology transfer	4	-	-	3	3	-	2	5	-	2	5	3
Cooperation /networking	2	2	-	1	4	1	2	2	3	3	4	3
Participation in R&D projects	2	2	-	-	4	2	2	2	3	5	3	2
Access to finance	4	-	-	2	4	-	1	1	5	2	7	1
n		4			6			7			10	

Source: survey *NU: No Use (tenants were asked to assess the Park location's added-value given a choice among six options: not applicable, 1-very low, 2-low,3-medium,4-high,5-very high)

None of the examined cases have so far been connected with a venture capital scheme. Firms with equity participation have been the exception (FORTHnet in Crete and a couple of the more recent tenants of CEEI). Based on their founders' tacit knowledge, services provision and regional or national market reference, most do not suit venture capital investors looking for high returns and clear exit-strategies(Pirnay et al., 2003). At the same time, with a few exceptions, researchers or entrepreneurs appeared either not willing or not interested in sharing ownership. As stated by the manager of Pancretia bank's[231] VC scheme:

"the main problem we face is that most researchers are not willing or are not prepared to share ownership. They want to maintain full control and do not understand the concept of the venture capital" (Sifakis, interview, 2006).

Above all, however, the most important of the Parks' incubation support functions is the presence/availability of financing tools that fit the needs of high-risk projects/ventures and

[231] Local bank of Crete

address the apparent market failures (Colombo and Delmastro, 2002), an issue further exaggerated in the lagging regions' context. While equity schemes (seed fund, VCs) are the most typical form, public grants or R&D project support also have a positive role. What is important is the simultaneous presence of business mentoring, networking and the pursuit of growth oriented strategies that most often accompanies equity financing.

The difference rests in the gradual evolution of the Spanish STPs towards a closer connection between the Parks' tenants and equity financing, driven (once more) by the direct or indirect support of the regional authorities. The five spin-offs of Cartuja93 used equity schemes developed or subsidised by the regional government. CEEI is also nowadays promoting the use of public or private equity schemes for new entrants, to which it offers business monitoring and networking support. Neither TTP nor STEP-C developed any similar type of connections, including the absence of any spin-offs supported from the PRAXE scheme, although they did appear to be actively pursuing them.

6.4.4 Conclusion

The analysis of the four STPs' incubation, and the parameters that affect its operation, point again to a similar direction. The limitations of the external environment, namely a low R&D base, an absence of entrepreneurial capital and weak demand, have been strong obstacles to their operation. The objective of technology based and growth oriented new firms has very rarely been achieved and the identified examples represent only exceptions. What is found, even at different levels, is the clear pressure to fall back towards more traditional, less innovative and non growth-oriented firms, to apply flexible admission and even more flexible graduation policies and to focus on basic support services.

It is not that the STP operation does not have a positive role for the few interested entrepreneurs. The quality infrastructure and basic services, the financial support through the decreased rent schemes and the prestigious profile represent valuable support for the few interested individuals and researchers. However, their operation offers much less in terms of addressing the limitations that entrepreneurs and NTBFs face in weak innovation systems, with limited demand for their products and technologies and need for access to broader markets. More importantly, it has not played any role in addressing the weaknesses of the lagging region and the absence of entrepreneurial culture.

The relative success of the Asturias Park highlights the extent to which properly developed mechanisms and processes can address the limitations of the economic environment. With a clear mandate, necessary financial resources and support from its promoters and a long term plan, the CEEI of Asturias has achieved much more positive results. This largely concerns the pre-incubation function that strengthens the absent entrepreneurial capital, as well as the subsequent support for the survival, graduation and the growth (although less so) of new ventures. Against that, the Greek STPs' context were matched by the absence of necessary support, weak mechanisms and an ad-hoc approach to incubation. The Greek Government has connected the weak results with the management failures of the public sector (Sofouli and Vonortas, 2007) and decided to promote the creation of privately managed incubators (the ELEFTHO program). Management has been a weakness of the Greek STPs, matched with limited support by the promoters to develop services and the necessary equity scheme.

Table 6-6: Summary table of Parks' incubation function and results

	PTA	C93	TTP	STEP-C
Sponsor	Regional government	Regional government	PRTO/central gov't	PRTO/ central gov't
Focus/priority	Innovative start-ups	Technology spin-offs/start-ups (not clearly defined)	Technology spin-offs/start-ups	Technology spin-offs/start-ups
Park conditions	No PRTOs Moderate size Park activity with few high-tech firms	PRTOs with entrepreneurial culture Large Park with some high-tech firms	Small PRTOs with no entrepreneurial culture Very small size	Moderate size PRTOs with some entrepreneurial culture Very small size
External environment	Moderate size HEI with limited but increasing entrepreneurship. Limited entrepr. culture in region Small market with low tech.demand	Large HEI and PRTOs with limited but increasing entrepr. orientation Large market but weak technology demand	Large size HEI but with no entrepreneurial culture Moderate market size with weak technology demand	Moderate size HEIs but dynamic with some entrepr. culture Very small market size and no technology demand
STP operation				
Sponsors support role	Clear mandate Strong financial support	Not defined Provision of resources and support	No clear mandate Limited financial support	No clear mandate Limited financial support
Admission/ selection	Innovation-oriented new firms (flexible)	No screening	Technology-based new firms (flexible)	Technology-based new firms (flexible)
Stirring activity	Active "region champion"	Limited but increasing	Passive/limited	Passive/limited
Mechanisms	Combination of real-estate with support in business, networks and financing and reactive Developed expertise	Real estate and (non-dedicated) support mechanisms	Real-estate focused More advanced support limited and reactive Limited expertise	Based on real-estate Advanced support limited and reactive Limited expertise
Results				
For incubator and Park	High tenancy levels High entrance and graduation rates No transfer to Park Some non-tech firms No research spin-offs	Presence of few dynamic spin-offs and start-ups	High tenancy Low entrance and low graduation rates Some non-tech firms	High tenancy Low entrance and low graduation rates Some non-tech firms, two spin-offs
For firms	Positive role in survival Limited but increasing role in growth	Positive role in survival Very limited in growth	Positive role in survival Very limited in growth	Positive role in survival Very limited in growth
For Parks' sponsors	Implement effectively entrepreneurship support policies	Positive profile	No spin-offs support mechanism No income creation Some positive profile	Space for spin-offs but limited support No income creation Some positive profile
For region	Important number of new firms created Support entrepreneurial culture/capital Limited employment creation	Very limited contribution to entrepreneurial capital and NTBFs creation No employment creation	Very small number of NTBFs No significant employment creation Limited role in entrepreneurial culture promotion	Few new firms in knowledge based sectors No significant employment creation Limited role in entrepreneurial culture promotion

Source: own elaboration based on research results

6.5 Can STPs in lagging regions succeed?

Based on the analysis of the STPs main functions, what can be concluded about the feasibility of creating successful STPs in lagging regions? Are the Parks "real" STPs or do they only hold the STP label, as it is often claimed? What appears to be the role that the external environment plays in the Parks' operation and performance? Which internal design parameters affect the Parks' operation and chances of success and how?

The picture illustrated shows that, at different levels, the Parks have failed in comparison to the general STP model, but also against most of the objectives set by their promoters (see summary Table 6-7). They have been only partially successful in building knowledge and innovation intensive spaces. It is not that knowledge creation and innovation activities do not exist; the presence of the public research centres signify important knowledge creation mechanisms, while a number of dynamic firms in all cases have high innovation-intensity. However, more often than not the focus of the activities is on the use of technology, the adoption of knowledge and technologies developed elsewhere. This is still innovation and is critical to the firms' productivity and supportive of their competitiveness, but this makes them competitive in the regional or national but not in the international market, in which only a few are active. Even more critically, next to them one can also find mainstream, not innovation-prone and not knowledge intensive firms and units. The Parks are not the same as their adjacent industrial or business parks in terms of overall levels of skilled labour, and the value added by their activities or innovative performance, but they tend to be mixtures of more and less innovative activities that only partially fit with the expected innovation intensive environment.

This is not their weakest point, though. What is much more important concerning their expected role, and thus their success, is observation of the limited interactions and knowledge flows. Linkages, interactions and synergies between firms and public research organisations remain the exception rather than the rule. Whenever they happen, they are based on prior cooperation between firms and researchers, and in the great majority they are small parts of broader networks and partnerships. The innovation supportive environment and the knowledge flows were not promoted and facilitated by a proximity element that is most often seen as irrelevant, nor by a culture of cooperation and creation of synergies that is generally absent, nor even by weak and underdeveloped and ineffective mechanisms that the majority of tenants do not use. Limited trust concerns and weakness in organising cooperation are absent both inside and outside the Parks' space. From the expected innovative milieu and industrial district environment that the Parks should have developed, the only element is the cost effective use of basic resources and services of the pure agglomeration model. The Parks in that respect are not that different from the adjacent industrial or business parks.

The Parks' role appeared similarly weak in supporting entrepreneurship and the creation of new technology firms. The Asturias Park represents an exception, if the promotion of innovation oriented entrepreneurship (and not strictly of technology based firms) is accepted as its target. The other three STPs have performed well below the relevant EU benchmarks, with very small numbers of real NTBFs created and, critically, with their added-value reduced to not much more than quality infrastructure and a prestigious address. This is particularly evident in the Greek STPs, which cited the creation of spin-offs and entrepreneurial support as a core objective of their creation. Again, they appear to be transforming towards real-estate projects, abandoning most parts of their expected incubation function.

Table 6-7: STPs' performance summary table – performance, role of Park mechanisms and evolution over time

		TTP	STEP-C	PTA	C93
Innovation intensity					
	Presence	***	***	**	***
	Evolution	O	O	O	+
R-I linkages					
	Presence	*	**	*	**
	Evolution	O	O	O	+
Synergies/networking					
	Presence	*	**	*	**
	Evolution	-	-	-	+
NTBFs creation					
	Presence	*	**	***	*
	Evolution	-	O	+	+

Source: own elaboration Presence: *:very limited, ***: moderate *****: very high Evolution: -: negative, o: no change, +: positive

The analysis of the role of the regional context confirms the basic hypothesis of this thesis. The Parks' broader context has been their main obstacle for success. The transferability of the STP model from the few successful cases in developed regions with a strong technological basis to the lagging regions appears limited, but is in some respects misplaced. At different levels, the Parks' environment posed obstacles and limitations to the development of the Parks' functions. They concern both those related to the STPs' proximity and the expected agglomeration forces, but also those related to the development of the intangible supportive structures and mechanisms.

The limitations of the local environment include the limited receptivity and absence of genuine demand from firms, organisations and individuals for most of the operations and the related functions that are in the core of the STP model. The majority of researchers in the Greek PRTOs and universities did not consider the exploitation of their research activity through the creation of spin-offs or cooperation with industry as a priority and did not change attitude just as a result of their location in the STP space, in contrast to Link's (2003) findings. The small amount of overall R&D activity in the regions, hence the potential for ideas, and the negative attitude towards exploitation caused the STP managers to struggle to find one or two high-tech start-up projects per year and they gradually abandoned the effort altogether. This situation was only marginally different in the Spanish regions. The relative success of the Asturias incubator proves the importance of pro-active promotion strategies that focus on stirring entrepreneurial culture and create the demand for incubation services.

Similarly, STP proximity could not by itself address the established absence of relational capital and local networks and lead to technological cooperation and the creation of synergies. All four cases support Capello and Morrison's (2005) assertion that lagging areas are particularly difficult environments for the development of local cooperation and interactions. While a few firms and researchers with prior experience used the Park space as a convenient location to transfer existing partnerships, for most others the absence of trust and a limited perceived added-value remained key. The Parks' advanced support mechanisms were expected to play a catalysing role and address the above obstacles. In practice, though, they were themselves limited by the absence of genuine interest for their use, coupled with the absence of the necessary sources to finance their long term viability.

The results support Isaksen's (2001) view that, in regions with limited technological resources and thin institutions, the STPs' promotion of local networking is probably misplaced. The more competent and technology oriented firms, and similarly the high quality PRTOs, focus almost exclusively on external sources of technology and innovation with the priority of integrating into broader sectoral innovation systems and markets. It is the external networks that can give them access to broader markets and advanced technology sources. The thin and weak regional context cannot offer much to their operation and success and, as suggested by Tsipouri and Gaudenzi(1998), may even have a negative impact. For the less technology/knowledge intensive firms or the production units, external markets are the main sources of equipment and machinery, their commonly used forms of technology upgrade. In this direction, the Parks' role is to strengthen the profile and reputation of the firms or to give them access to broader information networks. Local linkages and interactions appear, on the other hand, indifferent to both firms and researchers and the Parks' mechanisms, to the extent they are developed, seem irrelevant.

The above facts highlight that an infrastructure and support services supply-based STP policy cannot operate in the absence of necessary demand. These market limitations are further accentuated by unsupportive institutional and policy frameworks. Transferred/copied from outside, the STP idea did not have the integral element of innovation policies, which were either absent or only weakly articulated and with no clear priority towards innovation-led development. In the case of Cartuja93, only very recently did the gradually evolving regional innovation policy start operating in a more supportive form. In Asturias, the policy focus of addressing economic decline through new investment and employment creation made the Park part of an inward investment oriented industrial policy, but deprived it of most of the potential interface and knowledge transfer role.

Even more so in the Greek regions, the STPs remained marginal to the broader innovation policy, an experiment to which nobody at a regional or national level appeared committed. The STP schemes were imported in a top-down format without real interest from most of the local players and with no capacity to develop complementary and supportive policy measures. For the central government, the STPs remained an experiment with no supportive legal framework and with limited dedicated resources. The funding provided after 2000 for the creation of private incubators is suggested by some researchers as the result of a learning process that concluded that the public sector has a weak management capacity of the public sector (Sofouli and Vonortas, 2007). Even in this case, the conclusions were not applied to the Parks themselves, which were left in an unclear and unfavourable position. The limited actual demand for the STPs' mechanisms and operations from the local markets were matched with underdeveloped and unsupportive institutional frameworks.

In parallel to the role of the STPs' broader context, the comparison of the four cases points to internal design elements and implementation parameters (see Table 6-8). While the management structures, the coordination and the development of the advanced services were problematic in all four cases, there is a very clear difference between the capacity of the Greek and the Spanish management teams to organise the Parks' operation, to address weaknesses and evolve. The Greek STPs had no clearly defined targets, no sufficient operation resources and there are no evaluation procedures. Against that, the Cartuja93 management team had a clear mandate and, with the backing of its promoters and the necessary resources, it has gradually moved from the consolidation to the maturity phase, attempting to address over time some of the limitations and weaknesses of the Park space. This is much less so in Asturias Park as a result of an unsupportive management structure, but it has played an important role in the success of the CEEI incubator.

The importance of the Parks' knowledge and institutional base, characterised by its size, type and entrepreneurial character, is quite evident as suggested by Castells and Hall (1994). The engineering school in Cartuja93 and, to a certain extent FORTH C, proved more positive and supportive to the Parks' operation due to their size, but also mainly due to their pre-existing interactions with firms or their capacity for the creation of spin-offs . On the contrary, limited knowledge bases like those of TTP and Asturias, absence of any formal cooperation with the local universities and a negative position towards entrepreneurship are not supportive of the development of the STPs' activity.

The comparison of the two different types of Parks represented in the analysis, the technology-led and the property-led, does not appear to favour one over the other. Clearly the absence of critical mass in the Greek STPs decreased the probabilities of the presence of tenants with complementary activities and the expected agglomeration forces and can also be considered as decreasing the scope for the development of targeted advanced services. However, while Cartuja93 or even Asturias' sizeable Park had a larger, stronger and more complementary group of firms, thus representing greater opportunities for cooperation, this did not lead to synergies and cross-fertilisation processes on its own. In most cases, tenants remained indifferent, irrespective of the number of neighbouring firms. Nor does the Parks' size appear to be the most important limitation for the development of the necessary mechanisms. The described financial circuit (Komninos, 2002) that should connect the real-estate with the intangible support services was not present. In all STPs it is clear that the more advanced mechanisms requires strong public funding and support. This is more a matter of the objectives attached to the Parks' operation and, even more critically, to the support from its promoters.

This is possibly the important differentiating element between the Spanish and the Greek projects. In the Greek Parks, the research centres showed limited interest and capacity to support the Parks' operation and the development of the necessary intangible mechanisms. The new Park and incubator projects in Thessaloniki have led CERTH directors to a de-facto abandonment of most parts of Thessaloniki Park's functions, unable and unwilling to commit additional resources for their development and renewal. In comparison, the promoters and owners of the Spanish Parks have stepped up their support. As regional authorities, they had the capacity to finance the necessary mechanisms whenever this need was realised and the relevant policies supported it. In Asturias this was evident in the CEEI incubator, but much less so for the remaining park mechanisms. Cartuja93 has been equipped with the mechanisms and structures to promote cooperation and networking inside the Park and within the respective region. It is primarily this support that differentiates the Cartuja93 Park from the remaining three cases and, despite its current limitations, puts it on a more promising path towards collaboration, networking and synergies creation: the gist of the STP idea.

Table 6-8: Summary table - The role of external and internal mechanisms in STPs' operation

	TTP	STEP-C	PTA	C93
External				
Regional actors (PRTOs, firms, markets)	- Limited demand for STP mechanisms - Limited pool of ideas, no entrepreneurial culture	- Limited demand for STP mechanisms - Limited pool of ideas, no entrepreneurial culture - Very small market	- Limited demand for STP mechanisms - No attraction capacity - Limited number of innovative firms	- Limited demand for STP mechanisms - No attraction capacity - Limited number of innovative firms + Presence of a few dynamic KIBS
Institutional framework	- Unsupportive legal framework - Only recently developing regional innovation policy but Park has a marginal role	- Unsupportive legal framework - No relevant regional innovation policy	- Main focus on industrial policy - Gradual development of innovation policies but Park has a marginal role	- Initial focus on infrastructures + Gradual strengthening of innovation policies, Park role
Internal				
Ownership structure	- Unclear objectives - No commitment to Park development -Deviating objectives	- Unclear objectives - Limited commitment to Park development - Absence of other local players	- Focus on real-estate - No broader support attracted	+ Rather clear objectives + Dedication and support (only initial conflicts)
Management	- Weak structure with no resources	- Weak structure with no resources	- No dedicated management structure/no coordination (with the exception of CEEI)	+ Dedicated management structure + Increasing coordination role + Gradually increasing support for development of mechanisms
Financing	- No Incentives and subsidies -No equity capital schemes	- No incentives and subsidies -No equity capital schemes	+ Incentives and subsidies + Risk capital schemes (recent)	+ Incentives and subsidies + Risk capital schemes (recent)
Infrastructure	- Very limited, no critical mass	- Limited, no critical mass	+ Attractive - Pressure from costs	+ Attractive - Pressure from costs
Anchor tenant	- Small size and no entrepreneurial character	+ Relatively increased and developed entrepreneurial capacity	- Absent	+ PRTOs and few important local firms

Source: own elaboration +: positive,-: negative role

6.6 STPs role in supporting regional development

Given their weak internal performance and the strong deviation from their definition in most parts of their internal functions, what is the role that the STPs have assumed in the respective regions?

Theory provides a number of alternative mechanisms through which successful STP structures could have an impact on the regions' economies and the operation of their regional innovation systems. The growth pole view focused on the concentration of a sizeable base of high-technology activities and the development of backward and forward linkages and agglomeration forces developed around the Parks' propulsive activities (Luger and Goldstein, 1991). The endogenous view, on the other hand, focused on the Parks' role in exploiting existing resources for knowledge intensive firms, but also its support and strengthening of the technological and innovative capacity of the local firms (Tsipouri, 1998b). The innovation systems literature points to a potential institution building mechanism operating as an interface among the different players inside the system and supporting collective learning processes (Capello and Fagian, 2005). They are also seen as possible platforms that bring together local players in the formation of broader technology oriented development coalitions.

The examined STPs integrated the above objectives to different degrees. The large Spanish Parks followed the growth pole model, giving priority to the attraction of non-local sources to the region. Over time, though, and as result of the failure of the attraction policies, a more endogenous orientation assumed greater weight in both the Asturias and Cartuja93 cases. For the Greek Parks and their promoters, the focus was (from the beginning) on supporting and strengthening the local indigenous sources either through the creation of new firms or through the transfer of technology to the local fabric.

6.6.1 **Growth poles?**

The analysis of the four cases showed rather clear limitations for the operation of STPs as growth poles. Most of the essential requirements are missing and the regions appear unable to develop the necessary processes/mechanisms to exploit and diffuse their inputs. The main impacts that have been identified are so far limited to income multipliers and the expected firm expansions, new firms formation and attraction of high-tech activities derived from the Parks' operation are not developed.

Of the four cases examined, only Cartuja93, with its strong activity growth, is a Park with the necessary size (in respect of the broader local economy) to create the necessary threshold levels of demand that the Park model requires (Luger and Goldstein, 1991). The Asturias Park has so far remained a rather small concentration inside the regional economy, while the Greek STPs were a-priori limited in their potential to play this role. More important though, the majority of the Parks' tenants, firms and PRTOs, have remained disconnected from the local economies, and most of the processes through which the Parks' pole would bring broader development have been absent. The production units of Asturias Park, especially the few of non-local origin, cited limited integration into the local supply chain, especially in relation to technology inputs which tend to be imported from outside. In Cartuja93, the few non-local units, essentially CSIC research institutes, still have limited connections with the local industry and, as yet, have not played any significant attraction role to the regions. To the extent that the FORTH and CERTH research centres represented the Greek Parks' propulsive mechanisms, there are again very weak linkages with local industry and no capacity to attract firms from outside.

The apparent inability of the Parks to play the expected propulsive role is not a surprise. The requirements of the growth pole doctrine for a match between the Parks' activities (the pole) and the regional economy were not served (Luger and Goldstein, 1991). The propulsive activities are defined in each case in relation to the regions' characteristics and, as a result, the concentration of some high-tech firms or research organisations that are not integral elements of the regional economy could not play this role. Especially in Crete, the biotechnology, laser, computer sciences and computational mathematics research activities of FORTH have very limited overlap with a regional economy dominated by touristic services, primary sector activities and food processing. Similar to the case of large branch plants with no supply chain linkages, FORTH remains again a cathedral in the desert. To a lesser extent, this applies to CERTH in TTP or CSIC institutes in Cartuja93.

The Parks' operation has not led to the attraction of high-tech firms in the respective regions and the creation of high-tech clusters. All that has happened so far is only some intra-regional relocations of local-origin dynamic firms, attracted by the quality infrastructure and the prestigious address offered by the STPs. In Andalusia, Seville has strengthened, along with Malaga, its share of the regional high-tech activity and the presence of Cartuja93 has possibly played a role in that direction. In Asturias, the central area of Llanera where the Park is located has experienced particular growth in the services area and the same applies to the area east of Thessaloniki where TTP is located. In none of the above cases can the presence of positive agglomeration forces based on a thicker supply of support services or a skilled labour pool be excluded. However, the survey results show that, if these exist, they have only a secondary role.

Overall, the Parks have not developed most of the expected growth mechanisms that would render them effective growth poles, but it is also questionable whether, at least in the short to medium term, they will be able to develop such a role. In many cases, the inappropriate selection of tenants as propulsive industries, in combination with the weaknesses of the local industrial and services firms, does not allow them to be integral elements of the respective economies in order to develop the expected momentum. As a result, for a long time the effects are expected to be primarily the result of earnings multipliers coming from the Parks' high skilled employees. They may grow as the Parks' activities grow, but they have very little to do with the expected innovation diffusion to the broader economy.

6.6.2 **Strengthening local indigenous capacity?**

Despite growth pole mechanisms that have still not developed, the focus of the Parks onto the support of the local indigenous capacity has brought about some more positive outcomes. They can be linked to the fact that the development of innovation information and technology mechanisms, the provision of codification of the available knowledge to support technology transfer and activities to promote entrepreneurial culture were absent at the time of the Parks' creation. The Parks' operation represents a positive contribution towards addressing the latent demand for technology and increasing the interest in integrating innovation in the local firms' development strategy. Pro-active strategies such as that of Asturias' CEEI in raising entrepreneurial capital are even more supportive in this direction.

The Parks have been less successful, however, in providing more advanced technology services, although there is a clear distinction between the Greek and the Spanish cases. Despite the focus on participation in the various regional development programmes, the Greek STPs have not developed the necessary mechanisms and expertise. They remain "*not* *dynamic, limited and problematic*" (Georgiou, interview, 2005) and their future appears very much uncertain. In combination with the very poor results in NTBFs' creation and graduation, their role as indigenous support mechanisms has so far been rather marginal.

While not that different, one can point to more sizeable contributions in the case of the two Spanish Parks. The presence of public technology centres such as ITMA in Asturias Park and Citandalucia, IAT, Citagro and AENOR in Cartuja93 provide technology of certification services directed towards the effective use/absorption of technologies to increase their productivity and increase their potential to participate in regional and broader technology networks. The technology transfer activity of the engineering school of Seville through AICIA and the provision of skilled graduates, activities also present in a smaller scale from the Greek PRTOs, add to the contribution derived from the Parks.

The above public sector services of the Spanish Parks also complement the direct or indirect technology diffusion roles played by the Parks' tenants. In Asturias, this is mainly the result of a number of small and medium sized local-origin advanced services operating inside the Park, but also over 150 graduating firms and more than 1,000 entrepreneurs supported by CEEI. In Cartuja93, this concerns an even greater number of existing advanced services of local and non-local origin and a small number of technology based firms. Small or large, new or old, local or foreign, the ICT, engineering/technical analysis, business, legal and marketing services all have their positive role in facilitating the adoption, integration and more efficient use of new technologies into the local industry, supporting its productivity and competitiveness (Fontes and Coombs, 2001; Strambach, 2001; Moyart, 2005). Those few that also state cooperation and interaction with public PRTOs or partnerships with extra-regional firms operate as mechanisms that render knowledge and technology produced by PRTOs and foreign high-tech firms more complementary to the local market and economy's needs (Landabaso, 1997).

However, the role again of the STPs in all above processes is not clearly substantiated. In most cases, it appears limited to the provision of quality infrastructure and a convenient location. The absence of synergies that would support the STPs' tenants innovative activity and the negative or neutral role attached to networking and cooperation mechanisms means that the Parks' actual added value in this process in minimal. The STPs remain no more than the sum of their tenants' individual competencies. As summarised by the Cartuja93 tenants' association director: "Most firms will almost certainly grow and succeed, irrespective of the development of cooperation linkages with their neighbors in the Park" (Gonzalez, J., interview, 2006). The tenants' contribution to technology diffusion/adoption may be more or less advanced, but the Parks' own role remains marginal so far, limited primarily to the provision of quality infrastructure.

6.6.3 Strengthening the regions' innovation systems?

The quality infrastructure provision is also the main contribution of the Parks when examined from an innovation system' perspective. The public PRTOs that came with STEP-C and TTP, and those that followed the creation of Cartuja93, clearly broadened and strengthened the local R&D base, serving an institution thickening role (Phillips and Yeung, 2003). All four are examples of attempts to put the regions "on the map" among the many other "self-respecting" regions and cities with a similar type of infrastructure (Benko, 2000). Given the resources dedicated to Cartuja93, the marketing and promotion that came with Expo92 and also the much more active promotion of the management team, Cartuja93 has been much more successful than the other three cases in putting Seville "on the map".

Nevertheless, the absence of linkages – with few exceptions - and of effective interaction support mechanisms means that the Parks' role as facilitators of knowledge and technology flows and the development of collective learning processes has been so far limited. The Greek Parks' own operational limitations and the unsupportive local environment meant that the PRTOs' isolation has not changed radically since the Parks' creation. Maintaining the real-estate focus until now, Asturias Park promoters have largely deprived it of a role as a science-industry interface and a coordinator of knowledge flows. Of the four, only Cartuja93 has gradually assumed a more active interface role. The weaknesses and limitations were clearly documented, but a combination of some dynamic firms, strong public PRTO presence, an increasing base of technology transfer functions and a number of regional operation measures and mechanisms (e.g. CTA, RETA) place Cartuja93 gradually much more in the centre of the effort to develop a more effective regional innovation system.

Arguably, the results from all four Parks reveal a greater tendency of the park tenants to link with non-local and international partners. In some cases these linkages involve technological collaborations, mainly through the participation in the public R&D projects, that can strengthen their integration in European and international networks and support learning and innovation. But again, even at different levels, the Parks and their mechanisms have had very limited contribution in that respect. More important, as these linkages are not combined with local cooperation and interaction – thus not creating spillovers and knowledge transfer – the actual contribution of the Parks to the regions' scientific and technological potential and the strengthening of their competitive advantage remains also marginal.

Cartuja93 is also an example of a Park where some type of partnership has gradually developed around its operation. In the initial stages, the dominance of the public sector as the driver of the project was complete and, as suggested by Castells and Hall (1994), it shielded the Park from real-estate pressures to some extent, allowing it to maintain part of its high-tech character. The endogenous turn in 1997 was the initiation of an understanding between the public and the private local sector of a common action framework and a set of strategic initiatives (Vazquez-Barquero and Carrillo, 2004). As the Park evolved, the initially informal partnership developed further, based on mechanisms such as the tenants association or the regional technological corporation (CTA) that brought together most of the important regional players. The recent inclusion of the university and private investors in Cartuja93's management company[232] provides additional indicators of such a process. Activity growth, economic success and a greater potential for cooperation appear supportive of the gradual formation of a broader partnership around Cartuja93's operation.

The other three Parks have largely failed in this direction for different reasons. Asturias' promoters never really attempted to give the Park such a role and other local players were left outside the Parks' operation. While the Greek STPs' management teams were envisioned "...as potential mechanism to bring together the industry and the research community" (CPERI, 1991), they largely failed. In Crete, their role never really took place in the absence of an interested business community or local authorities. STEP-C is still "the park of FORTH, not the park of Crete" (Katharakis, interview, 04/05/2006). In Thessaloniki, the participation of a dynamic industry association created initially positive prospects, but diverging strategies and priorities gradually led to a degrading of the partnership scheme that has now lost its relevance. Other mechanisms (the EU RTPs and

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[232] The university holds since 2006 a symbolic 0.19% and one bank –Cajasol - 17.3% (Cartuja93, 2004).

RIS projects and the national innovation pole project) with many more resources and more explicit and externally imposed partnership rules proved much more successful (Benneworth, 2007). In this respect, TTP may only be seen as an unsuccessful forerunner.

6.6.4 Conclusion

At different levels, the Parks' roles inside the regions have only marginally moved beyond infrastructure provision, a high-profile label and possibly broader awareness raising. They are neither growth poles diffusing technology knowledge and supporting economic growth, nor do they play any critical role in technology transfer, networks and synergies creation or the effective operation of the regions' innovation system. In all the above functions, what is characteristically missing is the linkages and interactions between the local players and the external environment. These are linkages that only rarely require the Parks' physical element. They are based on relational proximity and absorptive capacity and the presence of those strong supportive mechanisms that will help them develop. As long as the Parks do not have these mechanisms, they are no more than the sum of their individual activities, attractive in their high quality and profile infrastructures, but with limited capacity to become real development poles, to diffuse innovation to the regions and to play a role in the strengthening and thickening of their innovation systems.

7 Chapter 7 – Conclusions and further research

7.1 Objectives of the thesis and methodology

This thesis has examined the development, operation and performance of Science and Technology Parks in lagging regions of Southern Europe. The objective was to assess the prospects of the success of STP-labelled projects in environments characterised as innovation averse (Rodríguez-Pose, 1999), with limited technological resources and knowledge creation effort and an absence of most of the contextual requirements commonly considered to be important for their success.

The research has been motivated by two considerations. The first is the general recognition of the role that knowledge and innovation play in the economic development and growth of countries and regions and the strong empirical evidence that innovation tends to develop in a cumulative and path dependent manner, that favours its concentration in a few places and locations (Komninos, 2002). As a result, regions that, for various reasons, lag behind in innovative capacity appear much less able to produce the innovative activity that is necessary for them to become competitive and to catch up. For the lagging regions of Southern Europe that used to rely on low cost labour, it has often been regarded as the only possible way to respond to the globalisation processes. Government and policy makers that want to increase the regions' growth prospects are nowadays encouraged to develop policies and tools that will help in the direction of strengthening the regions' innovative capacity (Landabaso, 1997). Transferring the experiences from successful stories and attempting to reproduce the positive conditions of high-tech and innovation intensive environments has been the driving force behind a number of initiatives and projects, among which STPs have a prominent role.

The second consideration is the apparent paradox that is related to the development of STPs in the context of lagging regions. The review of the literature on STPs in areas with significant technology and innovation resources, firms that invest in technology and innovation, and where cooperation and interaction are already developed, largely questions the STPs role and added-value. It also suggests that often the success of STPs depends on the success of the region itself and weak environments do not represent the appropriate base (Luger and Goldstein, 1991). At the same time, however, comes the observation of a continuing proliferation of STP-labelled structures in lagging regions promoted by central or regional authorities as projects and mechanisms to support knowledge based economic growth. If the existing empirical evidence questions the success of Parks in advanced contexts, what can be expected from the development of STPs in contexts with limited technological resources, limited demand and investment in innovation and no preexisting tradition of cooperation?

The research was structured around an examination of the interaction of the STPs' creation and operation with the lagging regions' context. The hypothesis was that STPs in such an environment cannot be expected to effectively develop the operations and functions described by their general model. They are expected to face obstacles, both in establishing the STP innovation intensive environment, but even more so in the development of the subsequent cross-fertilisation processes and synergies that are the essence of the STP model. They are expected to be hindered by both an absence of the supportive economic and technological characteristics of the regions and of the appropriate framework that would integrate them in a broader innovation-based development strategy.

Beyond testing the main hypothesis, the objective was to assess what STPs in such a context really are and identify the parameters that affect their operation, enhance their capacity to address the limitations of the lagging regional context and increase their prospects of success. The research combined a confirmatory and an exploratory approach in relation to the STPs' operation in the lagging regions of Southern Europe countries.

The study examined four STPs that belong to the first wave of the STP projects created in the early 1990s in Objective 1 regions of Southern Europe. Among a broader group of Parks, the selection of the four cases reflected the variation in relation to the main types of STP structures that are present in lagging regions, as revealed by an initial review of the STP population, and in respect of the dependent variable, the Parks' success. The final selection of two cases in Greece, the Parks of Crete and Thessaloniki, and two in Spain, the Parks of Cartuja93 and Asturias, reflect an important part of this variation.

7.2 Main results and conclusions

The results of the study verified the initial hypothesis of the research. Although to different degrees, large parts of the STPs' described model had remained underdeveloped or absent and a negative role of the Parks' context and, critically, an inability of the STPs' mechanisms to address the issues, had been documented.

Against the expected development of an innovation intensive environment characterised by linkages, interactions and cross-fertilisation processes, the Parks' analysis showed that they have operated so far as infrastructure providers for firms and organisations that do not always have a knowledge or innovation creation character. Those that do rarely connected their presence in the Park with access to knowledge spillovers derived from physical proximity. On the contrary, in most cases there was an absence of any communication or information concerning the neighbours' activities. Even if some cases, in this study it was Cartuja93 or STEP-C, revealed comparatively more positive pictures in their linkages between research and industry, the general picture is that proximity still remains very much ad-hoc and case specific, dependent on preexisting linkages and connections. Similarly, the creation and growth of new technology based firms and the support from the Parks' seedbed environment appeared rather marginal beyond what could be connected with the convenient location, a quality infrastructure and access to some basic support services. The Parks' expected supportive environment rarely played any of the roles attached to it by the STP model and Asturias' CEEI incubator success should also be qualified in relation to the moderate technological intensity of most of the developed projects. The direction towards the general promotion of entrepreneurial culture appeared a more feasible strategy for CEEI managers.

The analysis of the four cases illustrates the apparent limitations that the broader context brings to the development of successful STP structures; it highlights the apparent weaknesses of STP-labelled structures in addressing these limitations and questions the transferability of the STP-model. The STPs' creation in lagging regions represents a supply of infrastructures and support mechanisms in contexts where there is an absence of real demand for the STPs' services and systems. The weak technological and knowledge creation base, the absence of genuine demand for innovation services, the limited tradition and experience of cooperation and the dominant risk averse attitudes have, in all four cases, created important problems for the STPs in terms of attracting high tech activities and building an innovation intensive environment, but much more so for the development of linkages and synergies. In relation to documented weakness of the more advanced regions' STP structures, the picture appears either similarly or even more weak.

To the extent that STPs target the attraction of non-local knowledge and innovation activities as a mechanism to import or transfer, it is apparent that these can rarely be anything beyond production plants or services provision units that target a combination of incentives, market access and basic production inputs. This was evident in both the Asturias and Cartuja93 cases, which had the attraction of foreign high-tech activity as a prime objective. Central or regional governments attempted to strengthen the Parks' institutional base with the transfer of government research organisations (as was done with CSIC in Seville), but this cannot by itself attract multinational firms' R&D activities. What is observed here is what was also suggested by Castells and Hall (1994); at least in the initial stages of STPs' operation, branch plants and services provision units are the best these regions can expect.

Similarly problematic is the development of innovation intensive spaces based on endogenous resources, even if it is probably the only feasible alternative. In a context where the number of innovative firms is very limited and the investment in R&D is small, the Parks may easily end up dominated by public sector R&D units or by firms with limited investment in R&D and, in some cases, a total absence of investment in innovation. The limited number of local innovative firms means limited demand for STP structures, a pressure to downgrade the admission criteria and filling the Park with either public entities or firms/units that only vaguely have the expected high-tech character.

The gradual tertiarisation of the lagging regions' economies and the increasing demand for business services has led to an increase in absolute numbers of firms in those sectors that tend to be characterised as possessing highly skilled employment and higher than average knowledge intensity. STPs in the lagging regions, with their profile and quality infrastructures, provide a good fit for such activities. While this helps the Parks maintain an above average level of knowledge intensity and the presence of high value-added sectors, it does not necessarily mean the presence of knowledge and innovation creation. The use and adoption of new technologies and organisation processes with a focus on the local markets is more dominant. Innovation in the Parks is much more often about the adoption and localisation of non local knowledge, rather than knowledge and innovation creation. The Parks may, in that respect, be seen as mechanisms to promote and strengthen the presence and role of advanced business services in the regions, with the accompanying smaller or larger positive impacts this can have on local firms' productivity.

The creation of a high-tech space is still not the most important problem that STPs in lagging regions' have to address. Much more problematic is the inherent limited capacity, experience and interest of local firms and public organisations with regards to cooperation. In most cases, STPs were created as interface mechanisms to promote cooperation through proximity and support mechanisms, but when the firms' innovative activity, and thus the capacity to scan and recognise relevant complementary resources, is limited and the attitude towards cooperation is even less developed, the potential of STP mechanisms to succeed are small. The construction of large or small STP infrastructures can be fast, but the changes in culture and approach need much more time. Physical proximity did not change that for the majority of the Parks' tenants, while the demand for mechanisms that should increase this interaction is not able to sustain their development. A low demand-low supply trap was evident in all four examined cases and was only partly solved, at different levels, through the provision of public support/subsidies, with results that were not always clear in terms of quality and effectiveness.

At the same time, the study results support the proposed idea that the Parks' local networking and synergies creation objectives in lagging regions may be misplaced (Isaksen, 2001; Kim and Woo Yoo, 2007). For the few high-tech and innovative firms, but also for the less innovation intensive, what appears important is access to external non-local knowledge sources and partnerships. For the first, usually smaller, group it is the global/extra-regional linkages that provide the necessary knowledge and resources that will allow them to maintain their competitiveness in international markets and to integrate into international networks. For the latter, it is the external inputs in terms of adoption of non-locally developed technology through licensing or equipment purchase that sustains/increases their technological capacity. Local networking and the respective mechanisms maintain a largely marginal role and the demand for the STPs' location and services becomes relevant only to the extent that it provides access to external information sources and networks and possibly a high-profile prestige that increases their legitimacy. Their spatial limitations do not necessarily make them the most appropriate mechanisms for the promotion of this type of networking.

Having said that, the analysis of the four cases reveals that the unfavourable conditions of the lagging regions, design issues and internal parameters affect the STPs' prospects. The selection of the appropriate tenants, and especially the initial building of the institutional base with the establishment of PRTOs, can indeed be critical. From the examined four cases, a few examples of PRTOs that played a positive role in the Parks' operation were identified and many more have so far been either unable to do so or even negative. The engineering university with applied research activity and an established entrepreneurial character has been positive for the operation of Cartuja93. However, government research centres of small size and a focus on basic R&D did not play a similar role in the case of CERTH in TTP or CSIC in Cartuja93. The conclusion derived here from the four cases is in agreement with other studies (Luger and Goldstein, 1991; Castells and Hall, 1994).

The presence of a professional and effective management structure with clear construction, short term and long term targets and continuous evaluation procedures is also important. It goes along with clear ownership arrangements and dedicated promoters/sponsors with a long term view. None of the two have been present in the Greek Parks and they have operated with no clearly defined goals, no established targets and no resources to support their operation. While clearly the lagging regions' context and the absence of a supportive broader framework have posed constraints, there was also an absence of the professional management necessary to coordinate the Parks' activities, to provide the necessary expert support and promote cross-fertilisation. The comparison with the CEEI incubator of Asturias or Cartuja93's management teams highlights this difference. While initially weak and with a focus on the infrastructure element, they had much greater capacity to respond to the changing needs and step up and strengthen the respective mechanisms. If Parks are evolving organisations, the capacity of the management teams to learn and adopt is a key element that has been absent in both Greek STPs.

Above all, though, the four cases shows that the STPs only have a real chance to achieve longer term success if they integrate in broader regional development strategies that seek to connect their tangible mechanisms and infrastructure with the promotion of intangible partnership support mechanisms. The STPs' creation preceded the development of the necessary institutional framework at either the national and/or the regional scale. Thus, for a long period, the Parks remained connected with either traditional industrial policies, like in Asturias, or isolated from a broader policy framework that did not provide appropriate or supportive broader mechanisms, as demonstrated by the Greek STPs. The limited transferability or premature character of the Parks' creation has been made evident in all examined cases.

The increased autonomy and policy making capacity of the Spanish regions and the gradual evolution and strengthening of their innovation policies nowadays provides a more supportive context, especially in Andalusia where the Parks (not only Cartuja93) have been placed in the centre of the authorities' effort to strengthen the regional innovation system. The Park' creation was a long term process and in the meantime a large part of their space and mechanisms was sacrificed. However, the current prospects clearly look better than the Greek cases that still struggle to identify a role in the regions' innovation systems and subsequent policies have not supported their role. STPs can only assume a positive role and have higher chances of success if they are part of targeted strategies and follow or come together with other measures that target the increase of demand for knowledge, technology and innovation, the development of a more risk prone and entrepreneurial culture and the use of technology and other advanced services. The first wave of STPs in lagging regions preceded the development of relevant policies and frameworks and this eventually transformed many of them to simple real estate projects. The new STPs created and the older versions that become parts of more integrated regional policies may enjoy greater prospects for success. In view of the transfer of the STP wave to the new member states of Central Europe, it is essential that STPs' creation only follows the establishment of a more supportive framework and is integrated into a broader development strategy that will create the demand for their mechanisms. Otherwise, they are bound to face the very similar negative probabilities for success.

7.3 Limitations of the research

The limitations of this thesis need to be acknowledged. As argued in the literature, each STP represents a particular project with its own particular features and characteristics and this has implications on the external validity of the results when extended to the broader STP population. The examination of 4 different cases could have led to different conclusions concerning the role of the external context with regards to the STPs' operation and, more importantly, that of the internal design parameters. The absence of Italian and

Portuguese cases also reduces the generalisability of the conclusions for the lagging regions. The selection procedure attempted to reduce those limitations by slecting diverging cases following an extensive analysis of the population of STPs.

Furthermore, while they are all located in lagging regions, the selected cases also had apparent differences in relation to the specific resources available and the path dependencies that were present. One such element was the island character of Crete that, in some of the processes, especially the capacity to keep NTBFs inside the region, proved to be more important than what was initially envisaged. Similarly, the strong industrial decline that the Asturias region was experiencing at the time of the Park's establishment created a negative framework and directed the regional government priorities towards employment creation. The in-depth case studies addressed the above limitations of the external validity of the results by focusing on mechanisms and interrelations derived from the broader experience in the STPs' development and by comparing the conclusion concerning the underlying mechanisms in each examined case with other examined STPs.

Another limitation is related to time and the decision to apply a cut-off point of 1995. Driven by the need to be able to examine long term processes, more recently created, and possibly more successful, STPs were excluded. As suggested in Chapter 3, there is no theoretical basis regarding the use of a ten year cut-off point. Indeed, during or after the conduct of the fieldwork, cases with a potentially greater performance, at least in relation to activity levels, came to the attention of the author. More characteristic is that of the Science Park of Patras (region of Western Greece) that was established in 1998. While the Park had no more than six firms until 2004 (Sofouli and Vonortas, 2007), since then it has achieved a strong performance with more than 25 tenants (PSP, 2007) which, based on secondary evidence, have a strong technological character[233]. In agreement with one of the conclusions of this study, this change of performance coincided with the establishment of a strong, dedicated and pro-active management team. In addition, and in contrast to the other two Greek STPs examined, the central government maintained ownership of the Park and provided the resources to support the development of the necessary intangible structures and mechanisms. What relative current success of Patras Science Park appears to be driven by factors that are absent from the other two Greek STPs.

7.4 Further research agenda

The analysis of the four Parks has made evident at different levels the absence of effective intangible mechanisms of coordination and the provision of real technology services inside the STPs and the inability of the STPs' real-estate element to support the development of these structures. In the four cases, but also in many other studies in the literature, it is found that managers tend to be absorbed by the real-estate element and leave the intangible mechanisms behind. This raises the issue of alternative mechanisms to Research and Technology Parks that, according to the literature, include Real Technology Service Centres (Luger and Goldstein, 1991; Tsipouri, 1998b), University-industry Foundations, and Technology Transfer Networks, which are suggested as more appropriate for less developed regions. STP-labelled structures also include Virtual Technology Park structures such as those identified in Italy, which were not included in this study. In this respect, a comparison of the operation and successes among such alternative real and virtual STPs has increased policy relevance. It is necessary that a common evaluation framework is made available that will allow for meaningful comparisons. The use of territorial innovation models provides a framework for such comparison, as it gives priority to the development

[233] The positive assessment of the PSP current operation was corroborated by an unpublished study by the PRAXI network in Greece that the author had the opportunity to review.

of interactions and networks, the presence of institutions and support mechanisms and focuses more on the development of communication and cooperation processes. A comparison between the alternative mechanisms on this basis could be a meaningful exercise with could bring valuable policy insights.

Concerning the evolution of the Parks and the presence of necessary external support, the comparison of the Greek and the Spanish cases reveals the strong role that regional authorities' planning capacity play in the Parks' operation. The Spanish Parks have benefited from regional authorities that were active promoters and owners of the Parks, while in the Greek STPs, regional authorities have been absent in the formulation of the idea as well as in the subsequent development. Among the Spanish cases there has been a difference in the intensity with which the Andalusian and the Asturian authorities promoted the Parks, but also in the way the integrated them, along with the other STPs, into broader regional innovation policies. The extent to which this applies more generally, i.e. whether the presence of regional administration as a promoter, owner or partner in the Parks increases the chances of success, has to be tested further and on a broader basis. It may also be qualified in terms of the effort directed to regional innovation policy – one such approach being Fernandez (2005) classification of Spanish regions in different levels or stages of innovation policy sophistication. It can also be linked with the presence –in the case of Spain – or not – in Greece - of regional development agencies.

Another area of research that was derived from analysis of the Greek Parks is the possible differences between public and private technology incubators. In some parts of the literature (e.g. Hackett and Dilts, 2004; Grimaldi and Grandi, 2005) the view is that these are projects that target different types of activities. Private incubators tend to have a more short-term and high-return view, which means that in some respects there is less preference for risky and uncertain technology projects. The publicly run technology incubators or STPs are, on the contrary, linked in theory with longer-term views and the capacity to support riskier projects. They are thus seen as having a complementary role in the promotion of entrepreneurship. However, this has not been the case in the Greek structures examined where public and private structure operate in a rather competitive way, targeting the small number of similar type of firms and entrepreneurs.

This raises another question. In the Greek case, the transfer of the technology incubator development activity to the private sector, and the government's role as provider of subsidies to create the necessary incentives, was suggested as a way to address an apparent public management failure that was considered to be characteristic of the publicly run Science Parks (Sofouli and Vonortas, 2007). This is, however, a hypothesis that needs to be tested outside the Greek context. This study and the results from the CEEI incubator point to the importance of clear objectives and professional management and not the ownership structure.

Closing, the final comment in relation to the STPs' assessment is that "the jury is still out" (Castells and Hall, 1994). This study attempted to identify the trajectories of each examined case based on their own dynamic, the intentions of the promoters and relevant actors and the developments in the broader context. In the case of Thessaloniki Park, all indications are that the Park is gradually losing its technology transfer and incubation functions, focusing only on CERTH research activity. The region has, through new public programmes, developed other mechanisms that appear to be more effective/successful, at least for the time being. Unless there are radical changes in the priorities of TTP owners, connected with strong and long-term financial support, the Park cannot be expected to be more than a real-estate project to provide space for small firms/units or the few spin-offs created by CERTH in the future. Asturias and STEP-C's future prospects are less clear. Asturias park (PTA) may sooner or later reach higher occupancy levels that should allow its managers to consider the development of more added-value mechanisms. The question is, though, given the limited knowledge creation base and the increased weight of non-technologically oriented activities, whether such attempts will bring any value. The PTA is, at this point, a not particularly receptive environment for the development of cross-fertilisation and synergies. STEP-C, on the other hand, requires an upgrade of its intangible mechanisms, including a stronger management structure, more intensive demand' creating initiatives and a stronger integration in regional and extra-regional technology and business networks. There are questions whether there is the willingness and capacity from FORTH's direction to invest in such an effort, given the absence of relevant government support, or if they will leave the Park to operate in the "automatic pilot" mode that it finds itself in right now.

The most interesting case of those four examined is clearly Cartuja93. This is not only due to the size of the investment and the initial ambitious objective of a technological leapfrog for Andalusia, but is also due to the parallel presence of many of the essential requirements for a more promising trajectory along with some important limiting elements. The gradual development of the intangible mechanisms, the development of an associative culture among a core group of tenants but, at the same time, the dominant presence of public agencies or an important number of merely commercial activities, represent a conflicting mix. It is worth examining again the Park's evolution after ten or more years to see whether any of the synergies that are now planned or promoted have actually developed or if the Park has continued its current, limited and ad-hoc occurrence of knowledge exchanges and interactions. It is also worth examining if any of the broader regional policies that attempt to transform the science and technology parks of Andalusia to agents of a broader regional innovation system succeed. As it has been made clear there is no single success recipy. But if after all this funding, marketing and public support, Cartuja93 remains after 30 years in operation only a real estate project with limited success, synergies and interaction, it will be an even stronger proof of the important limitations of trying to create "de novo" innovation intensive environments using the STP real-estate model.

For the policy makers that continue to promote STP labeled high-profile projects, the conclusions of this in-depth research show clearly that before local conditions are characterized by genuine demand for knowledge cooperation and synergies and can support technology services, the STPs will most often end up as expensive real estate projects with limited returns to the regions. The funding available will be much more effective if it is oriented towards strengthening the local skills and increasing the demand for technology and innovation.

Appendixes

Appendix 1 – STPs evaluation literature

Author (Date)	Parameter(s)/questions examined	Study area	Methodology	Main conclusions
Focus: Analysis of STP operation, development of functions and added-value				
Monck et al. (1988)	Technology intensity of park firms Connection with HEIs Advantage of STP location for NTBFs	UK STPs	Firm survey Comparison with off-park sample	Higher level of qualifications of park firms More leading edge firms in STPs but not more connected with HEIs Not higher levels of patenting Main reason for location park image and prestige Positive role of management support Support to academic start-ups creation and survival No higher growth rates of park firms
Van Dierdonck & Debackere (1991)	STPs role in technology transfer	Netherlands and Belgium	Survey	Limited number of R&D cooperation of park firms with local university and limited role of STPs Increasing role of international network of R&D cooperation with no role of STPs
Massey et al. (1992)	Role in NTBFs creation R-I linkages promotion Employment creation Firms technology level	UK	Survey of STPs firms Compare with off-park sample	-Moderate success in NTBFs creation -Low level of university-industry links -Limited net employment creation as firms mainly local -Only a minority of firms are leading edge, more are diffusers of technology
Westhead & Storey (1994)	Closure rates of NTBFs Firms technology sophistication R&D inputs R&D outputs Links with HEIs Compare advanced and lagging regions Difference of managed and non-managed STPs	UK STPs	Survey of STPs firms Compare with similar off-park sample	No STPs role in survival No higher tech. sophistication Slightly higher R&D inputs No higher level of innovation More linkages but not more formal + no differences between less and more developed regions No connection with finance access Positive prestige role of STP Added-value of managers recognised but no role in HEI link
Felsenstein (1994)	Seedbed role of STPs for high-technology firms	3 STPs in Israel	Log-linear modelling	Connection with universities is higher in STPs but

Author (Date)	Parameter(s)/questions examined	Study area	Methodology	Main conclusions
	supporting innovation		Compare with off-park sample	innovation performance depends of prior experience STP location based on signalling
Westhead and Batstone(1998)	Perceived benefits of STP location	UK STPs	Statistical analysis based on tenants' survey Comparison with off-park sample	Role of prestige limiting new firms liability Positive role of access to HEI facilities Positive but limited role of management support
Phillimore (1999)	Interactions and networks developed	STP Western Australia	Survey of park firms	Presence of linkages with universities and firms but not more important than external linkages
Vedovello (2000)	R-I linkages developed in STPs Compare different STP models	Surrey STP (UK), Taguspar k (Portugal)	Survey of park firms	Limited role of STPs in the development of R-I linkages No difference between Surrey university strategy and Taguspark regional strategy Presence of firms with no R&D has negative role
Lofsten & Lindelöf (2001)	Added value to of STP to NTBFs (growth and profitability)	10 Swedish STPs	Econometric model based on tenants' survey Comparison with off-park sample	- High growth rates (sales and employment) -No higher profitability -Positive role of STP in linkage with HEIs but of limited intensity -No higher R&D outputs
Bakouros (2002)	Added value and linkages of NTBFs in STPs	3 STPs in Greece	Survey of park firms	Limited informal links with HEIs Very limited connections among park firms – no synergies
Colombo & Delmastro (2002)	Characteristics of park NTBFs Added value of STP to NTBFs	Italian STPs and incubator s	Survey of park firms Comparison with off-park sample	Higher qualifications level of STPs entrepreneurs More proactive – opportunity driven Higher growth rates Higher level of cooperation with HEI but not with other firms Better access to finance STP in laggard regions may have a higher value added
Dahlstrand and Klofsten(2002)	Matching of NTBFs services demand with STPs supply	Swedish STPs and incubator s	Firms survey	General higher level of demand than and supply of services – STPs focus on VC finance and general consulting services
Lofsten & Lindelöf (2003)	NTBFs characteristics and STP added-value	10 Swedish STPs	Econometric model based on tenants' survey Comparison with off-park sample	No provision of business networks -Higher links with HEIs and positive role of STP location -Positive role in attracting capital for firms -Attraction of more motivated entrepreneurs

Author (Date)	Parameter(s)/questions examined	Study area	Methodology	Main conclusions
Siegel et al. (2003)	Role of STP in enhancing firms research productivity (patents and new products from R&D)	UK	Econometric model with STP as dummy based on tenants' survey Comparison on and off-park firms	Positive role in higher R&D productivity
Ferguson & Olofsson, (2004)	Support NTBFs survival and growth Relation of park services with growth	STPs in 2 advanced Swedish cities	STP firms survey Comparison with off-park sample	Positive role for firm survival No role in growth Positive role of university cooperation
Lofsten & Lindelöf (2005)	Difference in the added value to academic and private sector NTBFs	10 Swedish STPs	Econometric model based on tenants' survey Comparison with off-park sample	Higher level of use of local HEI from academic NTBFs but lower capacity to transform to innovation
Fukugawa (2005)	STP support in linkages with local HEI	Japan	Econometric model based on tenants' survey Comparison with off-park sample	Positive role of STPs in linkages with HEIs but linkages are not with local HEIs
Chan & Lau (2005)	Added value of STPs incubator program in 9 parameters	Hong Kong science park	Multiply case study of 6 firms	Cost advantages from subsidies, positive role of university linkages Limited/No role of resources pooling, networking, business support, image
Focus: Analysis of external impact of STP				
Luger & Goldstein (1991)	Role of factors in parks success and failure (measured by employment creation)	US (72 parks)	Cross-sectional analysis of 72 parks and survey from 3 cases	Positive role of park age, linkage with a research oriented university and amenities Linkage of park failure with smaller regions with low growth rates and absence of research university
Longhi(1999)	Success factors of Sophia-Antipolis STP	France	Case study	Initial growth from exogenous resources supported establishment and presence of large firms Subsequent growth supported from endogenous development and new firms creation Gradual development of innovative milieu
Shin (2000)	Evaluation of the STP project outcome	Korea	Case study	Good infrastructure development Development of research activities and attraction of firms No spin-offs

Author (Date)	Parameter(s)/questions examined	Study area	Methodology	Main conclusions
				No linkages with economy No synergies
Shearmur and Doloreux (2000)	STPs role in creation of high-tech clusters in regions	Canada	Statistical analysis comparing with regions with no STP	No effect of STP creation on the development/growth of high-tech employment STPs tend to concentrate on regions with high-tech concentrations
Phillips and Yeung(2003)	Capacity of STPs space to transform to a place for R&D activities and innovation	Singapore	Case study	Facilities and services are not enough Limited capacity to develop local and non-local networks and synergies Non-local firms tend not to develop R&D activities – reliance on non-local linkages
Appold (2003)	Effectiveness to attract private R&D labs	US	Econometric model from US counties	No role of research parks creation in R&D labs attraction. Park tend to be located in areas with significant prior R&D activity and with larger population size.
Capello & Morrison (2004)	Effectiveness of STPs in promoting collective learning among local firms and network learning with long distance agents Role in firms innovative activity	2 STPs in Italy	Econometric model based on firms survey	Positive role of STPs bridging local firms and less in the networking with long distance that both have a positive role in innovation creation. Both depend on the firms own absorptive capacity and are more important for small firms
Focus : Identifying parameters of success				
Koh et al.(2005)	Parameters that support the STPs gestation and growth	Singapore Science park	Development of framework based on 3 success cases and applied in Singapore STP case	Multiple possible routes Critical role of ability to attract or create new firms and renew Positive role of R&D competences For less developed regions importance of international linkages
Link & Scott (2003)	Explain the development of STPs in US Explain the growth of a STP Impact of STP creation on academic mission of university	US	Econometric model based on survey of US universities	Growth parameters are University proximity, presence of venture capital in region, real-estate management and technology sector specialisation STP proximity shifts academic activity towards more applied research

Author (Date)	Parameter(s)/questions examined	Study area	Methodology	Main conclusions
Guillermo (2003)	Degree of accomplishment of park targets	Boecillo Technology park Castilla y Leon, Spain	Questionnaire based survey	Support of employment creation and diversification of economy Positive role of facilities but limited use of technology services Limited externalities and synergies developed so far Confusion of park coordination with regional development functions
Komninos (2002)	Establishment strategies for STPs in lagging regions	Spain, Italy, Greece lagging regions		Different strategies of STP development depending on local capacity and pre-conditions Shift from "focalised" growth pole strategies to more integrated strategies including all region
Souitaris and Daskalopoulos (2000)	Ability to create success STPs in low-tech environments Limiting parameters	Greece	Case study based on interviews in 3 parks	Failure of STPs in supporting firms and developing linkages Low-tech environment and management and organizations inefficiencies are obstacles Confusion of park management and regional development support activities
Ylinenpaa (2001)	Parameters of STPs success Role in regional development	US and Finland	Comparison of two case studies of different STPs strategies	Importance of linkage with applied research university Importance of large locomotive company Importance of favourable image Attraction and incubation strategies can both succeed but need to be focused and tailored

Appendix 2 – List of STPs in Objective 1 regions of South Europe

	COUNTRY	REGION	NAME	Openning year
1	IT	Puglia	Tecnopolis	1984
2	ES	Valencia	Valencia Parc Tecnologic	1990
3	GR	Attiki	Attika Technology Park – Leukippos	1991
4	ES	Asturias	Parque Tecnologico de Asturias	1991
5	ES	Valencia	Valencia Parc Tecnologic	1991
6	IT	Campania	Technapoli	1992
7	IT	Sicily	PST Sicily	1992
8	ES	Andalusia	Parque tecnologico de Andalucia- Malaga	1992
9	ES	Castilla y Leon	Parque Tecnologico de Boecillo	1992
10	ES	Galicia	Parque Tecnologico de Galicia	1992
11	GR	C.Macedonia	Thessaloniki technology park	1993
12	ES	Andalusia	Cartuja93	1993
13	GR	Crete	Science and Technology park of Crete	1994
14	IT	Campania	Salerno	1995
15	PT	Lisboa	Taguspark	1995
16	IT	Basilicata	BasenTech	1996
17	IT	Abruzzo	PST Abruzzo	1996
18	PT	Madeira	Madeira Tecnopolo	1997
19	ES	Andalusia	Campus de Ciencias de Salud de Granada	1997
20	ES	Balear Islands	Parque Balear de Innovacion Tecnologica	1997
21	ES	Galicia	Ferrol Metropoli	1997
22	GR	Western Greece	Science Park of Patras	1998
23	ES	Andalusia	Rabanales, Parque Cientifico Tecnologico de Cordoba	1998
24	ES	Valencia	Mediterranean Science Park	1998
25	GR	Attiki	Technological and Cultural Park of Lavrion	1999
26	PT	Norte	Tecmaia	1999
27	PT	Lisboa	Lispolis-Polo Tecnologico de Lisboa	2000
28	ES	Asturias	Science and Technology Park of Gijón	2000
29	ES	Valencia	Paterna – Parque Scientifico Burjassot	2000
30	GR	Epirus	Science and Technology Park of Epirus	2001
31	GR	Thessaly	Thessaly Technology Park	2001
32	PT	Centro	Parkurbis	2001
33	ES	Andalusia	Agroparque de Meditteraneo	2001
34	ES	Andalusia	AERÓPOLIS, Parque Tecnológico Aeroespacial de Andalucía	2002
35	ES	Castilla la Mancha	Parque Tecnologico de Castilla la Mancha	2002
36	IT	Campania	Citta della Scienzia	2003
37	IT	Sardegna	Polaris	2003
38	ES	Castilla la Mancha	Fundación Parque Científico y Tecnológico de Albacete	2003
39	ES	Galicia	Parque Tecnologico Logistico de Vigo	2003
40	ES	Murcia	Technology Park Fuente Alamo	2003
41	IT	Calabria	PST de Crotone	2004
42	PT	Lisboa	Madan Parque	2004
43	PT	Porto	Parque de Ciencia e Tecnologia do Porto	2004

	COUNTRY	REGION	NAME	Openning year
44	ES	Andalusia	Parque Metropolitano, Industrial and Tecnologico de Granada	2004
45	ES	Andalusia	Parque Científico-Tecnológico del Aceite y el Olivar	2004
46	ES	Castilla y Leon	Parque Científico de Leon	2004
47	PT	Centro	Biocantpark	2008
48	GR	C.Macedonia	Technopolis Thessaloniki	In planning
49	GR	Attiki	Acropolis	In planning
50	PT	Algavre	STP Algavre	In planning
51	PT	Lisboa	Parque Tecnologico da Mutela /Almada	In planning
52	PT	Centro	Tecnopole de Coimbra	In planning
53	ES	Andalusia	Parque de Innovacion y Tecnologia de Almeria	In planning
54	ES	Andalusia	Parque Agroalimentario de Cartama	In planning
55	ES	Cantabria	Parque Cientifico y Tecnologico de Cantabria	In planning
56	ES	Castilla y Leon	Parque Tecnologico de Burgos	In planning
57	ES	Valencia	Ciudad Politecnica de la Innovación	In planning
58	ES	Murcia	Parque Científico de Murcia	In planning

Sources: APTE, 2006; APSTI,2007; Tecparques, 2007 and own research

Appendix 3 - Information request form sent to STPs management entities during the first stage

PLEASE PROVIDE THE ANSWERS IN THE SECOND COLUMN OF THE TABLE	
1. Science and Technology Park name	
2. Position of respondent in STP management	
SECTION A – GENERAL PARK DATA	
4. Who are the owners of the parks premises/infrastructure?	
5. What is the management type/structure of the park? (please define whether private company, consortium, public entity, other)	
6. Please state the shareholders of the management entity/company?	
7. Please state the main objectives of the park and rank them according to importance:	
SECTION B - PARK PROPERTY SIZE AND LAND USES **Please provide the following information**	
8. Park total area:	
9. Space covered from R&D facilities:	
10. Incubator space:	
11. Space for high tech companies	
12. Common areas	
13. Other (specify)	
SECTION C - SERVICES PROVIDED TO TENANTS **Please state which of the above services are offered to the park tenants**	
14. Basic facilitie s services	
15. Rent subsidy	
16. Use of research facilities for companies	
17. Busi ness support/consultancy services	
18. Entrepreneurs hip/incubation support for new firms	
19. Technolog y transfer/brokerage/partner search	
20. Vent ure capital scheme available in park	
SECTION D - Connection of STP with the region	
21. Does the park management firm organise/participate in regional development programs (YES/NO and which)	
22. What is the share of turnover that comes from these programs	
SECTION E - ANALYSIS OF PRESENT ACTIVITIES IN THE PARK Please provide info on current level of activity (more recent data available)	
23. Number of: - R&D centres/Labs - Companies in incubator - HIGH-TECH Companies - Technology transfer/support agencies	

- Training
- Other (specify)

24. Number of employees:
- R&D centres/Labs
- Companies in incubator
- HIGH-TECH Companies
- Technology transfer/support agencies
- Training
- Other (specify)

24. Turnover levels of :
- R&D centres/Labs
- Companies in incubator
- HIGH-TECH Companies
- Technology transfer/support agencies
- Training
- Other (specify)

25. What is the sectoral distribution of the park tenants?

26. What is the number of :
    - Companies relocated from outside the region
    - Companies relocated from inside the region
    - New companies
    - subsidiary units

27. Type of R&D activity developed in the park
    - Basic research
    - Applied research
    - Technology development
    - Technology adoption/customisation
    - Quality assurance services

(please state the most dominant type/types of research in the park among the previous)

28. Education level of employees (% of people with secondary, tertiary, Masters, PhD)

29. Total R&D expenditure in park as share of turnover of park

30. Total number of R&D employees in park

SECTION F –PARK EVOLUTION AND RESULTS
Please provide data on the park activity evolution

31. Total emplo yment (times series if available)

32. Total nu mber of tenants (times series if available)

33. Total turnover (times series if available)

34. Number of companies graduated from incubator over the years of operation

35. Number of Spin-off firms from R&D centres

36. Total number of patents from companies in the park

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Appendix 4 – List of responses to questionnaire sent to STP management entities:

1. Tecnopolis Novus Ortus – Puglia
2. Technapoli – Campania
3. PST Sicilia – Sicily
4. STEP-Crete
5. TTP Thessaloniki – Central Macedonia
6. Parque Tecnologico de Galicia
7. Parque Tecnologico de Andalucia
8. Parque Tecnologico de Asturias

Non- respondents

1. Cartuja93 – Seville, Andalusia
2. Valencia Parc Tecnologic - Valencia
3. Taguspark – Lisbon
4. Parque Tecnologico de Boecillo - Castilla y Leon
5. PST Salerno and the internal area of Campania
6. CalPark – Calabria

Appendix 5 - STP management entity interview questionnaire

Section A – Description of Park

1. What is the name of the park? ____

2. What is your position/role in the park? ____

3. When did the Park start operating? ________

4. Who were the initiators?

5. What were the financing sources used for construction of the park?

6. What was the total cost of construction? __________________

7. What were the initial objectives for the creation of the parks and their relative importance? Did they change with the course of time?

8. What are the existing function zones of the Park and what is their size?
   a. R&D: ____________
   b. Incubation (spin-offs/start-ups): ____________________
   c. Production (SMEs and large companies space): ___________________
   d. Technology transfer services area:_______________________
   e. Other support facilities/amenities: ___________________________

9. How was the specific Park structure decided and why?
____
____

10. Did the park develop in one st age or more? Are there further stages of development/extension programmed for the future?
____
____

11. What are there criteria for Par k tenants selection and what are they? What is the selection procedure?
____
____

12. Ho w have the total number of companies established in the Park, employees, total turnover from activities of all tenants in the Park and Park total occupancy rate evolved since its establishment:

	1994	1996	1998	2000	2002	2004
Companies						
RTOs						
Employees						
Turnover						
Occupancy rate						

13. What was the total number of new technology based firms (spin-offs and start-ups) created, their origin and the number that have graduated/left the Park?

Spin-offs/start-ups created in the park	
Spin-offs/start-ups from organisations in the region	
Spin-offs/start-ups from organisations outside the region	
Graduated (cumulative total by year):	

14. What is t he qualification mix of the total number of employees in the park (% of total employment)?

	% of total
Postgraduate (PhD, Master)	
Graduate – bachelor	
Technical training	

15. What share of e mployees in the Park participate in R&D activity?

	Total
R&D employees (% of total)	

16. What was the share of R&D expenditures in the total Park turnover?

	1994	**1997**	**2000**	**2003**
R&D expenditures share of turnover (%)				

Section B - Data on Park management entity

17. What is t he form of Park management entity:
    a. _____ Anonymous Society
    b. ______ Branch/department of company
    c. ______Non-for profit organisation
    d. ______ Joint Partnership
    e. ______ Other : ____

18. Which are the main participants/shareholders ?

____

____

19. What is t he organisation structure of the Park management entity?

____

____

20. What was the number of employees of the Park management entity in the following years:
_____ 1995 b. ____ 1998 c.______ 2001 d. ______ 2004

21. E mployees qualifications (% of total employment)
    a. _____ % with PhD degrees
    b. _____ % with master /MBA: _______ %
    c. _____ % with bachelors
    d. _____ % with technical training

22. What was the total turnover of the Park management company in the following years (please give number in million Euros or state currency if different) :
________ 1995 b. _________1998 c. _________2001 d. _________2004

Section C- Provision of services

23. Which of t he following activities/services are offered from the Park management company ? (tick those offered)
   a. _____Maintenance/management of park facilities
   b. _____Provision of basic services (fax, email, post, etc.) to tenants in park and/or incubator
   c. _____ Information on R&D/innovation/technology support programs
   d. _____ Patenting assistance
   e. _____ Development and implementation of innovation programs
   f. _____ Technology transfer services (e.g. offer/demand databases)
   g. _____ Innovation management support
   h. ______ Training courses/programs
   i. _____Financial support (funding scheme management)
   j. _____Networking/brokerage activities
   k. _____Marketing of park and park tenants
   l. _____ Other : ________________________

24. Are t he above services described available to companies/organisations located outside the park?
_____YES _____NO Which? ________________________

25. What share of t he total Park management turnover comes from different income sources and how has it evolved during the last 5 years?

		Importance				**Evolution during the last 5 years**		
	% of total turnover (latest year)	**Zero**	**Low**	**Medium**	**High**	**Decreased significantly**	**Remained the same**	**Increased significantly**
Income for provision of basic services to tenants and use of facilities		☐	☐	☐	☐	☐	☐	☐
Income from companies rents/plots		☐	☐	☐	☐	☐	☐	☐
Income from other park facilities (conference halls, training rooms, restaurants, other amenities)		☐	☐	☐	☐	☐	☐	☐
Income for provision of advanced (technical/business) services to <u>tenants</u>		☐	☐	☐	☐	☐	☐	☐
Income for provision of advanced (technical/business) services to <u>outside</u> companies		☐	☐	☐	☐	☐	☐	☐
Income from participation in programs		☐	☐	☐	☐	☐	☐	☐
Other sources (specify)...		☐	☐	☐	☐	☐	☐	☐
	100%							

26. Ho w is the cost of premises and services provided to tenants compared to the average in the region;

	Cheaper	Same	More expensive
Office space	☐	☐	☐
Land	☐	☐	☐
Services	☐	☐	☐

27. Has the management company an organised form for the analysis of tenants activities and assessment of their satisfaction? How are they used?

____

____

28. Are t here existing plans for initiatives in the future concerning
_____Infrastructure?
   a. _____Marketing?
   b. _____Development of new services?
   c. _____Strategic partnerships?
   d. _____Other? :______________________________
29. What is t he importance of the web site/information technologies for the provision of the following services/activities of the management company?

	Not used	Small	Medium	High
Information provision concerning services/programs/initiatives	☐	☐	☐	☐
Provision of virtual services	☐	☐	☐	☐
Networking – brokerage	☐	☐	☐	☐
Other	☐	☐	☐	☐

Section D - Networking activities and regional cooperation

30. Has the management company organised any networking support activity/programs in the Park ? (YES/NO and which?).

____

____

31. Has the management company organised any networking support activity/programs with companies/organisations outside the Park ? (YES/NO and which?).

____

____

32. Is there and what is the form (formal/informal) and density (continuous/project based) of cooperation of the management company with the following partners in the region:
   a. Universities and other higher education institutions: ________________________
   b. Regional authorities: ________________________
   c. Industry/commerce/craft associations: ________________________
   d. Other technology transfer/support organisations: ________________________
   e. Other regional partners? (please specify) ________________________

33. What are the main obstacles for increasing cooperation with other regional partners?
   a. _____Conflicting interests with other partners /competition
   b. _____No interest in cooperation/no common targets/no priority
   c. _____Absence of institutions/channels for cooperation
   d. _____Limited funding/resources
   e. _____Other: ____

34. Ho w has the level of cooperation of the regional partners with the Park management evolved over time?
   _____Increased

_____More of less the same
_____Decreased

35. Is the Park management company member of regional, national, international association and who?
____
____

36. What t ypes of linkages/collaboration schemes has the Park management developed ? (virtual parks, development of common support tools, promotion of parks' tenants cooperation, etc.)
____
____

Section E – STP and region assessment

37. Please state your opinion concerning the perceived level of advantage for the Park tenants from their location in the Park? (1-very low, 3-fair, 5-vry high)

	Not apply	1	2	3	4	5
High prestige of Park location	☐	☐	☐	☐	☐	☐
Cost of premises/facilities	☐	☐	☐	☐	☐	☐
Quality of Park facilities and infrastructure	☐	☐	☐	☐	☐	☐
Access to basic business services	☐	☐	☐	☐	☐	☐
Access to financial support - incentives	☐	☐	☐	☐	☐	☐
Provided business, technology support/transfer and information services	☐	☐	☐	☐	☐	☐
Access to qualified personnel (researchers, graduates)	☐	☐	☐	☐	☐	☐
Presence of relevant RTOs/universities for collaboration	☐	☐	☐	☐	☐	☐
Presence of relevant firms for collaboration	☐	☐	☐	☐	☐	☐
Presence of a communal, synergetic atmosphere	☐	☐	☐	☐	☐	☐
Other source of advantage? (specify)	☐	☐	☐	☐	☐	☐

38. What is t he role of the park in the development of the following activities? (1-very limited, 3-fair, 5-very strong)

	Not apply	1	2	3	4	5
R&D activity and technology creation	☐	☐	☐	☐	☐	☐
Technology transfer	☐	☐	☐	☐	☐	☐
New technology firms creation	☐	☐	☐	☐	☐	☐
Support in R&D and innovation cooperation	☐	☐	☐	☐	☐	☐
Attraction of high-tech firms	☐	☐	☐	☐	☐	☐

39. Please state your opinion concerning the strength of the region on the following parameters

	Very weak	Weak	Moderate	Strong	Very strong
Infrastructure level of the region (transport, telecommunications, etc.)	☐	☐	☐	☐	☐
Market for technology and technology products and services	☐	☐	☐	☐	☐
Technological level of regional industry	☐	☐	☐	☐	☐
Research and technology organisations	☐	☐	☐	☐	☐
Education and training organisations	☐	☐	☐	☐	☐
Presence of incentives- government support	☐	☐	☐	☐	☐
Business support services	☐	☐	☐	☐	☐
Networking support mechanisms	☐	☐	☐	☐	☐

	Very weak	Weak	Moderate	Strong	Very strong
Technology transfer support mechanisms/organisations	☐	☐	☐	☐	☐
Cooperative -associative culture in region	☐	☐	☐	☐	☐
Regional authorities capacity to formulate research/innovation policy	☐	☐	☐	☐	☐
Financing mechanisms	☐	☐	☐	☐	☐
Other?					

Section G – Additional comments

40. Woul d you like to make any additional comments on any of the topics raised during the interview?

____

____

41. Would yo u like to receive a report with the results of the study?
YES___ NO ____

Thank you very much for your cooperation

Appendix 6 - PRTOs questionnaire

Unless otherwise stated the questions refer solely to the unit/entity operating inside the Park space

Section A - Description of organisations and activities

1. What is the name of the research centre/institute?
   ____

2. What is your position in the organisations? ____________________________________

3. When was your organization established? ______

4. What year was your organization established in the park? ______

5. What is the form of your organization

_____ Public
_____ Private
_____ Not-for profit organization/foundation
_____ Semi-public (partnership)
______ Other: ______________________________

6. Is your organization institutionally linked with any organization/agency?
NO _____ YES (which) ____________________

7. What are the scientific/research activity focus areas of your organization?

____

____

____

8. Please characterize the relative importance of the different research activity outputs for your RTO (1-very low importance, 3-medium importance, 5-very high importance)

	Not apply	1	2	3	4	5
Contribution to the scientific community (Including publications, research reports for the public, conference contributions)	☐	☐	☐	☐	☐	☐
Public education/training (including Internships/masters theses, PhD/Post-doctoral, Other degrees)	☐	☐	☐	☐	☐	☐
Projects for industry (including Technology consulting/transfer, Construction and testing of new products/processes, Processes optimization, training of industry personnel)	☐	☐	☐	☐	☐	☐
Projects for public bodies (including research reports, research programs implementation, programs evaluation)	☐	☐	☐	☐	☐	☐

9. The phases listed in the table below describe the process from basic research to product or process innovation in a company. Please state which of the services are offered from your organization and which are the 5 most important services.

	It is offered	**Five most important services**
Basic research	☐	☐
Feasibility studies	☐	☐
Acquisition and study of necessary information	☐	☐
Product/process development	☐	☐
Planning, project/personnel management	☐	☐
Prototype construction	☐	☐
Testing	☐	☐
Implementation of innovation in the company	☐	☐
Documentation and certification	☐	☐
Support for introduction to the marketplace	☐	☐
Other? (specify)	☐	☐

10. Ho w does your organisation build up its research and technology expertise – knowledge base (1-very low importance, 3-medium importance, 5-very high importance)?

	Not use	1	2	3	4	5
Internal own basic and applied research	☐	☐	☐	☐	☐	☐
Cooperation with other research and technology organizations and universities	☐	☐	☐	☐	☐	☐
Acquisition of patents/licenses	☐	☐	☐	☐	☐	☐
Acquisition of technology equipment	☐	☐	☐	☐	☐	☐
New personnel/researchers/ experts recruitment	☐	☐	☐	☐	☐	☐
Conferences/publications	☐	☐	☐	☐	☐	☐
Participation in R&D networks/programs	☐	☐	☐	☐	☐	☐
Other?	☐	☐	☐	☐	☐	☐

11. Does you organization develop or support any of the following innovation management methods/tools or provide certification for any type of quality standard for industry (e.g ISO9000, EFQM, etc.) ?

NO _____ YES ______

12. Ho w many people work in your organization (fill in for each year) and what is their qualification level?

	1995	1998	2001	2004
Researchers				
Technical personnel				
Trainees/interns				
Total number				

13. What was to the evolution of the total budget of your organisation in the following years?

	1995	1998	2001	2004
Total turnover				

14. Please state the main sources of financing and their share in your organization budget (% of total for last year available) and how they have evolved over the last 5 years (second part during interview)

Source	**Share in total budget**	**Decreased significantly**	**More of less the same**	**Increased significantly**
Public sector (institutional funding)		☐	☐	☐
Publicly funded research programs (of which:)		☐	☐	☐
Regional		☐	☐	☐
National		☐	☐	☐
EU		☐	☐	☐
R&D Projects and services to private companies and organisations		☐	☐	☐
Income from licensing of technology/IPR royalties		☐	☐	☐
Other income sources (specify)		☐	☐	☐
	100%			

15. Where are your clie nts located? What is the importance of clients in different locations for your organisation? (1- very low importance, 3-medium importance, 5-very high importance)

Clients:	**Not exist**	**1**	**2**	**3**	**4**	**5**
-in the Park	☐	☐	☐	☐	☐	☐
-in the region	☐	☐	☐	☐	☐	☐
-outside the region but inside the country	☐	☐	☐	☐	☐	☐
-outside the country	☐	☐	☐	☐	☐	☐

16. Please provide infor mation on the results of your R&D activity.

	1995	1998	2001	2004	Total
Number of publications					
Number of patents					
Number of R&D projects involved					

17. Where are the spin -offs created from your organization located (give number):
________ in the STP
________ in the region
________ outside the region

18. What was the total number of training events/seminars your organisation organised during the last 3 years (2002-2004)? ________

19. The participants (fir ms) of the training events and seminars organised were :

Companies/organisations	<25%	25-50%	51-75%	>75%
Froms inside the park	☐	☐	☐	☐
From inside the region	☐	☐	☐	☐

Section B. Linkages/cooperation analysis section

20. What are the reasons for developing research cooperation with external partners?

Reduce costs of internal R&D/ technological development	☐
Access specialized relevant R&D/ expertise/know-how	☐
Reduce risk of R&D activity	☐
Access technology/knowledge not available in the organisation	☐
Access government/EU funds	☐
Improve networking-relationships/contacts	☐
Other (specify):	☐

21. What is t he importance of the different partners in innovation/R&D cooperation? (1- no importance, 3-medium importance, 5-very high importance)

	Not exist	1	2	3	4	5
Universities/ Technical colleges	☐	☐	☐	☐	☐	☐
Other Research and Technology organizations	☐	☐	☐	☐	☐	☐
Companies	☐	☐	☐	☐	☐	☐
Providers	☐	☐	☐	☐	☐	☐
Consultants/producer services companies	☐	☐	☐	☐	☐	☐
Technology transfer intermediaries	☐	☐	☐	☐	☐	☐
Other?	☐	☐	☐	☐	☐	☐

22. What t ype of cooperation have you developed (during the last 3 years) with other RTOs and Universities in the different locations? (please tick all that apply)

	Not exist	Park	Region	Country	International
Universities/ Technical colleges	☐	☐	☐	☐	☐
Other Research and Technology organizations	☐	☐	☐	☐	☐
Companies	☐	☐	☐	☐	☐
Providers	☐	☐	☐	☐	☐
Consultants/producer services companies	☐	☐	☐	☐	☐
Technology transfer intermediaries	☐	☐	☐	☐	☐
Other?	☐	☐	☐	☐	☐

23. Ho w has the importance of innovation cooperation partners in the different locations evolved over time (please compare with year of establishment in park)?

	Decreased significantly	Remained more or less	Increased

		the same	significantly
STP	☐	☐	☐
Region	☐	☐	☐
Country	☐	☐	☐
EU/International	☐	☐	☐

24. What t ype of cooperation have you developed (during the last 3 years) with other RTOs and Universities in the different locations? (please tick all that apply)

	Park	Region	Country	International
Joint research projects	☐	☐	☐	☐
Partners in joint ventures	☐	☐	☐	☐
Exchange of researchers	☐	☐	☐	☐
Use of technology services	☐	☐	☐	☐
Use of facilities/equipment	☐	☐	☐	☐
Students/trainees from university in RTOs	☐	☐	☐	☐
Other?	☐	☐	☐	☐

25. What t ype of linkages have you developed (during the last 3 years) with firms located in the different locations? (please tick all that apply)

	Park	Region	Country	International
R&D contracts	☐	☐	☐	☐
Joint R&D programmes	☐	☐	☐	☐
Provision of technology services/ Analysis and testing	☐	☐	☐	☐
Licensing of R&D results/technology	☐	☐	☐	☐
Use of facilities/equipment from companies	☐	☐	☐	☐
Provide information on research activity	☐	☐	☐	☐
Researchers-students exchange in R&D programs	☐	☐	☐	☐
Training services	☐	☐	☐	☐
Company recruitment of researchers/graduates	☐	☐	☐	☐
Personal relationships with firms employees	☐	☐	☐	☐
Other? (specify)	☐	☐	☐	☐

26. Ho w does your organisation identify its research/innovation partners? (1- very low importance, 3-medium importance, 5-very high importance)

	Don't use	1	2	3	4	5
Partnership/brokerage events		☐	☐	☐	☐	☐
Internet databases	☐	☐	☐	☐	☐	☐
Journals/media	☐	☐	☐	☐	☐	☐
Personal/professional networks	☐	☐	☐	☐	☐	☐
Intermediary/brokerage organizations	☐	☐	☐	☐	☐	☐
Other (specify)	☐	☐	☐	☐	☐	☐

27. What are the most important barriers/obstacles for cooperation? (1- very low importance, 3-medium importance, 5-very high importance)

	Not relevant	1	2	3	4	5
Limited interest of your organisation	☐	☐	☐	☐	☐	☐
No demand/interest from other tenants	☐	☐	☐	☐	☐	☐
Absence of competent/ relevant partners	☐	☐	☐	☐	☐	☐
No existing support schemes for cooperation	☐	☐	☐	☐	☐	☐
Lack of trust-associative culture	☐	☐	☐	☐	☐	☐
Other? (please specify):	☐	☐	☐	☐	☐	☐

28. Has your organisation participated in one or more networking events/activities during the last year?

	Not exist	Passive	Active
In the park	☐	☐	☐
In the region	☐	☐	☐

29. Is your research organization member of any scientific or other association(s)? How would you characterise your participation in its(their) activities?

	No member	Passive	Active
STP	☐	☐	☐
Regional	☐	☐	☐
National	☐	☐	☐
EU	☐	☐	☐
International	☐	☐	☐

Section C- STP and region assessment

The following questions concern the role and added-value of the STP and region location for your organisation.

30. What where the main reasons for the location of your organisation inside the park (please indicate up to 5)

Prestige of Park location	☐
Cost of premises/facilities	☐
Quality of Park facilities and infrastructure	☐
Provision of secretarial/basic business services	☐
Access to financial support - incentives	☐
Provided management, innovation technology support/transfer services	☐
Access to qualified personnel (researchers, graduates)	☐
Proximity to research and technology organisations	☐
Proximity to firms	☐
Park location	☐
Other source of advantage? (specify)	☐

31. Which aspect s of your location in the STP has been of most importance/added value for you firm? Please grade their importance? (1-very low importance,3 –moderate, 5-very high importance)

	Doesn't apply	1	2	3	4	5
Prestige of Park location	☐	☐	☐	☐	☐	☐
Cost of premises/facilities	☐	☐	☐	☐	☐	☐
Quality of Park facilities and infrastructure	☐	☐	☐	☐	☐	☐
Provision of secretarial/basic business services	☐	☐	☐	☐	☐	☐
Access to financial support - incentives	☐	☐	☐	☐	☐	☐
Provided management, innovation technology support/transfer services	☐	☐	☐	☐	☐	☐
Access to qualified personnel (researchers, graduates)	☐	☐	☐	☐	☐	☐
Proximity to research and technology organisations	☐	☐	☐	☐	☐	☐
Proximity to other firms (suppliers, customers, competitors)	☐	☐	☐	☐	☐	☐
Presence of a communal, synergetic atmosphere	☐	☐	☐	☐	☐	☐
Other source of advantage? (specify)	☐	☐	☐	☐	☐	☐

32. Ho w satisfied is your firm from the following services provided in the Science and Technology Park? (1-very disatisfied,3 –neutral, 5-very satisfied)

	Doesn't exist	Not used	1	2	3	4	5
Financial support services	☐	☐	☐	☐	☐	☐	☐
Technology information services	☐	☐	☐	☐	☐	☐	☐
R&D project participation/proposal support	☐	☐	☐	☐	☐	☐	☐
Management/business/market support	☐	☐	☐	☐	☐	☐	☐
Support for spin-off creation	☐	☐	☐	☐	☐	☐	☐
Technology transfer/Innovation support services	☐	☐	☐	☐	☐	☐	☐
Networking/partnership services and events	☐	☐	☐	☐	☐	☐	☐
Other? (specify)	☐	☐	☐	☐	☐	☐	☐

33. Are t here services that you consider should be present in the park that are not currently offered?

____

____

____

____

34. Please state your opinion concerning the strength of the region in the following parameters (1-very weak, 3-fair, 5-very strong)

	Don't know	1	2	3	4	5
Infrastructure (transport, telecommunications, etc.)	☐	☐	☐	☐	☐	☐
Demand for advanced technology products and services	☐	☐	☐	☐	☐	☐
Research and technology organisations capacity	☐	☐	☐	☐	☐	☐
Education and training organisations capacity	☐	☐	☐	☐	☐	☐
Presence of qualified/skilled workforce	☐	☐	☐	☐	☐	☐
Business support services	☐	☐	☐	☐	☐	☐
Technology transfer support services	☐	☐	☐	☐	☐	☐
Cooperation/network supporting mechanisms	☐	☐	☐	☐	☐	☐
Cooperative -associative culture in region	☐	☐	☐	☐	☐	☐
Presence of important/necessary government bodies	☐	☐	☐	☐	☐	☐
Risk capital – Innovation finance availability	☐	☐	☐	☐	☐	☐

35. Is there an y other comment you would like to add concerning any of the issues raised during the interview?

____

____

36. Would yo u like to receive a report with the results of the survey? YES NO

Thank you very much for your cooperation

Appendix 7 - Firms questionnaire

Unless otherwise stated the questions refer solely to the unit/entity operating inside the Park space.

Section A - Description of firm activities

1. What is the name of your firm? ____

2. What is your position in the company? ____

3. What year was the firm established in the Science and Technology Park (STP)? : _____

4. Please classify your firm/business unit to the following categories (tick one):
_____ Existing Independent firm moved from outside the region
_____ Existing Independent firm moved from inside the region
_____ New Branch of existing firm
_____ R&D department of existing firm
_____ New firm created inside the STP
_____ Other: ____________________

5. Where is your firm located in the STP?
_____ in incubator
_____ in rented/owned business/space
_____ in its own plot in the park
_____ other: ____________________________________

6. Is your firm a spin-off company from a research organisation, university or private company?
NO ___ Spin-off of (organization name) : ________________

7. What are the sectors of activity of your firm? :
a. ____________________________________
b. ____________________________________
c. ____________________________________

8. What were the results of your firm research activity during the last 3 years?

R&D	☐
Software development	☐
Product design	☐
Analysis/testing	☐
Production	☐
Consulting services	☐
Sales/distribution	☐
Other? (specify)	☐

9. What share of your suppliers of materials and equipment are located in the following markets (please give an average of the last three years)?

	No suppliers	**<25%**	**25%-50%**	**51%-75%**	**>75%**
STP	☐	☐	☐	☐	☐
Region	☐	☐	☐	☐	☐

Country	☐	☐	☐	☐	☐
EU/International	☐	☐	☐	☐	☐

10. What share of your suppliers of materials and equipment are located in the following markets (please give an average of the last three years)?

	No suppliers	<25%	25%-50%	51%-75%	>75%
STP	☐	☐	☐	☐	☐
Region	☐	☐	☐	☐	☐
Country	☐	☐	☐	☐	☐
EU/International	☐	☐	☐	☐	☐

11. What share of t he scientific and management staff recruited from your firm during the last 3 years came from the following areas?

	<25%	25%-50%	51%-75%	>75%
Firms and research organisations in the park	☐	☐	☐	☐
Firms and research organisations in the region	☐	☐	☐	☐
Firms and research organisations outside the region	☐	☐	☐	☐

Section B – Innovative activity/intensity of the firm

12. What is t he share of employees that participated in R&D activities?
a. ____ 0% b.____ 1-5% c. ___ 6-10% d. ____ 11-20% e. ___21-40% f. ___>40 %

13. What was the average share of turnover spent in R&D activities in the last 3 years?
____ 0% b.____ 1-5% c. ___ 6-10% d. ____ 11-20% e. ___21-40% f. ___>40 %

14. What were the results of your firm research activity during the last 3 years?

Type	YES	NO	Number
New products (goods/services)	☐	☐	
New processes	☐	☐	
Significantly improved existing products	☐	☐	
Significantly improved existing processes	☐	☐	
Patents	☐	☐	
Other intellectual protection methods(trademarks, copyrights, design registrations)	☐	☐	
Other? (specify)	☐	☐	

15. What share of t he total sales comes from new and/or significantly improved products introduced during the last 3 years (goods and services)?
a. ___ less than 25% b. ____ between 25%-50% c. ____ between 50%-75% d. ____ over 75%

16. What is t he importance for your firm of the following activities for building up its technological capacity? (1- very low importance, 3-medium importance, 5- very high importance)

	Not use	1	2	3	4	5
Internal R&D	☐	☐	☐	☐	☐	☐
Contract R&D to other organizations/firms	☐	☐	☐	☐	☐	☐
Acquisition of technology equipment and machinery	☐	☐	☐	☐	☐	☐
Acquisition of software or other non-material technology	☐	☐	☐	☐	☐	☐
External knowledge acquisition (IPR rights purchase, use	☐	☐	☐	☐	☐	☐

of consultant/experts)						
Hiring/Training of personnel	☐	☐	☐	☐	☐	☐
Other? (please specify)	☐	☐	☐	☐	☐	☐

17. Is your company currently participating or has it participated during the last 3 years in one or more research/innovation programs funded by the following public authorities?
_____ NONE
_____ regional
_____ national
_____ EU/international

Section C – Innovation cooperation of your firm

Innovation cooperation refers to any form of active participation in research and technological innovation projects. It does not necessarily require presence of contract. Pure contract of work without active participation is not considered co-operation

18. Please rate the i mportance of different partners for the development of new or significantly improved products or processes. (1- very low importance, 3-medium importance, 5- very high importance)

	No cooperation	1	2	3	4	5
Suppliers of standardized materials and equipment	☐	☐	☐	☐	☐	☐
Suppliers of customized materials and equipment	☐	☐	☐	☐	☐	☐
Other business units within the firm group	☐	☐	☐	☐	☐	☐
Clients or customers	☐	☐	☐	☐	☐	☐
Competitor firms	☐	☐	☐	☐	☐	☐
Research centres and labs	☐	☐	☐	☐	☐	☐
Universities/technical colleges	☐	☐	☐	☐	☐	☐
Consultants – business services firms - experts	☐	☐	☐	☐	☐	☐

19. Please indicate the location o f the various types of partners for the development of new or significantly improved products or processes. (tick all that apply)

Types of cooperation	In the STP	In region	National	International
Suppliers of standardized materials and equipment	☐	☐	☐	☐
Suppliers of customized materials and equipment	☐	☐	☐	☐
Other business units within the firm group	☐	☐	☐	☐
Clients or customers	☐	☐	☐	☐
Competitor firms	☐	☐	☐	☐
Research centres and labs	☐	☐	☐	☐
Universities/technical colleges	☐	☐	☐	☐
Consultants – business services firms - experts	☐	☐	☐	☐
Other? (specify)	☐	☐	☐	☐

20. Ho w important are the following barriers for establishing innovation cooperation? (tick all that apply)

Cost of cooperation management	☐
Problems over Intellectual property rights	☐
Distance of partners	☐
Difficulty in identifying competent/relevant partners	☐
Luck of trust/ prior-experience	☐

Lack of cooperation culture	☐
No expected added-value	☐
No support schemes/mechanisms for cooperation	☐
Other (specify)	☐

21. What t ype of linkage(s)/cooperation has your firm developed with other firms –suppliers, customers, competitors - in the different locations? (tick all that apply)

	In STP	In region	National	International
Joint research projects	☐	☐	☐	☐
Joint ventures	☐	☐	☐	☐
Joint production	☐	☐	☐	☐
Exchange of research/technical personnel	☐	☐	☐	☐
Social/personnel interactions/contacts	☐	☐	☐	☐
Share/common use of equipment	☐	☐	☐	☐
Subcontracting	☐	☐	☐	☐
Other? (specify)	☐	☐	☐	☐

22. What t ypes of linkages have you developed with the Research and Technology Organisations and University research units/labs during the last 3 years? (tick all that apply)

Types of cooperation	In the STP	In region	National	International
Exchange of researchers/students in projects	☐	☐	☐	☐
Recruitment of graduates/researchers	☐	☐	☐	☐
Education/Training courses	☐	☐	☐	☐
R&D contracts	☐	☐	☐	☐
Licensing of technology				
Technology services (Analysis and testing)	☐	☐	☐	☐
Library services	☐	☐	☐	☐
Use of RTO/university staff for consultancy	☐	☐	☐	☐
Personal contacts	☐	☐	☐	☐
Access to information on research activity/results	☐	☐	☐	☐
Access to facilities/equipment	☐	☐	☐	☐
Other? (specify)	☐	☐	☐	☐

23. Have you participated in one or more networking/partnership events/activities organised during the last year?

	Not exist	Yes	No
In the park	☐	☐	☐
In the region	☐	☐	☐

Section D – Role of the STP/region location for the firm

24. What where the main reasons for the location of the firm/unit inside the park?

Prestige of Park location	☐
Cost of premises/facilities	☐
Quality of Park facilities and infrastructure	☐
Provision of secretarial/basic business services	☐

Access to financial support - incentives	☐
Provision of business, management, technology services	☐
Access to qualified personnel (researchers, graduates)	☐
Proximity to research and technology organisations	☐
Proximity to other firms (suppliers, customers, competitors)	☐
Park location inside the region	☐
Other? (specify)	☐

25. Which aspect s of your location in the STP has been of most importance/added value for you firm? Please grade their importance? (1-very low importance,3 –moderate, 5-very high importance)

	Doesn't apply	**1**	**2**	**3**	**4**	**5**
High prestige of Park location	☐	☐	☐	☐	☐	☐
Cost of premises/facilities	☐	☐	☐	☐	☐	☐
Quality of Park facilities and infrastructure	☐	☐	☐	☐	☐	☐
Provision of secretarial/basic business services	☐	☐	☐	☐	☐	☐
Access to financial support - incentives	☐	☐	☐	☐	☐	☐
Provision of business, management, technology services	☐	☐	☐	☐	☐	☐
Access to qualified personnel (researchers, graduates)	☐	☐	☐	☐	☐	☐
Proximity to research and technology organisations	☐	☐	☐	☐	☐	☐
Proximity to other firms (suppliers, customers, competitors)	☐	☐	☐	☐	☐	☐
Presence of a communal, synergetic atmosphere	☐	☐	☐	☐	☐	☐

26. Ho w satisfied is your firm from the following services provided in the Science and Technology Park? (1-very disatisfied,3 –neutral, 5-very satisfied)

	Doesn't exist	**Not used**	**1**	**2**	**3**	**4**	**5**
Financial support services	☐	☐	☐	☐	☐	☐	☐
Information services	☐	☐	☐	☐	☐	☐	☐
R&D project participation/proposal support	☐	☐	☐	☐	☐	☐	☐
Management/business/market support	☐	☐	☐	☐	☐	☐	☐
Technology transfer/Innovation support	☐	☐	☐	☐	☐	☐	☐
Support in networking/partnerships	☐	☐	☐	☐	☐	☐	☐
Other? (specify)	☐	☐	☐	☐	☐	☐	☐

27. Are t here services that you consider should be present in the park that are not currently offered?

____

____

28. Please state your opinion concerning the strength of the region in the following parameters (1-very weak, 3-fair, 5-very strong)

	Don't know	**1**	**2**	**3**	**4**	**5**
Infrastructure level (transport, telecommunications, etc.)	☐	☐	☐	☐	☐	☐
Demand for advanced technology products and services	☐	☐	☐	☐	☐	☐
Research and technology organisations capacity	☐	☐	☐	☐	☐	☐
Education and training organisations capacity	☐	☐	☐	☐	☐	☐
Presence of qualified/skilled workforce	☐	☐	☐	☐	☐	☐
Business support services	☐	☐	☐	☐	☐	☐
Technology transfer support services	☐	☐	☐	☐	☐	☐
Cooperation/network supporting mechanisms	☐	☐	☐	☐	☐	☐
Cooperative -associative culture in region	☐	☐	☐	☐	☐	☐

	Don't know	1	2	3	4	5
Presence of important/necessary government bodies	☐	☐	☐	☐	☐	☐
Risk capital – Innovation finance availability	☐	☐	☐	☐	☐	☐

Section E – Firm performance

29. W hat was the change of the total sales of your firm/unit during the years of operation inside the park?

	Reduced	Increased <5%	Increased 5-10%	Increased 11-20%	Increased 20-40%	Increased >40%
First 2 years						
First 5 years						
Average of all years inside the park						

30. What was the total number of employees in your firm/business unit the following years?

1994	1997	2000	2002	2003	2004	2005

Section F – Additional comments

31. Are t here any other comments you would like to make concerning any of the topics raised in the questionnaire?

32. Wou ld you like to receive a report with the results of the study? YES:_____ NO: ______

Thank you for your cooperation

Appendix 8 - Research and technology support programs, measures and actions in Crete and Central Macedonia during the period 1994-2006

	Crete	C.Macedonia
Budget for research and innovation support measures in regional operational programs (ROP) for the period 2000-2006 (thousand €)	7500	26290
Share in total ROP budget	1.49%	2.81%
Actual funds allocated	6040	10930
Regional program (after 2000)	Research infrastructures, Industrial research of new firms, R&D consortia, Innovative technologies demonstration projects	Research infrastructures, Incubators, R&D consortia, Innovation investment in processing sector, Support for new firms
Relevant national support programs (before 2000)	Research centres infrastructure, Industrial research (PAVE), Research joint ventures (EKBAN), Co-financing (SYN), Technology transfer centres, Liaison offices, Researchers support (PENED)	Research centres infrastructure, Industrial research (PAVE), Research joint ventures (EKBAN), Co-financing (SYN), Technology transfer centres, Liaison offices, Researchers support (PENED)
Relevant national support programs (after 2000)	Spin-offs support - PRAXE , , New economy development fund - TANEO (1 VC fund in Crete), Regional innovation poles, PRTOs liaison offices, Industrial research (PAVET), Industrial research for new firms (PAVET-N), Research consortia, Liaison offices	Spin-offs support - PRAXE Support for STPS and incubators - ELEFTHO (2 incubators), Regional innovation poles, PRTOs liaison offices, Thessaloniki Innovation zone, Industrial research support (PAVET), Industrial research for new firms (PAVET-N), Research consortia
EU innovative initiatives	RITTS(1997-2000) Innovative actions (2003-2005)	RTP (1995-1997), RIS+ (1999-2000) Excellence (2002-2003)

Source: Logotech (2006), Technopolis (2006), IRE Network (n.a.), EKT (n.a.)

Appendix 9 – Greek STPs management entities shareholder structure

Science and Technology park of Crete Management and Development Company S.A.

Shareholder	**Amount of capital invested (Euros)**	**Share**
FORTH	36.390	30.89%
Piraeus Bank	35.870	30.45%
All other private shareholders with shares of less than 3%	45.540	39.76%
Total	117.800	100%

Source : Survey

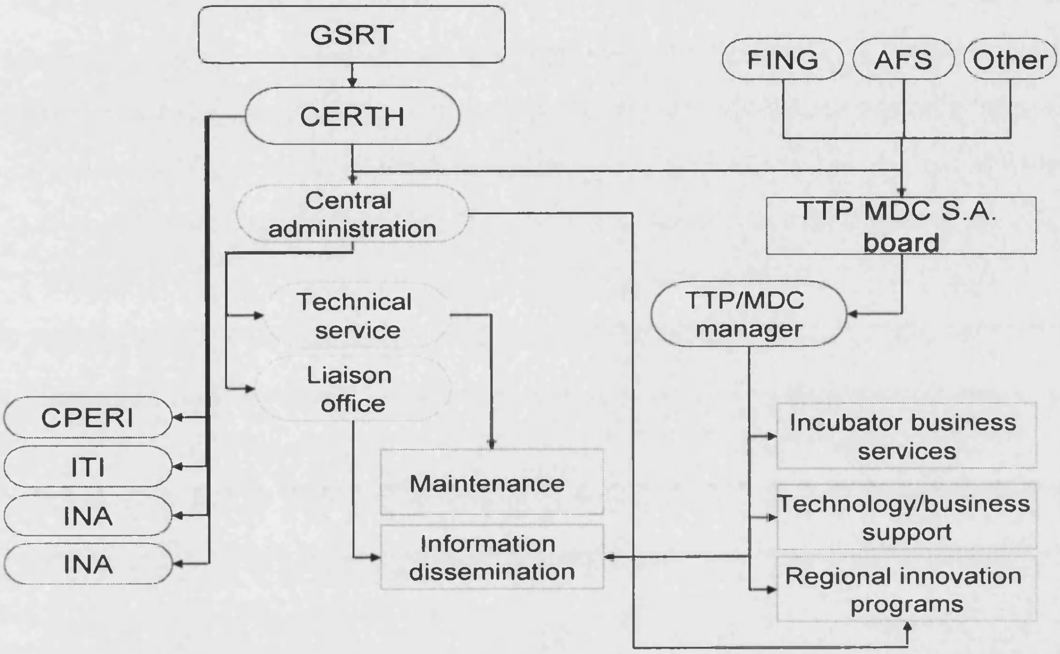
Thessaloniki Technology Park Management and Development Company

Shareholder	Amount of capital invested (Euros)	Share
CERTH	37.797	43%
Federation of Industries of Northern Greece	18.166	20.67%
American Farm School	15.529	17.67 %
All other private shareholders with shares of less than 3%	16.408	19.66%
Total	87.900	100%

Source : Survey

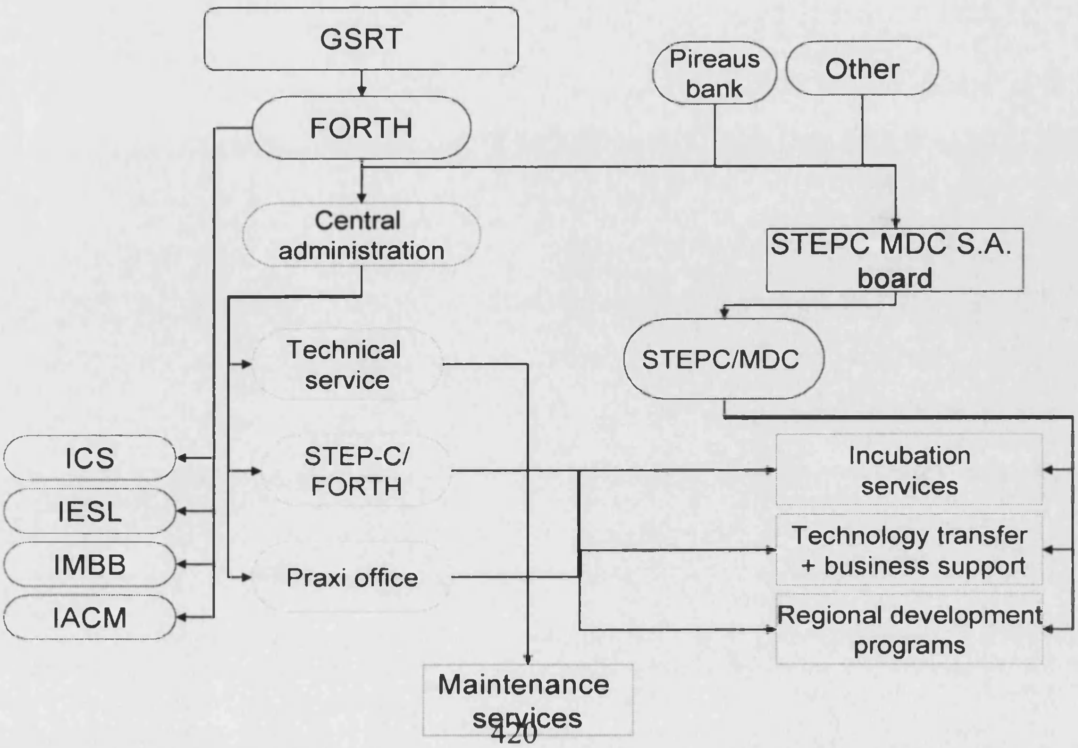
Appendix 10 – Greek STPs management structure

Figure 0-1– TTP-C organization structure



Source : Own elaboration

Figure 0-2 – STEP-C organisation structure



Source : Own elaboration

Appendix 11 - TTP past, current and new tenants[234]

	Name[235]	Main activity	Period	Description	Status
1	Daftsios	Pharmaceutical product development	1994-1998	Start-up[236]	Closed
2	Intelectron	Automatics/robotics	1995-1997	Local offices	Moved out
3	Biotrast	Medical/Biomedical technologies	1995-1999	Existing company that moved in	Acquired
4	Mangos	Audiovisual production/services	1995- 2001	Local branch	Moved out
5	Heletel *	E-commerce software development	1995-Today	Start-up	In incubator
6	Ambeloeniki *	Vineyard-winery production R&D and technical services	1996-Today	Start-up	In incubator
7	Forthnet	Internet/Telecommunication services	1996-1999	Local offices	Moved out
8	Namtek	Product design services	1997-1999	Existing company that moved in	Moved out
9	Egnatia	Construction	1997-1999	Unit of construction company	Moved out
10	METEK	Medical/biomedical equipment certification	1997-Today	Existing company that moved in	Will move out by 2006
11	Helabio *	Biomedical products	1997-Today	Start-up	Will move out by 2006
12	SEKEP	Environmental studies	1998-2002	Association offices	Closed
13	Stocktrade	Stock market software	1999-2000	Start-up	Acquired
14	Forth-e com	E-commerce services	1999-2001	Spin-off of private company	Moved out
15	AST *	Specialized software	1999-2004	Start-up	Moved out
16	IQS*	Internet applications	2000-Today	Start-up	Will move out by 2006
17	Paxatouridis	Aromatic product development	2000-2002	Start-up	Closed
18	Urnet	Internet services	2001-2004	Start-up	Closed
19	Intelligen *	Chemical processes software development	2001-Today	R&D branch of international company	In incubator
20	Compucon	Product design specialized software	2002-2004	Local sales branch	Moved out
21	ESEKTA	Chemical processes software development	2002-2004		Closed
22	Liaison *	Stem cells storage, multiplication and modification	Expected before 1/2006	Spin-off from University	
23	Pharmathen-Industrial *	R&D in active pharmaceutical ingredients	Expected before 1/2006	Spin-off of pharmaceutical company	
24	VRSence *	Virtual reality specialized software	Expected before 1/2006	Spin-off from ITI	
25	Cperi-Solutions	Chemical processes services	Expected before 1/2006	Spin-off from CPERI	
26	Eurogenetica	Molecular biology and genetics R&D centre	Expected before 1/2006	Existing company that moved in	

Source: TTP/MDC S.A.

[234] The companies that participated in the research project are labelled with an asterisk (*)
[235] The companies that participated in the research project are labelled with an asterisk (*)
[236] Some start-ups were legally formed before their establishment in the park

Appendix 12 – Detailed analysis of Greek STPs PRTOs linkages by partner, importance and type of linkage

TTP research institutes

Institute	Partner	Park	Region	Greece	Abroad
CPERI	PRTO	No	Importance: High Joint research programs, student training, facilities/equipment use	Importance: Medium Joint research programs, R&D services, student training	Importance: Very high Joint research programs, R&D services
	Firm	No	Importance: Low Analysis/testing, Social contacts	Importance: Low /Medium R&D contracts, analysis/testing, social contacts	Importance: High/Very high R&D contracts, consultancy, analysis/ testing, social contacts
ITI	PRTO	No	Importance: High Joint research programs, R&D services and student training, facilities/equipment use	Importance: Medium/High Joint research programs, R&D services, student training, researchers exchange, facilities/ equipment use	Importance: High/Very high Joint research programs, R&D services, student training, researchers exchange, facilities/ equipment use
	Firm	No	Importance: Low R&D contracts, consultancy, analysis/testing, use of lab equipment, training, social contacts	Importance: Medium/High R&D contracts, consultancy, social contacts, analysis/testing, use of lab/equipment training	Importance: High/Very high R&D contracts analysis/testing, use of lab equipment, training , social contacts
HIT	PRTO	No	Importance: High Joint research programs, R&D services and student training	Importance: Medium/High Joint research programs, R&D services	Importance: High Joint research programs, R&D services, use of lab/equipment, student training
	Firm	No	Importance: Low R&D contracts, consultancy, social contacts	Importance: High R&D contracts, consultancy social contacts, training	Importance: Low R&D contracts analysis/testing, use of lab equipment, training , social contacts
INA		No data	No data	No data	No data

Source : Survey and own elaboration

STEP-C research institutes

	Partner	Park	In region	Greece	Abroad
ICS	PRTO	Importance: High IMBB : joint research group (Bio-informatics) Joint R&D programs: IACM,IESL	Importance: Medium Joint R&D programs, student training	Importance: Medium/High Joint R&D, researchers exchange	Importance: High Joint R&D, researchers exchange
	Firm	Importance: Medium Joint R&D project, use of facilities, consultancy (FORTHnet, VIrtualTrip, Infocharta,CyTech)	Importance: Medium Consultancy services, training	Importance: Very high Research contracts, consultancy, training	Importance: Low Research contracts
IESL	PRTO	Importance: High Joint R&D projects: ICS,IMBB,IACM	Importance: Very Low Student training	Importance: Low Student training	Importance: Very high Joint R&D projects, Researchers exchange, Use of facilities, Student training
	Firm	Importance: Very Low Joint R&D projects, Consultancy, Researchers exchange (ARTT)	NO	Importance: Low Research contracts/ programs with firms	Importance: High Research contracts/ programs, analysis/testing, researchers internships
IACM	PRTO	Importance:High Joint R&D programs: IESL, ICS	Importance: High Joint R&D programs and student training	Importance: High Research/product development contracts Joint R&D projects	Importance: High Joint R&D programs and student training
	Firm	Importance: Very Low Joint R&D projects (Infocharta)	Importance: Low R&D projects Consulting	Importance: Low/Medium R&D and product development contracts Consulting	Importance: Low
IMBB	PRTO	Importance: High ICS : joint research group (bio-informatics) Joint R&D programs: IESL	Importance: Medium Student training analysis/testing	Importance: Medium/High Joint R&D programs Student training	Importance: Very high Joint R&D programs Student training with PRTOs
	Firm	Importance: Very low Use of facilities analysis/testing (Minotech, Microchemistry)	Importance: Very Low Joint R&D programs Use of facilities analysis/testing	Importance: Low Joint R&D programs R&D contracts	Importance: Very high Joint R&D programs R&D contracts, analysis/testing

Source : Survey and own elaboration

Appendix 13 – Detailed analysis of Greek STPs firms linkages by category of partners, type of linkage and location[237]

TTP firms

	External R&D	Important partners	TTP In park	Linkages with PRTOs and firms[237] In region	Greece	International
Hellabio	Very low	PRTOs, Customers, Suppliers	PRTOs: 3,11	PRTOs: Firms:		Firms:
Heletel	Very high	PRTOs,Univ, Consultants	-	PRTOs:5,8 Firms:1	PRTOs:5,8	
Ampeloenik i	No	Suppliers, PRTOs, Univ	PRTOs: 4	PRTOs: 3 Firms: 4,6	PRTOs:4,8,9 Firms: 4,6	PRTOs: 3,5,8,9
IQ systems	No	Competitor	PRTOs: 2,5	Firm: 1	-	Firms:
Intelligen	No	Same company units	-	-	-	Firms: 1

Source: Survey

STEP-C firms

	External R&D	Important partners stated	STEP-C In park	Linkages with PRTOs and firms[239] In region	Greece	International
Virtual Trip	Very Low	Univ, PRTOs, Clients, Company units	PRTOs: 2,5,6,7,8,9,1 1 Firms: 1	PRTOs: 10,11 Firms : 4,5	Firms:1,4,5	Firms: 3
FORTH-net	Medium	Univ, PRTOs Customers, Suppliers Other company units	PRTOs: 2, 4,5,6,7,11 Firms: 1,6	PRTOs: 1,2,4,5,6,7,1 0, 11 Firms: 1,3,6	PRTOs: 1,5,7,11 Firms: 1,3,6	PRTOs: 5,7,11 Firms: 1,6
CyTech	Very Low	Univ, PRTOs, Clients	PRTOs:1,2 Firms: 1,6	PRTOs: 1,4,6,7,10,11	Univ:10 Firms:3	-
Palmera	Very high	PRTOs	PRTOs: nd Firms: 1	-	Firms:	-
Infocharta	High	Univ, PRTOs Clients, Suppliers, Competitors	PRTOs: 2,4,6,7,11 Firms: 2,3,4,5,6	Firms:1,6	Firms: 1,3,6	Firms: 1
ARTT	No	Univ, PRTOs	PRTOs:2,5,8	PRTOs: 2,5,8,10 Firms: 1,3	Firms: 2,3	-
VEIC	No	Univ, PRTOs	PRTOs:7	PRTOs :9,11	PRTOs:	PRTOs:7

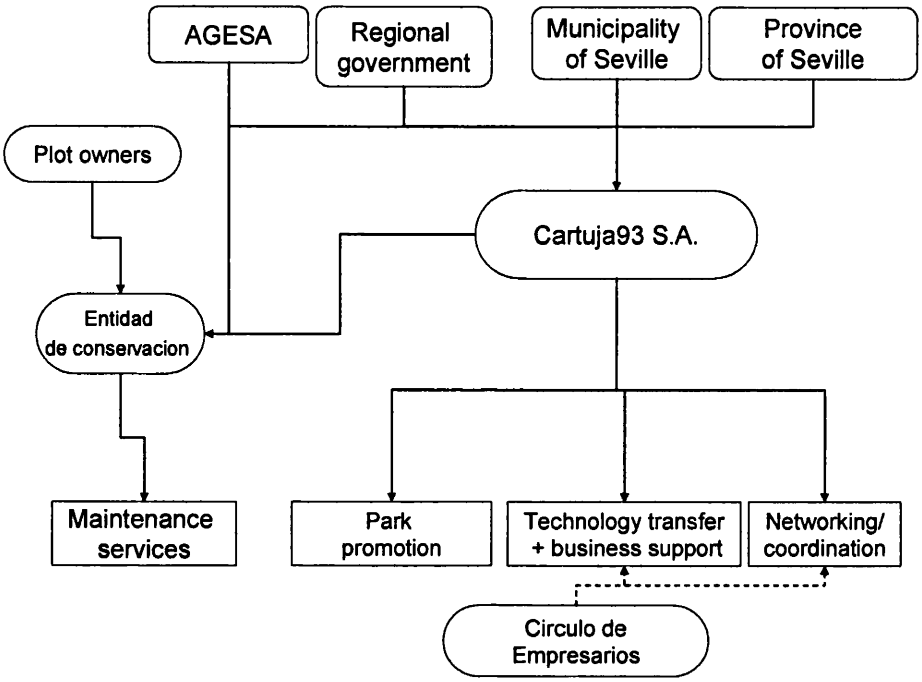
[237] <u>Linkages with PRTOs</u>: **1.** Research results licensing, **2.** R&D contracts, **3.** Joint ventures, **4.** Analysis/testing **5.** consultancy, **6.** Use of equipment/facilities, **7.** Information on R&D activities, **8.** Exchange/recruitment of researchers, **9.** training of personnel, **10.** student traineeships, **11.** social interactions <u>Linkages with firms include</u>: **1.**R&D contracts/projects **2.**joint ventures, **3.**technology services, **4.** Shared equipment, **5.** Exchange of personnel, **6.** social relations

	External R&D	Important partners stated	STEP-C Linkages with PRTOs and firms[239]			
			In park	In region	Greece	International
TUV	No	Customers Other company units Consultants		Firms:3 Firms:6	Firms:3 Firms	Firms:1, 3
Phaistos	Low	Clients, Suppliers, Competitors, Company units		PRTOs: Firms:1,2,6	PRTOs:3,9,1 1 Firms: 1,3,4,5,6	Firms: 3,6
Minotech	No	Univ, PRTOs, Clients	PRTOs:2,11	PRTOs: 2,11	PRTOs: 2,11	Firms: 1
Micro-chemistry	Low	Univ, PRTOs	PRTOs: 4,7 Firms:3,6	PRTOs:4,5,6 ,7 Firms:3,4,6	PRTOs: 4,7,10 Firms: 3,6	PRTOs:4 Firms:3

Source: Survey

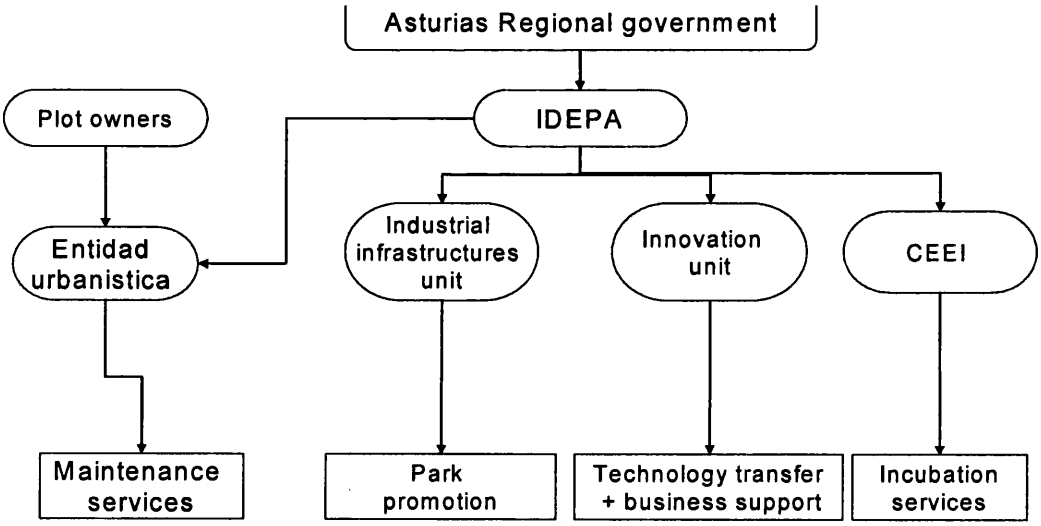
Appendix 14: Spanish STPs management structure

Cartuja93 management structure



Source :Own elaboration

PTA management structure



Source :Own elaboration

Appendix 15 - Research and technology organizations operating at the end of 2005 in Cartuja93

Name of institute	Research/technology area	Year	Employees	Budget (000s €)	R&D type
Centro Nacional de Aceleradores*	Particles acceleration	1999	17	935	Basic /technological applications
Instituto de Investigaciones Químicas*	Chemistry and catalysis	1995	70	?	Basic/applied /technology implementation
Instituto de Bioquímica Vegetal y Fotosíntesis*	Biotechnology	1996	104	2940	Basic/applied
Instituto de Ciencias de los Materiales de Sevilla*	Materials science, nanotechnology	1996	91	1400	Basic/applied
Asociación de Investigación y Cooperación Industrial de Andalucía *	Engineering/industrial applications	1997	60	7635	Basic/applied /technology implementation
Instituto de Automática avanzada y Robótica	Robotics, and Vision systems	1995	37		Applied/Technology development and adoption
Centro de Nuevas Tecnologías Energéticas*	Energy technologies	1995	8		Applied. Technology development/adoption
Instituto Andaluz de Energias Renovables	Renewable energy technologies	?	4		Applied/Technology development and adoption
Centro Andaluz de Metrología	Metrology/calibration	1999	12		Applied. Technology development/adoption
Centro de las Nuevas Tecnologías del Agua	Water/environment	1994	?		Applied. Technology development/adoption / services
Instituto Andaluz de Tecnología*	Innovation management	2001	85	6100	Technology implementation and services
CITAGRO *	Agro-food technologies	2000	18	830K	Technology implementation and services
Centro de Investigación y Desarrollo Postal	Postal services	?	?		Technology development/adoption
Instituto de Monocristales, S.L.	Synthetic Diamonds	?	?		Applied research, technology development
Estación de Ecología Acuática"Príncipe Alberto I de Mónaco"	Aquatic systems, Ecology, Limnology	1993	?		Basic/Applied
FIDAS	Architecture	1993	?		Basic

Name of institute	Research/technology area	Year	Employees	Budget (000s €)	R&D type
Fundación laboral Andaluza del Cemento y el Medio Ambiente	Environment/Technologies for cement industry	2004	?		?
Fundación Gerontológica Internacional	Gerontology	1995	?		?
Instituto Andaluz del Patrimonio Histórico	Cultural studies, History	1993	?		Applied research
Instituto de Estadística de Andalucía	Statistics (regional)	1995	?		Statistical data collection, studies
Instituto Nacional de Estadística	Statistics	1995	120		Statistical data collection, studies
Institute for Prospective Technological Studies *	EU advisory body	1994	180		Technology policy and legislation studies/counseling

Source: Survey

Appendix 16 – List of Interviews

Case	Date	Name	Type	Position/Role
TTP/ STEP-C	03/06/2005	Dr Dimitris Deniozos	Semi-structured recorded interview	Former General Secretary for Research and Technology (2000 - 2004) and responsible for the First Operational program for Research and Technology of Greece (EPET I) used to finance the Technology Parks
TTP	09/06/2005	Mr Stamatis Tsiakiris.	Semi-structured recorded interview	General director of the regional authority of Central Macedonia
TTP	10/06/2005	Mr Dimitris Litsas	Semi-structured not-recorded interview	Representative of American Farm School
TTP	12/06/2005	Mr Kostas Tramantzas	Semi-structured recorded interview	Employee in the Thessaloniki Technology Park Management company since its establishment. Currently executive director
TTP	16/06/2005	Mr Spiros Ignatiadis	Semi-structured recorded interview	Information Technology Companies of Northern Greece (SEPVE)
TTP	18/06/2005	Mr Christos Georgiou	Semi-structured recorded interview	Director of Studies unit of the Federation of Industries of Northern Greece
TTP	20/06/2005	Prof. Nikos Komninos	Semi-structured interview (in Greek)	Professor in Aristotle University of Thessaloniki and expert in regional innovation and technology park topics. Performed the initial study for the creation of TTP
TTP	21/06/2005	Prof. Iakovos Vasalos	Semi-structured recorded interview (in Greek)	Director of the Centre for Research and Technology Hellas (2000-2005), Executive director of Thessaloniki Technology Park Management and Development Company during the period 2001-2005
TTP	07/07/2005	Prof. Vasileios Kelesidis	Semi-structured phone interview (in Greek)	Head of Technology Transfer Unit of TTP/MDC S.A. in the period 1995-2000
STEP	04/05/2006	Mr Haralampos Stratigis	Semi-structured recorded interview (in Greek)	Head of administration and economic services of FORTH
STEP	04/05/2006	Mr. Michalis Katharakis	Semi-structured recorded	Chamber of Commerce of Herakleion

Case	Date	Name	Type	Position/Role
			interview (in Greek)	
STEP	04/05/2006	Mr Nikos Dialynas	Semi-structured recorded interview (in Greek)	Consultant of the general secretary of the regional authority of Crete
STEP	05/05/2006	Mrs Georgia Papadaki	Semi-structured phone interview (in Greek)	University of Crete Liaison office officer
STEP	05/05/2006	Mr Giannis Sifakis	Semi-structured interview	Director of Pancretia VC manager
STEP	08/05/2006	Mr Artemis Saitakis	Semi-structured interview (in Greek)	Executive director of STEP-C MDC S.A.
STEP	08/05/2006	Mr. Panagiotis Ignatiadis	Semi-structured recorded interview (in Greek)	IRC-Praxi STEP-C unit consultant
STEP	09/05/2006	Mr Zinon Kozanas	Semi-structured interview (in Greek)	Piraeus Bank representative in MDC S.A.
STEP/TTP	16/05/2006	Dr. Vasileios Tsakalos	Semi-structured recorded interview (in Greek)	Director of PRAXI IRC
TTP	09/10/2006	Mrs Athina Oikonomidou	Semi-structured phone interview (in Greek)	Editor of feasibility study of CERTH for the creation of infrastructure to develop entrepreneurship activity
TTP	04/01/2007	Prof. Panas	Semi-structured interview (in Greek)	Vice-rector of Aristotle University of Thessaloniki
TTP	04/01/2007	Prof. Kiparisidis	Semi-structured interview (in Greek)	Director of CERTH since 2006
PTA	04/10/2005	Sr Isaac Pola Alonso	recorded semi-structured interview (in Spanish)	Director of unit for business and industrial infrastructure of Instituto de Desarollo Economico de Asturias (IDEPA)
PTA	04/10/2005	Sra Irene Menendez	semi-structured recorded interview,	Technical assistant in Centro Europeo de Empresas e Innovacion (CEEI Asturias), recorded semi-structured interview

Case	Date	Name	Type	Position/Role
			(in English)	
PTA	02/10/2005	Sr Alberto Gonzalez Menendez	semi-structured recorded interview, (in Spanish)	General secretary of Federacion Asturiana de Empresarios (FADE), semi-structured remorded interview
PTA	06/10/2005	Sra Elena Suarez	semi-structured recorded interview, (in Spanish)	Head of Technology Transfer Unit of Fundacion para el Fomento en Asturias de la Investigación Cientifica y la Tecnología (FICYT)
PTA	07/10/2005	Sra Marisa Negrete Plano	semi-structured recorded interview, (in Spanish)	Director of Asociación de Poligonos Industriales de Asturias (APIA), semi-structured recorded interview
PTA	07/10/2005	Mencia Muro	semi-structured recorded interview, (in English)	Officer of the Office of Technology Transfer of Universtiy of Oviedo, semi-structured recorded interview
PTA	08/03/2006	Sr Emilio Gumiel	semi-structured recorded interview, (in Spanish)	Director of Parque Cientifico y Tecnologico de Gijon,
PTA	08/03/2006	Sra Ana Garcia Solar	semi-structured recorded interview, (in Spanish)	Director of Club Asturiano de Innovación
Cartuja93	16/02/2006	Sr Jose Maria Benjumea Pino	semi-structured recorded interview, (in Spanish)	Technical director of Cartuja93 S.A
Cartuja93	17/02/2006	Sra Angeles Gil	semi-structured recorded interview, (in Spanish)	General director of Cartuja93 S.A.
Cartuja93	20/02/2006	Sr Jose Gonzalez Jimenez	semi-structured recorded interview, (in Spanish)	President of Circulo Empresarios de Cartuja93
Cartuja93	20/02/2006	Sr Luis Palma Martos	semi-structured recorded interview, (in Spanish)	Professor of Political Economy in University of Seville
Cartuja93	21/02/2006	Sr Miguel Rivas Casado	semi-structured recorded interview,	Former Director of Sevilla Global – The development company of the municipality of Seville

Case	Date	Name	Type	Position/Role
			(in Spanish)	
Cartuja93	22/02/2006	Sr Antonio Delgado	semi-structured recorded interview, (in Spanish)	Director of Office of Technology Transfer (OTRI) of University of Seville
Cartuja93	22/02/2006	Sr Daniel Escasena	semi-structured recorded interview, (in Spanish)	Technical director of CITANDALUCIA
Cartuja93	23/02/2006	Sr Manuel Perez	semi-structured recorded interview, (in Spanish)	Reprsentative of AGESA – State controlled company that manages part of Cartuja93 park space
Cartuja93	30/03/06	Sr José María Rodríguez Sánchez	semi-structured recorded interview, (in Spanish)	Director General de Innovación y Administraciones Públicas de Junta de Andalucia

Appendix 17 – List of research organisation and firms that participated in the survey with the response code

Public Research and Technology Organisations

Park	Response code and PRO name
STEP-C	RCr-1 Institute of computer sciences (ICS) RCr-2. Institute of Electronic Structure and Laser(IESL) RCr-3. Institute of Applied and Computational mathematics (IACM) RCr-4 Institute of Molecular biology and biotechnology (IMBB)
TTP	RT-1. Institute of Telematics and Informatics (ITI) RT-2.Chemical processes research institute (CPERI) RT-3 . Hellenic Institute of Transport (HIT)
PTA	RPA-1. Technological institute of Materials (ITMA)
Cartuja93	RC93-1. Engineering school of Seville - AICIA RC93-2.National accelerator centre- CNA RC93-3.Institute of plant biochemistry and photosynthesis (IBVF) RC93-4. Institute of Materials Science of Seville (ICMS) RC93-5. Institute of Chemical research (IIQ) RC93-6. Institute of Prospective Technological Studies (IPTS) RC93-7. CITAGRO RC93-8. Andalusian Technology Institute (IAT) RC93-9. Centre for new energy technologies (CENTRE)

Firms

Park	Firm name and response code	
STEP-C	FCr-1. ARTT FCr-2. CyTech FCr-3. FORTHnet FCr-4. Infocharta FCr-5. Microchemistry FCr-6. Minotech	FCr-7.Phaistos Networks FCr-8. Palmera FCr-9. TUV Hellas FCr-10.VEIC FCr-11.Virtual-trip
TTP	FT-1. Ampeloeniki FT-2. Hellabio FT-3. Heletel	FT-4. Intelligen FT-5. IQSystems
PTA	FPA-1.Alamo Systems, FPA-2.Asac Comunicaciones*[238] FPA-3.Asturareces FPA-4.Asturnet FPA-5.Buhodra Ingenieria FPA-6. Dispal Astur FPA-7. ECA S.A FPA-8. Ensilectric FPA-9. Fuelgeras Tecnologicas de la Informaciòn* FPA-10. Fluor S.A. FPA-11. Gonzalez Soriano/ Normalux* FPA-12. Grupo Gesor FPA-13. Helice Gabinete FPA-14. Imagine800	FPA-15. Impulso Industrial Alternativo FPA-16. Ingenieros Asesores FPA-17. Isastur Servicios FPA-18. Isotelco FPA-19. Lider Integrated consulting FPA-20. Logica Equipamientos FPA-21. Phoenix Contact FPA-22. Prozes e-consulting FPA-23. Repromores FPA-24. Rolan FPA-25. Selegna Design FPA-26. SisPyme FPA-27. Tecsolpar FPA-28. Anonymous answer

[238] * Firms that returned incomplete questionnaires.

Park	Firm name and response code	
Cartuja93	FC93-1.AENOR	FC93-14. Ingeniatrics
	FC93-2. AnaFocus	FC93-15. Logitec Consultores
	FC93-3. Biomedal	FC93-16. MacPuarsa*
	FC93-4. CASSFA	FC93-17. Neocodex
	FC93-5.CDCON	FC93-18. Nynco Consultores
	FC93-6. Cemedi	FC93-19. Oracle Iberica
	FC93-7. Grupo Clever	FC93-20. Sadiel
	FC93-8. Grupo Detea	FC93-21. Satec
	FC93-9. E-qulture	FC93-22. Sky Cross engineers*
	FC93-10. EGMASA	FC93-23. Soluciones Globales Internet
	FC93-11. Endesa Ingeniería	FC93-24. Tecnologica
	FC93-12. GFI	FC93-25. VEIASA
	FC93-13. Inerco	FC93-26. Anonymous answer
		FC93-27. Anonymous answer

Past tenants	
Cartuja93	NewBiotechnic
TTP	AST

New/incoming tenants	
Cartuja93	-
PTA	Treelogic
STEP-C	-
TTP	Biomatrix, Pharmathen, VRSense

8 References

Acs, Z., Anselin, L. and Varga, A., (2002). Patents and innovation counts as measures of regional production of new knowledge, *Research Policy*, 31(7): 1069-1085.

Aernouldt, R., (2004), Incubators: tools for entrepreneurship, *Small business economics*, 23: 127-135.

AICIA, (2007), *Association's goals* [online], Association of Research and Industrial Colaboration of Andalusia, Retrieved on 17/12/2007 from http://www.aicia.es/principal_e.htm.

Amin, A. and Thrift, N., (1995), Living in the global, in Amin, A. and Thrift, N.(eds), *Globalization, Institutions, and Regional Development in Europe*, Oxford University Press, pp.1-22

Amin, A. and Tomaney, J., (1998), Regional development potential of inward investment,in Storper, M., Thomadakis, S. and Tsipouri, L.(eds), *Latecomers in the global economy,* Routledge: London, pp.181-200

Amirahmadi, H. and Saff, G., (1993). Science parks: a critical assessment, *Journal of Planning Literature*, 8(2): 107-123.

Analistas Economicos, (2006), *Central de Balances de Andalucia* [online], Analistas Economicos de Andalucia, Retrieved on 17/06/2006 from http://www.centraldebalancesdeandalucia.org.

Antoncic, B. and Hisrich, R., (2003). Clarifying the intrapreneurship concept, *Journal of Small Business and Enterprise Development*, 10(1): 7-24.

Antonelli, C., (2003), *The economics of innovation, new technologies and structural change,* Routledge, London

APSTI, (2007), *Map of members of the Association of Italian Science and Technology parks* [online], Association of Italian Science and Technology parks Retrieved on 10/02/2006 from http://www.apsti.it/index.php?id=52&L=1.

APTE, (2003), *Los parques cientificos y tecnologicos: una comtribucion fundametal en el sistema de Ciencia y Tecnologia en Espana* (The science and technology parks: a fundamental contribution to the system of science and technology in Spain) [online], Assossiation of Spanish Science and Technology Parks, Retrieved on 1/11/2004 from http://www.apte.org/ftp/publicacion/LIBRO11.pdf.

APTE, (2005), *Evolution of members of APTE* [online], Association of Technology and Science Parks of Spain, Retrieved on 05/02/2005 from http://www.apte.org/cgi-bin/apte02/estadistica.pl?i.

Archibugi,D. and Iammarino, S., (1999), The policy implications of the globalisation of innovation, Research policy, 28 : 317-336

Armstrong, H., (2000), *Regional economics and policy,* 3rd edition, Blackwells : Oxford.

Arora, A., Fosfuri, A. and Gambardella, A., (2002), *Markets for technology - the economics of innovation and corporate strategy,* MIT Press, Cambridge, MA

Arundel, A. and Bordoy, C.,(2007), *Summary report for respondents: The ASTP survey for fiscal year 2006*, Association of Science and Technology Transfer professionals.

Asian, C. R., (2004), The role of multinational firms on the producer services sector: repercussions for peripheral regions, *Proceedings of 44th congress of the European regional science association*, Porto, Portugal.

Audretsch, D., (1998), Agglomeration and the location of innovative activity, *Oxford Review of Economic Policy*, 14(2): 18-29.

Audretsch, D., Bozeman, B., Combs, K., Feldman, M., Link, A., Siegel, D., Stephan, P., Tassey, G. and Wessner, C., (2002), The economics of science and technology, *Journal of technology transfer*, 27: 155-203.

Audretsch, D. and Keilback, M., (2004), Entrepreneurship capital and economic performance, *Regional studies*, 38(8): 949-959.

Autio, E., (2007), *2007 High-Growth Entrepreneurship Report* [online], Global Entrepreneurship Monitor, Retrieved on 01/05/2008 from http://www.gemconsortium.org/document.aspx?id=606.

Aydalot, P., (1986), *Innovative environments in Europe*, Gremi, Paris.

Bakouros, L., Mardas, C. and Varsakelis, N., (2002). Science park, a high tech fantasy?: an analysis of the science parks of Greece, *Technovation*, 22,(2): 123-128.

Bathelt, H., Malmberg, A. and Maskell, P., (2002), *Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation* [online],DRUID Working Papers Retrieved on 10/03/2008 from http://ideas.repec.org/p/aal/abbswp/02-12.html.

Benito del Pozo, P., (2000), El fenomeno de tecnopolos en España. Los casos comparados de Asturias y Castilla y León (The phenomenon of tecnopoles in Spain. The comparative cases of Asturias and Castilla y León), *Lecturas Geográficas. Homenaje a José Estébanez,*Universidad Complutense de Madrid, Madrid

Benito del Pozo, P., (2001). Obstáculos y estímulos a la integración de las regiones atlánticas regresivas, *Investigaciones Geográficas*, 26: 121-133.

Benjumea Pino, J. M., (2003). Diez años de parque cientifico y tecnológico, *Cartuja Innova*, 18

Benko, G., (2000), Technopoles, high-tech industries and regional development: a critical review, *GeoJournal*, 51: 157-167.

Benneworth, P.,(2007), *Leading innovation*, NESTA, London.

Bergek, A. and Norrman, C., (2007), Incubator best practice:A framework *Technovation*, 28 (1-2): 20-28

Bigliardi, B., Ivo Dormio, A., Nosella, A. and Petroni, G., (2006), Assessing science parks' performances: directions from selected Italian case studies, *Technovation,* 26(4): 489-505

BOE, (1992), *Ley 31/1992 de 26 de Noviembre de incentivos fiscales aplicables a la realización del proyecto CARTUJA 93 (Regulation 31/1992 of the 26th of November concerning the fiscal incentives applicable for the realisation of the project Cartuja93)* [online], Boletin Oficial de Estado, Ministerio de la Presidencia de Espana, Retrieved on 12/07/2006 from http://www.boe.es/g/es/bases_datos/doc.php?coleccion=iberlex&id=1992/26319.

Bolanos, A., (2003), Cartuja93 ya no es una torre de Babel - Entrevista: Jose Antonio Viera (The Cartuja93 is not any more a Babel tower - Interview: Jose Antonio Viera) [online], *ElPais.com*, Retrieved on 03/02/2007 from http://www.elpais.com/articulo/andalucia/Viera/_Jose_Antonio/Cartuja/93/torre/babel/elpepuespand/20031020elpand_16/Tes.

Bollingtoft, A. and Ulhoi, J., (2005), The networked business incubator- leveraging entrepreneurial agency, *Journal of business venturing*, 20: 265-290.

BOPA, (2002), *Boletin Oficial del Principado de Asturias* [online], Principado de Asturias, Retrieved on 17/01/2006 from http://download.princast.es/bopa/disposiciones/repositorio/LEGISLACION01/66/6/001U001UEQ0002.pdf.

Boschma, R., (2005). Proximity and innovation: a critical assessment, *Regional studies*, 39(1): 61-74.

Broadhurst, T., National Westminster, B. and UK Science Park Association., (1993), *The development and operation of science parks,* United Kingdom Science Park Association : Birmingham.

BusinessWeek, (2005), The Top 500 [online],*BusinessWeek magazine*, Retrieved on 17/07/2006 from http://businessweek.com/magazine/content/05_43/b3956814.htm.

Cabral, R., (1998). The Cabral-Dahab science park management paradigm: an introduction, *International journal of technology management*, 16(8): 721-725.

Caloghirou, Y., Vonortas, N. and Ioannides, S., (2003), *European collaboration in research and development,* Edward Elgar Publishing

CALPARK, (2004), *Technology park of Calabria website* [online], Retrieved on 1/11/2004 from www.calpark.it.

Camagni, R., (1995), The concept of innovative milieu and its relevance for public policies in european lagging regions, *Papers in Regional Science*, 4: 317-340.

Cantwell,J. and Iammarino,S., (2003), *Multinational corporations and regional systems in Europe,* Routledge

Capello, R. and Fagian, A., (2005). Collective Learning and Relational Capital in Local Innovation Processes, *Regional studies*, 39(1): 75-87.

Capello, R. and Morrison, A., (2005), An Evaluation of the Effectiveness of Science Parks in Local Knowledge Creation: a Territorial Perspective, *Proceedings of 5th Triple Helix Conference*, Turin, Italy

Carlsson, B. and Jacobsson, S., (1997), The technological system for factory automation, in Carlsson, B.(eds), *Technological systems and industrial dynamics*, Kluwer Academic Publishers: Dondrecht, pp.37-60

Cartuja93, (2002), *Technological Evaluation of Cartuja93* [online], Instituto Andaluz de Tecnologia, Retrieved on 1/04/2004 from www.cartuja93.es.

Cartuja93, (2004), *Cartuja93 website* [online], Cartuja93 S.A., Retrieved on 2/11/2004 from www.cartuja93.es.

Cartuja93, (2007), *Agencia IDEA y CSIC firman en el Cabimer de Cartuja 93 un convenio para crear nuevas spin-offs* (IDEA agency and CSIC signed in Cabimer [building] of Cartuja93 an agreement for the creation of new spin-offs) [online], Retrieved on 04/09/2007 from http://www.cartuja93.es/ver_resumen.jsp?idres=1083.

Cartuja93 S.A., (1994), El proyecto Cartuja93, Cartuja 93 S.A., Seville.

Castells, M. and Hall, P., (1992), *Andalucía: innovación tecnológica y desarollo económico,* Espasa calpe: Madrid.

Castells, M. and Hall, P., (1994), *Technopoles of the world: the making of 21st century industrial complexes,* Routledge, London and New York

CEEI,(2005), *CEEI website* [online], Centro Europeo de Empresas e Innovación, Retrieved on 20/12/2005 from www.ceei.es/el_ceeis.asp.

CEEI,(2006), *Memoria de Actividades 2006*, Centro Europea de Empresas e Innovación, Llanera.

CEEI, (2007), *El vivero del CEEI alcanza una ocupación del 100% (The incubator of CEEI reached an ocupation of 100%)*, [online], Centro Europeo de Empresas e Innovación, Retrieved on 20/1/2008 from http://www.ceei.es/vernoticia.asp?idNoticia=yq56w58wwu8w

CERTH, (2004), *CERTH Annual turnover* [online], Center for Research and Technology Hellas, Retrieved on 2/11/2004 from www.certh.gr.

CERTH, (2005), *Achievements* [online], Centre for Research and Technology Hellas, Retrieved on 20/11/2005 from http://www.certh.gr/&en/about/achievements.htm.

Chan, K. F. and Lau, T., (2005), Assessing technology incubator programs in the science park: the good, the bad and the ugly, *Technovation*, 25(10): 1215-1228

Charles, D. and Howells, J., (1992), *Technology transfer in Europe : public and private networks,* Belhaven press, London

Chaves, M. G., (2003), Innovando para ganar el futuro (Innovating to win the future), *Cartuja Innova*, 18

Chorda, I., M., (1996). Towards the maturity stage: an insight into the performance of French technopoles, *Technovation*, 16(3): 143-152

CICE, (2005), *Plan Andaluz de Investigación, Desarollo e Innovación (Research, Development and Innovation plan of Andalusia)*[online], Consejeria de Innovacion, Ciencia y Empresa de Andalucia, Retrieved on 10/06/2006 from http://www.upo.es/general/investigar/otri/otri_docu/PAIDI_may05.pdf.

Cieslik, J., (2007), *General Trends and Roles of High-Growth Firms in the Polish Manufacturing Sector 1996 – 2006* [online], Paper Prepared for OECD workshop on the measurement of high-growth enterprises, Retrieved on 10/05/2008 from http://www.oecd.org/dataoecd/47/3/39639594.pdf.

CIRCA, Tsipouri, L. and PricewaterhouseCoopers,(1999), *Impact of the structural fund 1994-1999 on Research, Technology Development and Innovation (RTDI) in Objective 1 and 6 regions,* Final Report to European Commission, Vol.2: Country reports regional innovation profiles case studies, Dublin.

Circulo de Empresarios de Cartuja93, (2006), *Memoria Marzo 2005- Febrero 2006,* Retrieved on 05/06/2006 from http://www.circuloempresarioscartuja.com/info/memorias.asp.

Clarysse, B., Wright, M., Lockett, A., Van de Velde, E. and Vohora, A., (2005). Spinning out new ventures: a typology of incubation strategies from European research institutions, *Journal of business venturing*, 20: 183-216.

Cohen, W. and Levinthal, D., (1990), Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*, 35: 128-152.

Colombo, M. and Delmastro, M., (2002), How effective are technology incubators? Evidence from Italy, *Research Policy*, 31(7): 1103-1122.

Cooke, P., (2001), From technopoles to regional innovation systems: the evolution of localised technology development policy, *Canadian journal of regional science*, 24(1): 21-40.

Cooke, P., Uranga, M. G. and Etxebarria, G., (1997), Regional innovation systems: institutions and organisational dimensions, *Research Policy*, 26: 475-491.

CORDIS, (2006), *Artificial vision technology proves a sight for sore eyes* [online], Retrieved on 01/05/2007 from http://cordis.europa.eu/ictresults/index.cfm/section/news/tpl/article/BrowsingType/Features/ID/81796.

COTEC, (2000), *Los Parques Científicos y Tecnológicos. Los Parques en España (Science and Technology Parks: The Parks in Spain)* [online], COTEC, Retrieved on 01/03/2005 from http://www.cotec.es/index.jsp?seccion=132&id=200505110040.

COTEC, (2005a), *Documento para el debate sobre el sistema de innovación en el Principado de Asturias* [online], COTEC, Retrieved on 18/01/2006 from http://www.cotec.es/docs/ficheros/200505100024_6_0.pdf.

COTEC, (2005b), *Libro Blanco de la Innovación en el Principado de Asturias* [online], Retrieved on 18/01/2006 from http://www.cotec.es/docs/ficheros/200509270001_6_0.pdf.

CPERI,(1991), *Technological Park of Thessaloniki proposal to Science Park Consultancy Scheme*, Thessaloniki.

Dahlstrand, A. L. and Klofsten, M., (2002), Growth and innovation support in Swedish Science Parks and Incubators, in Oakey, R., During, W. and Kauser, S.(eds), *New technology based firms in the new millenium,* Elsevier Science, Oxford.

DataInvex, (2007), *DataInvex Estadísticas de Inversión Extranjera en España (DataInvex Statistics of foreign investment in Spain)* [online], Retrieved on 15/04/2008 from http://datainvex.comercio.es/index.htm.

Deniozos, D., (1993), Τεχνολογική Πολιτική [Technology policy] in Giannitsis, T. (eds), *Βιομηχανική και Τεχνολογική Πολιτική στην Ελλάδα (Industrial and Technology Policy in Greece),* Themelio, Athens, pp. 209-261

Doloreux, D., (2002), What we should know about regional systems of innovation, *Technology in Society*, 24: 243-263.

Dosi, G., (1988), *Technical change and economic theory,* Pinter, London.

EC,(1996), *Comparative study of science parks in Europe: Keys to community innovation policy*, European Commission, No.29.

EC,(2001), *Workshop on the mechanisms for the implementation of regional and local development actions,* 06/12/2001, Athens, Greece.

EC, (2002), *Benchmarking of Business Incubators - Final report* [online], DG Enterprise, Retrieved on 20/07/2005 from http://www.europa.eu.int/comm/enterprise/entrepreneurship/support_measures/incubators/.

EC, (2003), *Regional Innovation performances*, Technical paper 3, European Innovation scoreboard 2003 [online], European Commission - Directorate General Enterprise, Retrieved on 10/11/2004 from http://www.trendchart.org/scoreboards/scoreboard2003/pdf/eis_2003_tp3_regional_innovation.pdf.

EC, (2006a), *The 2005 EU Survey on R&D Investment Trends in 10 Sectors* [online], European Commission, Retrieved on 31/08/2007 from http://iri.jrc.es/research/survey_2005.htm

EC, (2006b), *The 2006 EU Industrial R&D Investment Scoreboard* [online], European Commission - Directorate General Joint Research Centre, Retrieved on 26/03/2007 from http://iri.jrc.es/research/scoreboard_2006_data.htm.

EKT, (n.a.), *Operational Programme for Research and Technology (EPET II)* [online], Retrieved on 01/01/2007 from http://www.ekt.gr/content/display?ses_mode=rnd&ses_lang=en&prnbr=14917

EOI, (2006), *EOI* [online], Escuela de Negocios, Retrieved on 17/06/2006 from www.eoi.es.

ESIC, (2006), *ESIC* [online], Escuela Superior de Gestión Comercial y Marketing, Retrieved on 17/06/2006 from www.esic.es.

ESYE, (2004), *Statistical data* [online], General Secretariat of National Statistical Service of Greece, Retrieved on 1/12/2004 from www.statistics.gr.

EUA, (2001), *The University of Crete: European University's Association reviewers report* [online], Retrieved on 10/09/2006 from www.uoc.gr.

Europa, (2004), *Maps of Europe*, European Commission, Directorate General for Press and Communication.

EUROSTAT, (2005a), *General and regional statistics* [online], EUROSTAT, Retrieved on 20/07/2005 from http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136162,0_45572073&_dad=portal&_schema=PORTAL.

EUROSTAT, (2005b), *Science and technology statistics* [online], EUROSTAT, Retrieved on 25/07/2005 from http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136250,0_45572552&_dad=portal&_schema=PORTAL.

EUROSTAT, (2008), *General and regional statistics* [online], EUROSTAT, Retrieved on 20/07/2008 from http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136162,0_45572073&_dad=portal&_schema=PORTAL.

EXPO, (2008), *EXPO92 - Facts* [online], Retrieved on 01/04/2008 from http://www.expo92.es/laexpo/index.php?seccion=cifras&pag=1.

Feldman, M., (1994), *The geography of innovation,* Kluwer Academic Publishers, Dordrecht.

Felsenstein, D., (1994), University-related science parks -- 'seedbeds' or 'enclaves' of innovation?, *Technovation*, 14(2): 93-110.

Ferguson, R. and Olofsson, C., (2004), Science parks and the development of NTBFs - Location, survival and growth, *Journal of technology transfer*, 29: 5-17.

Fernandez, I. L., Mas, F. V. and Tortosa, E. M., (2006), *Políticas autonómicas de innovación: coincidencias y divergencias (Autonomous [regions] innovation policies: convergences and divergences)*, Retrieved on 01/09/2008 from http://www.redotriuniversidades.net/index.php?option=com_docman&task=doc_download&gid=386&Itemid=33&mode=view.

Ferraro, F. J., (2000), Tecnología e industria en Andalucía: Análisis y valoración de las políticas (Technology and industry in Andalusia: Analysis and evaluation of policies), *Economia Industrial*, 335/336: 83-94.

FICYT, (2001), *Plan de investigación, desarollo tecnológico e innovación, 2001-2004* [online] (Plan of research, technology and innovation 2001-2004), Fundación para el Fomento en Asturias de la Investigación Científica Aplicada y la Tecnología, Retrieved on 08/06/2006 from http://www.idepa.es/portal/p%2Bd%2Bi.pdf.

Fontes, M., (2005), Distant networking: The knowledge acquisition strategies of "out-cluster" biotechnology firms, *European Planning Studies*, 13(6): 899-919.

Fontes, M. and Coombs, R., (2001), Contribution of new technology based firms to the strengthening of technological capabilities in intermediate economies, *Research Policy*, 30: 79-97.

FORTH, (2006), *FORTH website* [online], Retrieved on 12/11/2006 from www.forth.gr.

FORTHnet, (2005), *Annual shareholders report* [online], FORTHnet S.A., Retrieved on 20/11/2006 from http://www.forthnet.gr//media/Company/EthsiaDeltia/2005/ANNUAL_REPORT_2005_final_GR.pdf.

Freel, M., (2000), External linkages and product innovation in small manufacturing firms, *Entrepreneurship and regional development*, 12(3): 245-266.

Freeman, C., (1991), Networks of innovators: A synthesis of research issues, *Research Policy*, 20: 499-514.

Freire, C., (2003), Taguspark: Fostering entrepreneurship, *Proceedings of XX IASP world conference on Science and Technology Parks*, Lisbon, IASP.

Freire, C., (2005), *Taguspark - Lisboa Science and Technology Park* [online], Retrieved on 01/12/2005 from http://www.yes.be/data/news/TAGUSPARK_-_Presentation_Carlos_Freire_050401_1153831234.pdf.

Fritsch, M., (2001), Co-operation in regional innovation systems, *Sage Urban Studies Abstracts 29, no. 4*: 411-568

Fuente, A., (2003), La evolucion de la economia asturiana 1955-1998 (The evolution of the economy of Asturias 1955-1998) , *Papeles de economia española*, 20: 137-152.

Fuente, A. and Rubio, P., (2006), Denuncian el traslado de la firma Autotex a Chequia, *La Voz de Asturias,* 06/10/2006,

Galanakis, K., Saitakis, A., Ignatiadis, P. and Papamichael, G.,(2005), *Technology foresignt for the region of Crete using the EASW methodology,* Report for the IN.TRACK EU project, Herakleion.

Garcia, A., (2001), Parc Tecnológic: razones de un fracaso (Parc Tecnologic [of Valencia], Reasons for a failure) [online], *El Pais.com*, Retrieved on 10/03/2005 from http://www.elpais.com/articulo/Comunidad/Valenciana/Parc/Tecnologic/razones/fracaso/elpepuespval/20010301elpval_7/Tes.

Garcia, M. E., Gayo, M. E., Del Pozo, L. B. and IDETRA S.A., (2006), *Analysis of the regional dimension of investments in research.Case study regional report: Andalusia* [online], Erawatch, Retrieved on 01/04/2007 from cordis.europa.eu/erawatch

Geenhuizen, M. V. and Soetanto, D., (2008), Science parks: What they are and how they need to be evaluated, *International journal of of foresignt and innovation policy*, 4(1/2): 90-111.

GEM, (2005a), *Greece GEM 2005 National Report* [online], Global Entrepreneurship Monitor, Retrieved on 31/08/2007 from http://www.gemconsortium.org/document.aspx?id=533.

GEM, (2005b), *Spain National Report 2005* [online], Global Entrepreneurship monitor, Retrieved on 31/08/2007 from http://www.gemconsortium.org/document.aspx?id=523.

Gertler, M., (2003), Tacit knowledge and the economic geography context, the undefinable tacitness of being there, *Journal of economic geography*, 3: 75-99.

Gibb, J. L., (2007), Optimising intellectual capital development: a case study of brokering in a science park, *International journal of entrepreneurship and innovation management*, 7(6): 491-505.

Gil, A. G., (2003). Innovaciön y allianzes para seguir creciendo, *Cartuja Innova*, 18.

GMV, (n.d.), *Interview with Miguel Hormigo Ruiz - Director of GMV delegation in Seville* [online], Retrieved on 04/09/2007 from http://www.gmv-sgi.com/imagenes_comunicacion/entrevistas/entrevista_3.htm.

Goldstein, H. and Luger, M., (1991), Science technology parks and regional development: prospects for the United States, in Hilpert, U.(ed.), *Regional innovation and decentralization - High tech industry and government policy,* Routledge, London

Gonzalez, J., A. and Diaz Perez, F., (1995), Los Parques Tecnologicos Espanoles como instrumento de desarollo economico regional (The Technology Parks of Spain as an instrument for regional economic development), *Economia Industrial*, 301: 63-74.

Gordon, I. and McCann, P., (2000), Industrial clusters: Complexes, Agglomeration and/or Social networks?, *Urban Studies*, 37(3): 513-532.

Government Gazette, (2000), *Presidential decree 77- Foundation of the Centre for Research and Technology Hellas*, Vol. 1, pp. 1279-1286.

Granovetter, M., (1985), Economic Action and Social Structure: The Problem of Embeddedness, *American Journal of Sociology*, 91: 481-510.

Grayson, L., (1993), *Science parks : an experiment in high technology transfer,* British Library Science Reference and Information Service, London.

Grimaldi, R. and Grandi, A., (2005), Business incubators and new venture creation: an assessment of incubating models, *Technovation*, 25(2): 111-121.

GSRT, (2001), *Evaluation of research centres (in Greek)* [online], General Secretariat for Research and Technology, Retrieved on 1/05/2005 from http://www.gsrt.gr/default.asp?V_ITEM_ID=1836.

GSRT, (2004), *Statistical data and performance indicators of supervised entities (in Greek)* [online], General Secretariat for Research and Technology, Ministry of development, Greece, Retrieved on 1/06/2004 from www.gsrt.gr.

GSRT, (2005), *Greek research centres and institutes evaluation* [online], General Secretariat for Research and Technology, Retrieved on 15/05/2006 from http://www.gsrt.gr/default.asp?MARK_SEARCH=YES&SEARCH_ID=s1&V_ITEM_ID=110.

GSRT, (2006), *R&D statistics* [online], General Secretariat for Research and Technology, Retrieved on 11/11/2006 from http://www.innowestmac.gr/images/stories//r&d%20data%202003.xls.

Guillermo, A., (2003), Externality creation through technology parks: The case of Castilla y Leon, *Proceedings of XX World conference on Science and technology parks*, International Association of Science Parks, Lisbon, Portugal.

Guillermo, A. M., (2002), *Las estrategias para la innovación tecnológica en Castilla y León (Strategies for technological innovation in Castilla y Leon)*, PhD Thesis, University of Valladolid, Economic and Business sciences department, Valladolid.

Hackett, S. M. and Dilts, D. M., (2004), A Systematic Review of Business Incubation Research, *The Journal of Technology Transfer*, 29(1): 55-82.

Hagedoorn, J., Link, A. N. and Vonortas, N., (2000), Research partnerships, *Research Policy*, 29: 567-586.

Harper, C. J., (2003), *Improving links between tenant companies and higher education institutions :exploring emerging scenarios for Manchester Science park* [online], PREST, Retrieved on 25/1/2004 from http://les.man.ac.uk/PREST/Download/Science_Parks_final.pdf.

Hassink, R., (1996), Technology Transfer Agencies and Regional Economic Development, *European Planning Studies*, 4(2): 167-184.

Hauschildt, J. and Steinkuhler, R., (1994), The role of science and technology parks in NTBF development, in Oakey, R.(ed.), *New technology based firms in the 1990s*, Paul chapman publishing, London

Hermosa, H. J. and Barroeta, B., (1998), The technology park at Beocillo: an instrument for regional development in Castilla-León, *Progress in Planning*, 49(3-4): 241-254.

Hilpert, U., (1991), *Regional innovation and decentralization : high tech industry and government policy*, Routledge: London.

Howells, J., (1999), Research and Technology Outsourcing, *Technology Analysis & Strategic Management*, 11(1): 17-29.

Howells, J., (2005), Innovation and regional economic development: A matter of perspective *Research Policy*, 34: 1220-1234.

Howells, J., (2006), Intermediation and the role of intermediaries in innovation, *Research Policy*, 35(5): 715-728.

Hu, T. S., Lin, C. Y. and Chang, S. L., (2005), Technology-based regional development strategies and the emergence of technological communities: a case study of HSIP, Taiwan, *Technovation*, 25(4).

Hytti, U. and Mäki, K., (2006), *Profiling Finnish Technology Incubators: Common Elements and Particular Features* [online], Retrieved on from http://www.techbusiness.ru/conf/helsinki2006/hs004.pdf.

IASP, (2007), *About Science and Technology Parks - Definitions* [online], International Association of Science Parks (www.iasp.ws), Retrieved on 01/10/2007 from http://www.iasp.ws/publico/index.jsp?enl=1.

IASP, (2008), *The IASP at a glance - Facts and Figures* [online], International Association of Science Parks, Retrieved on 10/04/2008 from www.iasp.ws.

IAT, (2004), *Inventario y evaluación tecnológica de las empresas y organizaciones instaladas en el Parque Científico y Tecnológico Cartuja93(Inventory and technological evaluation of the firms and organisations installed in the Science and Technology Park of Cartuja93),* Cartuja93 S.A., Seville.

IAT, (2005), *Inventario y evaluación tecnológica de las empresas y organizaciones instaladas en el Parque Científico y Tecnológico Cartuja93 (Inventory and technological evaluation of the firms and organisations installed in the Science and Technology Park of Cartuja93),* Cartuja93, Seville.

IAT, (2006), *Inventario y evaluación tecnológica de las empresas y organizaciones instaladas en el Parque Científico y Tecnológico Cartuja93 (Inventory and technological evaluation of the firms and organisations installed in the Science and Technology Park of Cartuja93),* Cartuja93, Seville.

IDEPA, (1995-2004), *Memoria de actividades 1995-2004* [online], Instituto de Desarollo Economico de Principado de Asturias, Retrieved on 15/01/2006 from http://www.idepa.es/.

IDEPA,(1998), *Memoria de Idepa*, IDEPA.

IDEPA,(1999), *Memoria de Idepa*, IDEPA.

IDEPA, (2002a), Asturias, elegida como sede para salvar vidas, *IDEPA Activa magazine*, 1: 4-5.

IDEPA,(2002b), *El sector de los servicios avanzados e las empresas en Asturias: Estudio de la situación, perspectivas y necesidades (The sector of advanced services and firms in Asturias: Study of the current situation prospects and needs)*, Universidad de Oviedo, Departamento de Economía Aplicada, Oviedo.

IDEPA, (2002c), *Evolución de los centros de empresas en el Principado de Asturias* [online] (Evolution of the business centres in the Principality of Asturias), Institute de Dessarollo de Principado de Asturias, Retrieved on 10/07/2006 from http://www.idepa.es/portal/emprendedores2.asp.

IDEPA, (2003), Ervisa:Plástico limpio pra envasados y embalajes, *IDEPA activa magazine*, 4: 9-11.

IDEPA, (2006), *Parque Tecnológico de Asturias* [online], Instituto de Desarollo Economico de Principado de Asturias, Retrieved on 01/12/2005 from www.idepa.es.

IDEPA, (2007), *Video de promoción del Parque Tecnológico de Asturias* [online], Instituto de Desarollo Economico de Principado de Asturias, Retrieved on 05/05/2007 from http://www.idepa.es/sites/web/idepaweb/servicios/parque/index.jsp?&csection=2&section=2&posl1=5&posl2=-1&posl3=-1.

IEA, (1999), *Servicios prestados a las empresas en Andalucia (Services offered to firms in Andalusia)* [online], Instituto de Estatisticas de Andalucia, Retrieved on 1/03/2007 from http://www.juntadeandalucia.es/institutodeestadistica/ServEmpresas/pub/ServEmpresas.pdf.

IFR, (1991), *The Technological Park of Asturias,* Instituto de Fomento Regional de Asturias, Oviedo.

IFR,(2002), *Parque Tecnológico de Asturias*, Instituto de Fomento Regional de Asturias, Oviedo.

INE, (2006a), *Cuentas economicas - Contabilidad Regional de España* [online], Instituto Nacional de Estadistica, Retrieved on 10/07/2006 from http://www.ine.es/inebase/cgi/um?M=%2Ft35%2Fp010&O=inebase&N=&L=.

INE, (2006b), *Directorio Central de Empresas: explotación estadística* (Firms' central Directory : statistical analysis) [online], Retrieved on 10/07/2006 from http://www.ine.es/inebase/cgi/um?M=%2Ft37%2Fp201&O=inebase&N=&L=.

INE, (2006c), *Inebase - Science and Technology Statistics* [online], National Statistics Institute of Spain, Retrieved on 1/11/2006 from www.ine.es.

Innovatia, (2004), *Aristeia sti Kentriki Makedonia(Excelence in Central Macedonia),* Report for the current situation and the future prospects of the Information Technology and Telecommunications firms in Central Macedonia [online], SEPVE, Retrieved on 01/05/2005 from http://www.aristeia.gr/eter_plhr_km.pdf.

Intracom, (2003), *2003 Investors annual report* [online], Intracom, Retrieved on 21/11/2006 from http://www.intracom.gr/downloads/pdf/invest/annual_report/annual_repor2003_en.pdf.

Invertia, (2005), *CARTUJA 93 - Aprobada incubadora empresas supondrá inversión de 5,2 millones* (Cartuja93 - Approved business incubator means an investment of 5,2 million) [online], Retrieved on 20/07/2006 from http://www.invertia.com/noticias/noticia.asp?idnoticia=1297352.

IOBE, (2006), *The ICT sector in Greece: Situation and prospects (in Greek)* [online], Information Society Observatory, Retrieved on 01/12/2006 from http://www.observatory.gr/page/default.asp?la=1&id=183&pl=110&pk=264&ap=101.

IOBE,(2007), *Η επιχειρηματικότητα στην Ελλάδα (Entrepreneurship in Greece)*, IOBE.

IRE, (n.a.), *University Student Entrepreneurship (UNISTEP): generating technological projects for commercialisation* [online], Retrieved on 04/09/2007 from http://www.innovating-regions.org/content_db/cddb.cfm?action=article&publication_id=4080&appId=2&is_article=1.

Isaksen, A., (2001), Building regional innovation systems: Is endogenous industrial development possible in the global economy, *Canadian journal of regional science*, 24(1): 101-120.

ISI, (2006), *Science Citation Index* [online], Thomson Corporation, Retrieved on 20/11/2006 from http://wok.mimas.ac.uk/.

Jaffe, (1989), Real effects of academic research, *American Economic review*, 79: 957-990.

Johannisson, B., Alexanderson, O., Nowicki, K. and Senneseth, K., (1994), Beyond anarchy and organisation: Entrepreneurs and contextual networks, *Entrepreneurship and regional development*, 6: 329-356.

Joseph, S. A., (1989). Technology parks and their contribution to the development of technology oriented complexes in Australia, *Environment and Planning C : Government and policy*, 7: 173-192.

Kang, B. J., (2004), A study on the establishing development model for research parks, *Journal of technology transfer*, 29(2): 203-210.

KANTOR, (2005), *Επισκόπηση Ελληνικής αγοράς Τηλεπικοινωνιών 2005 (Greek Telecommunications market survey 2005)* [online], KANTOR Management consultants, Retrieved on 10/02/2007 from http://www.kantor.gr/Files/media/surveys/telecomssurvey2006_v3.ppt.

Kasteli, I., (2000), *Science and Technology Policy in Greece - Policy initiatives for R&D cooperation* [online], Fondazione Eni Enrico Matei, Retrieved on 24/01/2007 from http://www.feem.it/NR/rdonlyres/5131EEE1-AABC-41B3-9BC1-C5AF7DCB5A56/264/6900.pdf.

Kelessidis, V. C., (1998), *The role of technology parks in regional development - the case of Northern Greece*, Paper presented on the XV IASP World Conference on Science & Technology Parks, Perth.

Kelessidis, V. C., Vasalos, I. J. and Komninos, N., (1999), *Planning for Science and Technology Parks in Southern Europe: Experiences from Spain, Italy and Greece* [online], XXVI IASP World Conference on Science & Technology Parks, Retrieved on 01/12/2003 from http://drillinglab.mred.tuc.gr/Publications/TP_02.pdf.

Kim, J. and Woo Yoo, C., (2007), Why "design" does not work well for cluster policy? With the implications for the Science and Technology manpower policy, *International journal of technology management*, 38(3): 321-338.

Knight Frank, (2007), *Mercado de oficinas Sevilla - Annual 2007 (Office' space market in Seville - Annual report 2007)* [online], Knight Frank Newmark Global, Retrieved on 17/12/2007 from http://www.knightfrank.es/es/informes/Doc/Oficinas_Sevilla_Oct_2007.pdf.

Koh, F., Koh, W. and Tschang, F. T., (2005), An analytical approach for science parks and technology districts with an application to Singapore, *Journal of business venturing*, 20: 217-239.

Kohler, H.-D., (2003), La sociedad Asturiana asentada en declive (The Asturian society situated in decline), *Papeles de economia española*, 20: 19-29.

Komninos, N., (1993), *Technopoles - Strategies for development in Europe (in Greek)*, Gutenberg, Athens.

Komninos, N., (1998), Innovation and geographical restructuring of Greek development (in Greek), in Sefertzi, E.(ed), *Καινοτομία [Innovation]*, Gutenberg, Athens

Komninos, N., (2002), *Intelligent cities: innovation, knowledge systems, and digital spaces*, Spon Press, London.

Komninos, N. and Manos, S., (2005), *Η Θεσσαλονίκη της τεχνολογίας - 10 χρόνια προγραμματισμού τεχνολογικής ανάπτυξης(Thessaloniki of technology - 10 years of technological development planning)* [online], URENIO research unit, Retrieved on 05/05/2005 from http://www.urenio.org/courses/files/3/articles/Thessaloniki_of_%20Technology.doc.

Koschatzky, K., (2001), Networks in innovation research and innovation policy - an introduction, in Koschatzky, K. and Kuklinski, A.(eds), *Innovation networks-concepts and challenges in the European perspective,* Physica Verlag, Heidelberg

Kuklinski, A., (1972), *Growth poles and growth centres in regional planning,* Mouton, Paris.

Kyrgiafini, L. and Sefertzi, E., (2003), Changing regional systems of innovation in Greece: the impact of regional innovation strategy initiatives in peripheral areas of Europe, *European Planning Studies*, 11(8): 885-910.

Labrianidis, L., (1996), Subcontracting in Greek manufacturing and the opening of the Balkan markets, *Cyprus Journal of Economics*, 9(1): 29-45.

Landabaso, M., (1997), The promotion of innovation in regional policy: proposals for a regional innovation strategy, *Entrepreneurship and regional development*, 9: 1-24.

Landabaso, M. and Mouton, B., (2005), Towards a different regional innovation policy: eight years of European experience through the European regional development fund innovative actions in Geenhuizen, M., van,, Gibson, D. and Heitor, M.(eds), *Regional development and conditions for innovation in the network society*, Purdue university, pp.209-240

Lazaric, N., Longhi, C. and Thomas, C., (2004), Codification of knowledge inside a cluster: the case of the Telecom Valley in Sophia Antipolis., *Proceedings of DRUID SUMMER conference 2004 Industrial dynamics, Innovation and development*, Sophia Antipolis, France.

Lindelöf, P. and Löfsten, H., (2004), Proximity as a resource base for competitive advantage: University- Industry links for technology transfer, *Journal of technology transfer*, 29: 311-326.

Lindelöf, P. and Löfsten, H., (2006), Science park effects in Sweden: dimensions critical for firm growth, *International journal of public policy*, 1(4): 451-474.

Link, N. A. and Scott, J., (2003), U.S. science parks: the diffusion of innovation and its effects on the academic missions of universities, *International Journal of Industrial Organization*, 21(9): 1323-1356.

Löfsten, H. and Lindelof, P., (2005), R&D networks and product innovation patterns—academic and non-academic new technology-based firms on Science Parks, *Technovation*, 259(9): 1025-1037.

Löfsten, H. and Lindelöf, P., (2001), Science Parks in Sweden - industrial renewal and development?, *R&D Management*, 31(3): 309-322.

Löfsten, H. and Lindelöf, P., (2002), Science Parks and the growth of new technology-based firms--academic-industry links, innovation and markets, *Research Policy*, 31(6): 859-876.

Löfsten, H. and Lindelöf, P., (2003), Determinants of the entrepreneurial milieu: Science parks and business policy in growing firms, *Technovation*, 23: 51-64.

Logotech, (1998), *Εθνική Απογραφή Καινοτομίας 1994-1996, 1997-1998 (Greek National Innovation Survey 1994-1996, 1997-1998)* [online], General Secretariat for Research and Technology, Retrieved on 21/1/2006 from http://www.innowestmac.gr/images/stories//sinopsi_apografi_94_98.doc.

Logotech, (2004), *3rd Community Innovation Survey (in Greek),* General Secretariat for Research and Technology, Ministry of Development, Athens.

Logotech, (2006), *Analysis of the regional dimensions of investment research-Case study regional report : Crete* [online], Retrieved on 01/10/2007 from http://cordis.europa.eu/erawatch/index.cfm?fuseaction=intService.display&topicID=588&countryCode=AT.

Longhi, C., (1999), Networks, Collective Learning and Technology Development in Innovative High Technology Regions: The Case of Sophia-Antipolis, *Regional studies*, 33(4): 333-342.

Longhi, C. and Quere, M., (1997), The Sophia Antipolis project or the uncertain creation of an innovative milieu, in Ratti, R., Bramanti, A. and Gordon, R.(eds), *The dynamics of innovative regions - the GREMI approach,* Ashgate publishing

Loquendo, (2005), *Voiceweb and Loquendo Technology Power: The Pythia Taxi Dispatching System in Greece* [online], Retrieved on 02/12/2006 from http://www.loquendo.com/en/news/news_pythia_taxi.htm.

Lubias, F. R., (2003), Los Parques Cientificos y Tecnológicos, Sistemas Visrtuosos de innovación, *Economia Industrial*, 354(VI): 85-102.

Luger, M. I. and Goldstein, H. A., (1991), *Technology in the garden, research parks and regional economic development,* University of North Carolina Press :Chapel Hill, NC.

Maggioni, M., (2002), The development of high-tech clusters - Theoretical insights and policy implications, in Feldman, M. and Massard, N.(eds)., *Institutions and systems in the geography of innovation,* Kluwer Acedemic Publishers: Dordrecht

Maillat, D., (1995), Territorial dynamic, innovative milieu and regional policy, *Entrepreneurship and regional development*, 7(205-262).

Mäki, K., (2002), Science Parks as Network Providers, *Proceedings of European Academy of Management 2nd Annual Conference on Innovative Research in Management, Track Networks - Supporting Early Venture Development*, Stockholm, Sweden.

Maldonado, E., (2001), El parque tecnologivo de Asturias despega tras bajar el precio del suelo (The technology park of Asturias takes off after the reduction of land prices) [online], *Cinco Dias*, Retrieved on 06/09/2007 from http://www.cincodias.com/imprimir.html?xref=20010417cdscdiemp_22&anchor=cdsemp&type=Tes&d_date=

Malecki, E., (1980). Dimensions of R&D location in the United States *Research Policy*, 9: 2-22.

Malmberg, A. and Maskell, P., (2001), The elusive concept of localisation economies - Towards a knowledge based theory of spatial clustering, *Proceedings of Association of American Geographers Annual conference* New York.

Maltez , L., (2004), STPs in Portugal, *Proceedings of XXI IASP world conference on Science and Technology Parks*, IASP, Bergamo, 523-531.

Massey, D., Quintas, P. and Wield, D., (1992), *High-tech fantasies : science parks in society, science, and space,* Routledge: London.

McCandless, M. E., (2004), Spain:Building a future in Spain - Intrerview with Robert S. Yorgensen, President & COO of Specialized Technology Resources España, S.A. (STRE*)* [online], *Business facilities*, Retrieved on 30/06/2006 from http://www.businessfacilities.com/bf_04_12_global3.asp.

Mian, S. A., (1996), Assessing value-added contributions of university technology incubators to tenant firms, *Research Policy*, 25: 325-335.

Monck, C. S. P., Porter, R. B., Quintas, P., Storey, D. J. and Wynarczyk, P., (1988), *Science parks and the growth of high technology firms,* Published in association with Peat Marwick McLintock, Croom Helm: London.

Morgan, K., (1997), The learning region: institutions, innovation and regional renewal, *Regional studies*, 35(4): 343-348.

Morgan, K., (2001), The exaggerated death of geography:Localised learning, innovation and uneven development, *Proceedings of Future of innovation studies conference*, Eindhoven.

Morgan, K. and Nauwelaers, C., (1994), A regional perspective on innovation: from theory to strategy, in Morgan, K. and Nauwelaers, C.(eds), *Regional innovation strategies - the challenge for less-favoured regions,* Routledge:London

Moulaert, F. and Sekia, F., (2003), Territorial innovation models: a critical survey, *Regional studies*, 37: 289-302.

Moyart, L., (2005), The role of producer services in regional developemnt: What opportuniteis for medium-sized cities in Belgium?, *The services industries journal*, 25(2): 213-228.

Muller, E., (2001), Knowledge innovation processes and regions, in Koschatzky, K., Kuklinski, A. and Zenker, A.(eds), *Innovation networks: concepts and challenges in the European perspective*, Physica-Verlag: Heidelberg

Muñoz, E., Espinosa de los Monteros, J. and Diaz, V., (2000), *Innovation policy in Spain - Technology, innovation and economy in Spain: National and regional influences*, Paper presented in CONVERGE Project Workshop, Université Louis Pasteur (BETA), Strasbourg.

Nijkamp, P., Van Oirschot, G. and Oosterman, A., (1994), Knowledge networks, science parks and regional development - An international comparative analysis of critical success factors, in Cuadraro - Roura, J. R., P., N. and Salva, P.(eds), *Moving frontiers: economic restructuring, regional development and emerging networks,* Ashgate Publishing ltd.

NTUA and ICAP, (2002), *GSRT research project final report: Measurement of cooperation between research and production organisations (1995-2001) (in Greek)* [online], General Secteratiat for Research and Technology, Retrieved on 25/11/2006 from http://www.gsrt.gr/default.asp?V_ITEM_ID=2094.

Oakey, P. and Mukhtar, S. M., (1999), UK High-technology Small Firms in Theory and Practice: A Review of Recent Trends, *International small business journal*, 17(2): 48-64.

OECD,(1997), *Science, Technology and Industry. Scoreboard of Indicators*, Organization for Economic Cooperation and Development, Paris.

OECD, (2005), *STI Outlook: Greece case* [online], OECD, Retrieved on 01/08/2005 from http://www.oecd.org/dataoecd/25/44/2109316.pdf.

OECD, (2007), *OECD Science, Technology and Industry Scoreboard 2007 - Classification of manufacturing industries based on technology* [online], Organisation for Economic Co-operation and Development, Retrieved on 10/05//2008 from http://miranda.sourceoecd.org/pdf/sti2007/922007081e1-annex1.pdf.

Oikonomidou, A.,(2005), *Feasibility study for the creation of infrastructure to develop entrepreneurial activity and commercial exploitation of research results (in Greek)*, Center for Research and Technology Hellas, Thessaloniki.

Ondategui, J., C., (1997), *Tecnología, industria e innovación : los parques tecnológicos en España*, Universidad Complutence de Madrid, Madrid.

Ondategui, J., C., (1999), Redes de Innovación y Desarollo Regional en el Noroeste Peninsular, *Revista de Estudios Regionales*, 55: 77-107.

Ondategui, J., C., (2001), *Los Parques Científicos y Tecnológicos en España: retos y oportunidades(The Science and Technology Parks in Spain: challenges and opportunities)* [online], Communidad de Madrid - Dirección general de investigacion, Retrieved on 2/11/2004 from http://www.madrimasd.org/informacion/publicacion/doc/ParquesCientificosTecnologicos.pdf.

Ondategui, J. C., (2002), Parques Científicos e innovación en España: Quince años de experiencia, *Economia Industrial*, 346: 147-159.

Oughton, C., Landabaso, M. and Morgan, K., (2002), The regional innovation paradox: Innovation policy and industrial policy, *Journal of technology transfer*, 27: 97-110.

Pantelidis, P. and Nikolopoulos, E., (2008), FDI Attractiveness in Greece, *International Advances in Economic Research*, 14(1): 90-100.

PCTG, (2006), *Parque Cientifico y Tecnológico de Gijon* [online], Retrieved on 16/12/2006 from http://www.pctg.net/index.htm.

Peneder, M., (2003), Industry Classifications: Aim, Scope and Techniques, *Journal of Industry, Competition and Trade*, 3(1): 109-129.

Perroux, F., (1955), Note sur la notion de pôle de croissance, *Economie Appliquée*, 8: 307-320.

Pessoa, A. and Lopes, E., (2003), The evolution of NTBF tenants in Taguspark - 1998 to 2002 Perspective [online], *Proceedings of XX IASP world conference on Science and technology Parks (www.iasplisboa.com/conference_papers.asp)*, Lisbon, IASP.

Phan, P., Siegel, D. and Wright, M., (2005), Science parks and incubators: observations, synthesis and future research, *Journal of business venturing*, 20(2): 165-182.

Phillimore, J., (1999), Beyond the linear innovation in science park evaluation: An analysis of Western Australia Technology Park, *Technovation*, 19: 673-680.

Phillips, S. A. M. and Yeung, H. W. C., (2003), A place for R&D? The Singapore Science Park, *Urban Studies*, 40(4): 707-732.

Pirnay, F., Surlemenot, B. and Nlemvo, F., (2003), Towards a typology of university spin-offs, *Small business economics*, 21: 355-369.

Plaza, E., (2007), CEEI: un futuro innovador [online], *La hora de Asturias - Diario digital,* Retrieved on 17/12/2007 from http://www.lahoradeasturias.com/index.php?id_not=0000006926&id_ed=00000069.

Preer, R., (1992), *The emergence of technopolis: knowledge intensive technologies and regional development,* Praeger publishers, New York.

PREST, (2002), *A Comparative Analysis of Public,Semi-Public and Recently Privatised Research Centres, Final Project Report - Part III: Case Study Reports* [online], Retrieved on 10/05/2006 from ftp://ftp.cordis.lu/pub/rtd2002/docs/ind_report_prest2.pdf.

PSP, (2007), *Patras Science Park website* [online], Patras Science Park, Retrieved on 20/11/2007 from www.psp.org.gr.

PSTSA, (2004), *Science and Technological Park of Salerno and the Internal Area of Campania* [online], Retrieved on accessed on 1/10/2004 from.

PSTSicilia, (2004), *Science and Technology park of Sicily* [online], Retrieved on 1/10/2004 from www.pstsicilia.it.

PT Asturias, (2007), *PT Asturias* [online], Retrieved on 31/08/2007 from http://www.ptasturias.es/index.php.

PTA, (2004), *Parque Tecnologico de Andalucia* [online], Retrieved on 1/12/2004 from www.pta.es.

PTG,(2004), *PTG presentation document*, Parque Tecnologico de Galicia management company, [Document received be email 14/06/2004]

Pyka, A., Gilbert, N. and Ahrweiler, P., (2003), Simulating innovation networks, in *Innovation networks - theory and practice.* Pyka, A. and Kuppers, G.(eds), Edward Elgar, Cheltenham,

RITTS,(2000), *RITTS Crete - Final report to the monitoring committee*, Herakleion.

Rivas, C. M., (2002), *Un nuevo plan de ordenacion general ante las actividades productivas: una valoracion (A new plan for the general planning of the productive activities: en evaluation)*[online], Sevilla Global, Retrieved on 10/07/2006 from http://www.sevillaglobal.es/documentos/papers/Doc012002_Informe_Valoracion_PGOU.pdf.

Rodríguez-Pose, A., (1999), Innovation prone and innovation averse societies: Economic performance in Europe, *Growth and Change*, 30: 75-105.

Rodríguez, F. and Menendez, R., (2005), *Geografía de Asturias,* Ariel S.A., Barcelona.

Rodríguez, F. R.,(2005), *I+D y Territorio. Análisis y Diagnóstico de la Innovación empresarial en Andalucía (R&D and space. Analysis and diagnosis of firms' innovation in Andalusia)*, Consejo Economico y Social de Andalucía, Seville.

Romer, P., (1986), Increasing Returns and Long-Run Growth, *Journal of Political Economy*, 94(5): 1002-1037.

Romera, F., (1995), Redes de PMEs y experiencias en los parques cientificos y tecnologicos - El caso del Parque Tecnologico de Andalucia en Malaga, *Economia Industrial*, 301: 75-83.

RTP, (1996), *Regional Technology Plan of Central Macedonia - Final report* [online], URENIO, Retrieved on 05/08/2005 from http://www.urenio.org/rtp9.htm.

Rubini, D., (2002), *A critical analysis of Science and Technology parks: Learning from the Italian experience,* MSc thesis, Technical university of Lisbon, Instituto Superior Tecnico, Lisbon.

Rubio, P., (2006), Autotex confirma a la plantilla que cerrará la planta de Llanera [online], *La Voz de Asturias*, Retrieved on 12/12/2006 from http://www.lavozdeasturias.com/noticias/noticia.asp?pkid=294137.

Rubiralta, M. and Vendrell, M., (2004), *Benchmarking of Science Parks. A new model of Science park: Bercelona Science Park* [online], Retrieved on 10/10/2006 from http://www.pcb.ub.es/homePCB/docs/ppt/biospain.pdf.

Sanz, L.,(2002), *The role of Science and Technology Parks in economic development,* International Association of Science Parks, Malaga.

Sefertzi, E., (1998), *Καινοτομία [Innovation],* Gutenberg, Athens.

Sefertzi, E. and Skiadas, X., (1996), Technology supply in Central Macedonia, In *Regional Technology Program of Central Macedonia,* Polytecnhic of Crete- Hania, Hania, Greece.

Shearmur, R. and Doloreux, D., (2000), Science parks: actors or reactors? Canadian science parks in their urban context, *Environment and planning A*, 32: 1065-1082.

Shin, D., H., (1999), An alternative approach to developing science parks: a case study from Korea, *Papers in Regional Science*, 80: 103-111.

Shin, D., H., (2000), Networks of venture firms around a science park: the case of Taejon in Korea, *Proceedings of 2nd International critical geography conference*, 9-13 August 2000,Taegu University, Taegu, Korea,.

Siegel, D., Westhead, P. and Wright, M., (2001), Science parks and the performance of new technology based firms: a review of recent UK evidence and an agenda for future research, *Small business economics*, 20: 177-184.

Siegel, D., Westhead, P. and Wright, M., (2003), Assessing the impact of university science parks on research productivity: exploratory firm-level evidence from the United Kingdom, *International Journal of Industrial Organization*, 21(9): 1357-1369.

Simmie, J. M., (2004), Innovation and Clustering in the Globalised International Economy, *Urban Studies Journal*, 41(4-5): 1095-1112

Smedlund, A., (2005), The roles of intermediaries in a regional knowledge system, *Journal of intellectual capital*, 7(2): 204-220.

Smith, H. L., (2007), Universities, innovation and territorial development: a review of the evidence, *Environment and Planning C : Government and policy*, 25: 98-114.

Sofouli, E. and Vonortas, N., (2007), Science and technology Parks and Business Incubators in middle-sized countries: The case of Greece, *Journal of technology transfer*, 32: 525-544.

Solow, R., (1957), Technical Change and the Aggregate Production Function, *Review of Economics and Statistics*, 39: 312-320.

Souitaris, V. and Daskalopoulos, T., (2000), Managing science and technology parks in low-tech environments - A resource based strategic mapping framework, *International journal of manufacturing technology and management*, 2(1/2/3/4/5/6/7).

STEP-C, (2004a), *INsular Regions Knowledge TRACKer (IN.TRACK) Program regional evaluation report* [online], Retrieved on 01/01/2007 from http://www.intrack.org/index.php?option=com_docman&Itemid=158&task=view_category&catid=21&order=dmdate_published&ascdesc=DESC.

STEP-C,(2004b), *Science and Technology Park of Crete evaluation report*, [Document received by email on 27/05/2004]

STEP-C,(2004c), *Science and Technology Park of Crete* [online], Retrieved on 1/11/2004 from www.stepc.gr.

Sternberg, R., (1996), Reasons for the genesis of high-tech regions--Theoretical explanation and empirical evidence, *Geoforum*, 27(2): 205-223.

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

Storper, M., (1998), Industrial policy for latecomers: products, conventions and learning, in Storper, M., Thomadakis, S. and Tsipouri, L.(eds), *Latecomers in the global economy*, Routledge, London

Strambach, S., (2001), Innovation processes and the role of knowledge intensive business services, in Koschatzky, K., Kulicke, A. and Zenker, A.(eds), *Innovation networks: concepts and challenges in the European perspective*, Physica-Verlag: Heidelberg

Technapoli, (2004), *Science and Technological Park of the metropolitan area of Napoli website* [online], Science and Technological Park of the metropolitan area of Napoli, Retrieved on 1/10/2004 from www.technapoli.it.

Technopolis,(2006), *Strategic Evaluation on Innovation and the Knowledge Based Economy in relation to the Structural and Cohesion Funds for the programming period 2007-2013. Country Report: GREECE*, European Commission - Directorate-General Regional Policy, Contract n° 2005 CE.16.0.AT.015.

Tecnopolis, (2004), *Tecnopolis website* [online], Tecnopolis CSATA Novus Ortus, Retrieved on 1/12/2004 from www.tno.it.

Tecnopolis,(2005), *Tecnopolis evaluation report*, [document received by email on 12/01/2005 from Tecnopolis general director, Mr Luciano Schiavoni]

TESPA, (2005), *Technological & Scientific Park of Attica "Lefkippos" website* [online], Retrieved on 01/01/2005 from http://www.demokritos.gr/texnologikoparko/englishVersion/FramesetEN.htm.

TESPA, (2008), *Technological & Scientific Park of Attica "Lefkippos"* [online], Retrieved on 01/05/2008 from http://www.demokritos.gr/texnologikoparko/englishVersion/FramesetEN.htm.

Tödtling, F., (1995), The Uneven Landscapes of Innovation Poles: Local Embeddedness and Global Networks, in Amin, A. and Thrift, N.(eds), *Globalization, Institutions, and Regional Development in Europe,* Oxford University Press, Oxford, pp.68-90

Tsipouri, L., (1991), The transfer of technology issue revisited: some evidence from Greece, *Entrepreneurship and regional development*, 3: 145-157.

Tsipouri, L., (1998a), Promoting coordination at regional level: the case of Northern Greece, in Storper, M., Thomadakis, S. and Tsipouri, L.(eds), *Latecomers in the global economy,* Routledge: London, 275-298

Tsipouri, L.,(1998b), *Report on innovation and territories: Upgrading Knowledge and Diffusing Technology in a Regional Context*, OECD DT/TDPC(99)8, DT/TDPC(99)8.

Tsipouri, L. and Gaudenzi, S., (1998), Principles of an operational industrial policy for latecomers : Failures of analogy, strategies and degrees of freedom, in Storper, M., Thomadakis, S. and Tsipouri, L.(eds), *Latecomers in the global economy,* Routledge: London, 76-103

TTP,(2004a), *Thessaloniki Technology Park Management and Development Company evaluation report*, [Report received by email on 12/02/2004]

TTP, (2004b), *Thessaloniki Technology Park* [online], Retrieved on 1/11/2004 from www.techpath.gr.

TTP/MDC,(2004), *Thessaloniki Technology Park - Management and Development corporation presentation*, Thessaloniki Technology Park - Management and Development.

TTP/MDC, (2005), *Thessaloniki Technology Park Management and Development Company* [online], Retrieved on 15/07/2005 from www.techpath.gr (old website).

Tübke, A., (2004), *Corporate spin-offs in the knowledge economy : Factors, impacts and policies* [online], Retrieved on 01/08/2007 from http://in3.dem.ist.utl.pt/downloads/cur2000/papers/S04P01.PDF.

UKSPA,(1996), *The United Kingdom Science Parks Association Annual report*, Birmingham.

UKSPA, Burr, D. and Cooke, S., (1990), Science parks in urban and regional development, *Proceedings of the UK Science Park Association's Annual Conference*:

The Impact of Science Parks and Their Tenant Companies on Urban and Regional Development, Birmingham.

UNCTAD, (2007), *World Investment Report 2007* [online], United Nations Retrieved on 17/12/2007 from www.unctad.org/fdistatistics.

UNIOVI, (2004), *Análisis de la Producción Científica en la Universidad de Oviedo 2000-2002 (IV Edición)(Analysis of the scientific production of the University of Oviedo 2000-2002)* [online], Universidad de Oviedo:Vicerectorado de investigación, Retrieved on 08/06/2006 from http://www.uniovi.es/vicinves/info/AnalisisProduccionCientifica2000-2002.pdf.

UNO, (2006), Dropsens se convierte en la tercera spin-off que ve la luz en Asturias (Dropses is the fourth spin-off that sees the light in Asturias) [online], *Revista digital de la Universidad de Oviedo*, Universidad de Oviedo, Retrieved on 05/07/2007 from http://www.uno.uniovi.es/portada57/Document%20Library/breves.htm.

URENIO, (1999), *Regional technology plan of Central Macedonia* [online], Retrieved on 10/10/2005 from http://www.urenio.org/rtp/rtp.htm.

URENIO, (2003), *Excellence in Central Macedonia* [online], Retrieved on 10/10/2005 from http://www.urenio.org/excellence/.

URENIO,(2006), *Summary Report on the regional S&T intermediary system- Northern Greece - The current state of intermediation services* - Report for SUPER-SME program financed from the European Union, Thessaloniki.

US, (2005), *Anuario Estadistico de Universidad de Sevilla (Annual statistical [report] of the University of Sevilla)* [online], University of Seville, Retrieved on 25/07/2006 from http://portal.us.es/informacion/uscifras.

Van Dierdonck, R., Debackere, K. and Rappa, M., (1991), An assessment of science parks: Towards a better understanding of their role in the diffusion of technological knowledge, *R&D Management*, 21(2): 109-123.

Vasalos, I. and Bakouros, L.,(1993), *Thessaloniki Technology Park - Final Report for SPRINT programme submitted to DG XIII,* Chemical Processes Research Institute Thessaloniki.

Vazquez-Barquero, A. and Carrillo, E., (2004), Cartuja 93 : A Technological Park located at the site of Sevilla's World's Fair, *ERSA conference papers*, 04(486).

Vedovello, C., (1997), Science parks and university-industry interaction: Geographical proximity between the agents as a driving force, *Technovation*, 17(9): 491-502.

Vedovello, C., (2000), Science parks and university-industry links: a comparative analysis between a British and a Portuguese experience, *International journal of services technology and management*, 1(4): 357-373.

ViaMichelin, (2007), *Via Michelin Maps*, [online]. Retreived on 05/05/2007 from http://www.viamichelin.com/viamichelin/int/dyn/controller/Cartes

Von Hippel, E. and Tyre, M. J., (1995), How learning by doing is done: problem identification in novel process equipment, *Research Policy*, 24(1): 1-12.

Wallsten, S., (2004), The role of government in regional technology development: the effects of public venture capital and science parks, in Bresnahan, T. and Gambardella, A.(eds), *Building high-tech clusters - Silicon Valley and beyond,* Cambridge university press, Cambridge.

Weiss, C., (1998), *Evaluation,* 2nd edition, Prentice Hall, Upper Saddle River

Westhead, P., (1997), R&D `inputs' and `outputs' of technology-based firms located on and off science parks, *R&D Management*, 27: 45-61.

Westhead, P. and Backstone, S., (1999), Perceived benefits of a managed science park location, *Entrepreneurship and regional development*, 11: 129-154.

Westhead, P. and Batstone, S., (1998), Independent Technology-based Firms: The Perceived Benefits of a Science Park Location, *Urban Studies*, 35(12): 2197-2219.

Westhead, P., Storey, D. J., Great Britain. Department of Trade and Industry., United Kingdom Science Park Association., KPMG Peat Marwick. and National Westminster Bank., (1994), *An assessment of firms located on and off science parks in the United Kingdom,* HMSO: London.

Wolfe, D. A. and Gertler, M. S., (2004), Clusters from the Inside and Out: Local Dynamics and Global Linkages, *Urban Studies v41*, n5-6: 1071-1093.

Yin, R. K., (1994), *'Case Study Research - Design and Methods,* Sage Publications, 2nd Newbury Park.

Ylinenpaa, H., (2001), Science parks, cluster and regional development, *Proceedings of 31st European Small Business Seminar,* Dublin.

Zoumpoulaki, M., Komninos, N. and Tarani, P., (1996), *Inter-firm cooperation and technology transfer in Central Macedonia* [online], Regional Technology Program of Central Macedonia, URENIO, Retrieved on 05/03/2005 from http://www.urenio.org/rtp.htm.