



The role of science parks and business incubators in converging countries: Evidence from Portugal

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ABSTRACT

Researchers and economic development professionals have linked the technology transfer and high-tech firm output from science parks (SP) and business incubators (BI) to economic growth, as well as job and wealth creation in developed and developing countries. Yet little has been said about their role in converging economies, such as Portugal. The authors analyse the population of the Portuguese SPs and BIs in promoting economic growth using the case study method. Further, the authors search for the success factors of Portuguese SPs and BIs. This initial study suggests a modest contribution of SPs and BIs to economic growth in Portugal. Moreover, our findings confirm university links and suitability of management to be critical to an SP or BI success in this converging economy. We also discuss how SPs and BIs might make better contributions to economic growth in converging economies.

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1. Introduction

Science parks (SP) and business incubators (BI) have been established throughout the world as spurs to economic development. Traditionally linked to job and wealth creation (Amirahmadi and Saff, 1993; Phan et al., 2005), SPs and BIs are believed to provide an effective vehicle for university and industry to interact (Link and Scott, 2003b; Marques et al., 2006; Vedovello, 1997). The success of SPs such as Silicon Valley in California, Route 128 in Massachusetts (Castells and Hall, 1994; Saxenian, 1994), the Research Park Triangle in North Carolina (Link and Scott, 2003a) and Cambridge in the UK (Koh et al., 2005) has influenced other countries to replicate the SP model, such as Kuwait (Al-Sultan, 1998), Brazil (Cabral and Dahab, 1998), Russia (Kihlgren, 2003), Taiwan (Lai and Shyu, 2005), India (Vaidyanathan, 2008), Israel (Rothschild and Darr, 2005) and China (Watkins-Mathys and Foster, 2006). The same happened with business incubators (Barrow, 2001). According to the NBIA, there were approximately 1400 BIs in North America in late 2006, almost double than in 1998, generating about 100,000 jobs and annual revenue of USD17 million (NBIA, 2007). A recent EU study estimates 900 BIs across Europe, generating around 27,000 new jobs every year (EC, 2002).

Although practitioners claim the success of SPs (e.g. UKSPA, 2003) and BIs (e.g. NBIA, 2007), others criticise their actual role as

promoters of regional growth (Amirahmadi and Saff, 1993; Castells and Hall, 1994; Massey et al., 1992; Quintas et al., 1992). However, no systematic framework to understand SPs and BIs has been used and hence the current lack of clarity in identifying the nature of their performance (Amirahmadi and Saff, 1993; Hackett and Dilts, 2004; Phan et al., 2005). Several models exist in the extant literature based on features such as ownership (Carayannis and von Zedtwitz, 2005; Grimaldi and Grandi, 2005), management characteristics (Aerts et al., 2007; Clarysse et al., 2005), strategic objectives (Hackett and Dilts, 2004; Koh et al., 2005; von Zedtwitz and Grimaldi, 2006) and available business support services (Grimaldi and Grandi, 2005; Hansson et al., 2005). Yet research is still mostly atheoretical (Hackett and Dilts, 2004). Recently, some efforts have been made to ascertain the usefulness of evaluating SPs and BIs against their goals, mission and overall characteristics (Bergek and Norrman, 2008; Bigliardi et al., 2006).

SPs and BIs and their impact on economic growth and regional development has been widely researched in developed economies (EC, 2002; OECD, 1997, 1999) and developing countries (Al-Sultan, 1998; Cabral and Dahab, 1998; Kihlgren, 2003; Vaidyanathan, 2008; Watkins-Mathys and Foster, 2006). Yet little has been done in middle-sized converging countries such as Portugal. Arguably, these countries also possess less and younger SPs and BIs, making it more difficult to assess their contribution to the overall economy. To our knowledge, the only previous effort to document BIs in Portugal was made by Marques (Marques, 2005; Marques et al., 2006) focusing exclusively on BIs with clear linkages to universities; Durão et al. (2005) also studied the case of Tagus Park to illustrate virtual and real estate SPs. Recent work analysed

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the role of SPs and BIs in another converging European economy: Greece (Bakouros et al., 2002; Sofouli and Vonortas, 2007).

Our research covers the population of both SPs and BIs in Portugal, an example of a converging economy. We modified previous definitions of a converging economy as a country between developed and developing and converging exclusively in terms of economic performance (Harvey and Carvalho, 2002; Tsionas, 2001). Instead, we considered converging economies as countries having the infrastructure of developed countries yet lagging behind in innovation performance. Typically, these countries are also surrounded by more developed economies. The main proposition is to investigate the efficacy of SPs and BIs as tools of economic growth in a converging economy. SPs and BIs only have a potential role in creating job and wealth if they are successful. Hence, we also research what are the main underlying determinants for the success of SPs and BIs. We start by searching the extant literature for a definition of SPs and BIs. We analyse previous work to find what the main characteristics of SPs and BIs are and what can contribute more for their success. In the following sections, we justify our choice of Portugal as an example of a converging economy and the use of multiple case study methodology in our research. After presenting an outlook of SPs and BIs in Portugal, we discuss the underlying determinants found to explain performance differentials across SPs and BIs. These are: (i) *university links*, comprising aspects such as the need for scientific production, the efficiency of links and the institutional engagement between the SP or BI and knowledge production institutions; and (ii) *suitability of management*, which encompasses the aspects related to vision, strategy, value-added services availability to tenants and innovative ideas that go beyond the tenants' verbalised needs and expectations. Finally, we discuss their role in contributing to economic growth. Results suggest this contribution to be modest, mainly as a result of a generalised poor performance according to the underlying determinants for success.

2. Literature review

We build on the work of others who have researched on several issues concerning SPs and BIs to investigate their added value to converging economies. Our literature review starts with the definitions presented below. Next, we discuss the most common characteristics of SPs and BIs that will allow us to better investigate the underlying determinants for success of SPs and BIs.

2.1. Definitions

There are many definitions used by both researchers and practitioners to define SPs and BIs (Aernoudt, 2004; Amirahmadi and Saff, 1993; Barrow, 2001; Bergek and Norrman, 2008; EC, 2002; Hackett and Dilts, 2004; Hansson et al., 2005; IASP, 2002; NBIA, 2007; Quintas et al., 1992; Rice, 2002; Smilor and Gill, 1986; UKBI, 2007; UKSPA, 2006; Vedovello, 1997). Most of these have common themes such as regional development, technology focus, job and wealth creation and alike. Researchers have found more commonalities between both SPs and BIs definitions positing they are mostly property-based organisations sharing the mission of business development using knowledge agglomeration and resource sharing (Phan et al., 2005). Practitioners also further similar concepts emphasising in their definitions the business development processes rather than in providing space (IASP, 2002; NBIA, 2007; UKBI, 2007; UKSPA, 2006). SPs have been more focused on regional development (Amirahmadi and Saff, 1993) by supporting regional technological strengths or promoting the development of new ones (Castells and Hall, 1994; Link and Scott,

2003a). Supporting young technology-based firms to establish and flourish (Amirahmadi and Saff, 1993) as well as attracting anchor firms to a given location (Felsenstein, 1994) is also often among their objectives.

BIs, on the other hand, have been closely linked to the concept of entrepreneurship (Aernoudt, 2004). The concept of BI has been evolving since the 1970s, when initially emerged among other small enterprise support initiatives as a low-cost space and management training provider to entrepreneurs (Barrow, 2001). Today's BIs have become collaborative service providers, offering consultancy, networking and access to venture capital (EC, 2002; Lalkaka and Bishop, 1996). For a full discussion about definitions of business incubators, business incubation, science parks and business support centres see SPICA directory online (SPICA, 2008a). Similarly to the definitions of SPs, definitions proposed for BIs do not focus conspicuously on physical space, but rather emphasise the effective combination of services (NBIA, 2007; OECD, 1997; UKBI, 2007). Such services may include physical premises for incubated firms as the key defining feature. Yet incubation is much more than providing a key-in-hand office and shared building services (Aernoudt, 2004). Typical services include coaching (Bergek and Norrman, 2008; Peters et al., 2004), access to professional services through a network of contacts (Bøllingtoft and Uthøi, 2005; Chan and Lau, 2005; Hackett and Dilts, 2004; McAdam and McAdam, 2008; Nowak and Grantham, 2000), training (Aerts et al., 2007; Mian, 1997), seed and venture capital (Lee and Osteryoung, 2004; McAdam and McAdam, 2008; Sofouli and Vonortas, 2007) and virtual support (Barrow, 2001; Carayannis and von Zedtwitz, 2005; Durão et al., 2005; Nowak and Grantham, 2000).

We researched SPs and BIs together for four reasons. Firstly, their definitions have several common points. Secondly, empirical research in this field does not clearly distinguish SPs and BIs and often bundles them together as business support initiatives (Chan and Lau, 2005; Colombo and Delmastro, 2002; Sofouli and Vonortas, 2007). Also, literature suggests their resemblance in terms of goals and basic characteristics (Phan et al., 2005). Lastly, it is often seen that SPs house and manage BIs. To some extent, BIs can work as tenant-feeders to SPs, supporting nurturing ventures during a significant time in their lifecycle.

2.2. Characteristics of SPs and BIs

Two main characteristics arise from literature as the most important for the success of SPs and BIs: university links and suitability of management.

2.2.1. University links

Definitions of both SPs and BIs mention knowledge transfer arising from universities and R&D institutions as well as the creation of new firms commercialising new technologies to be among their goals (EC, 2002; IASP, 2002; Lalkaka and Bishop, 1996; NBIA, 2007; OECD, 1997; UKBI, 2007; UKSPA, 2006). Furthermore, Hackett and Dilts (2004) in their comprehensive review of BI studies also list university ties as a key characteristic for success of BIs; Phan et al. (2005) posit that universities have been creating SPs and BIs as a mean to foster the creation of start-ups. It is therefore reasonable to assume that both SPs and BIs should have some kind of link to these institutions and such linkages should impact the success of SPs and BIs.

2.2.2. Suitability of management

Management practices also emerge from literature as having a critical role in the success of SPs and BIs. Grimaldi and Grandi (2005) distinguish between the kinds of services provided by BIs

and relate them to the company types and outcomes desired. von Zedtwitz and Grimaldi (2006) describe two models for BIs in terms of strategic objectives and competitive core, and suggest a typology for incubators, mostly based on their promoters. Clarysse et al. (2005) differentiate BIs in terms of their practices managing the spin-off process. Aerts et al. (2007) focus on assessing the critical role of one specific management practice: screening and selecting tenants for BIs. However, literature does not describe which management practices specific to SPs and BIs are more effective in terms of increasing their performance.

These characteristics emerge as the general determinants for the success of SPs and BIs. We will investigate, however, what constitutes in fact university links and suitability of management. In other words, what are the underlying determinants for the success of SPs and BIs.

3. Our choice of Portugal as a converging economy

Portugal is a middle-sized country located in the south-western tip of Europe. It covers about 92,000 km² and its current population is 10.6 million inhabitants (Eurostat, 2008). The country has a diversified and progressively more service-based economy since entering the European Union (EU) in 1986 and it qualified for the European monetary Union in 1998, adopting the new currency (Eurostat) in 2002 (CIA, 2008). After a period of high economic growth in the beginning of the 1990s, Portugal has been slowly converging to EU's average. Its current gross domestic product (GDP) per capita is about 74% of EU-27 average (Eurostat, 2008). In terms of innovation performance, Portugal is labelled as a catching-up country (EIS, 2008); its innovation performance has been increasing relative to the average EU trend over the past 5 years (EIS, 2008). Despite the governmental goal of achieving 1% of R&D expenditure, the figure in 2007 was about 0.81%, one of the lowest in the EU (Eurostat, 2008). The comparative analysis of the European Innovation Scoreboard highlights this weakness as well as the low performance in terms of patenting (EIS, 2008).

As a country, Portugal is similar to other converging economies within the EU, such as Greece and Spain. Both these countries were accepted in the EU in the 1980s and after experiencing a period of rapid growth till the mid 1990s, have been slowly converging to EU's average. Yet their convergence was faster than the Portuguese. Both countries are already closer to EU's average in terms of GDP per capita: Greece, 95.3%, and Spain 103.9% (Eurostat, 2008). Moreover, some of EU's new members can also be labelled as converging economies. Czech Republic, Malta, Poland and Slovenia exhibit the same pattern of economic convergence (Eurostat, 2008). In terms of innovation performance, all the countries perform below EU-27 levels (EIS, 2008) and have similar figures for R&D expenditure (Eurostat, 2008).

SPs and BIs have been traditionally linked to economic growth and job creation (Amirahmadi and Saff, 1993; Castells and Hall, 1994; Phan et al., 2005). Despite the lack of governmental framework for the development of SPs and BIs, the abundance of such infrastructures in the country leads us to think that they are definitely part of the economic development strategy (Table 1). In fact, Portugal has more SPs and BIs than some developed economies of the EU such as France, Italy or the UK (both in absolute terms as well as relative to population).

4. Methodology

We have chosen to use the more qualitative case method approach due to our sample size and newness of our topic. We use the case study method as suggested by Yin (2003), Eisenhardt

(1989) and others as the appropriate analytical approach given our sample parameters. Case studies were written using a written survey combined with a semi-open phone interview (Dillman et al., 2008).

4.1. Research question

Our main proposition is to investigate the efficacy of SPs and BIs as tools for economic growth. In order to contribute to job and wealth creation, SPs and BIs need to be planned and operated to be successful. Therefore, our research question is: *What are the determinants for success of Science Parks and Business Incubators?* Our model focuses on the underlying determinants for success (Fig. 1) within the two main categories of determinants derived from literature. In other words, we will investigate which underlying determinants explain differences in performance of SPs and BIs.

One of the problems in defining performance of SPs and BIs is the fact that their mission and goals do not remain unchanged across institutions. Some authors claim that performance should be evaluated against each SP's or BI's mission, promoters and regional context (Bergek and Norrman, 2008; Bigliardi et al., 2006). We do not necessarily agree with this premise since SPs and BIs typically share their missions. This implies that the observable measures of success should be rather similar. To improve our analysis, we listed the characteristics of SPs and BIs and the variables in which they are expected to have impact on (Table 2). Such correspondence will be used in our analysis to proxy success.

Success is defined as performance in each expected impact. For instance, a positive growth in terms of jobs, turnover of tenants or a high number of graduate companies can be translated as success. Furthermore, services available are also considered to have a positive influence in the SP/BI performance. However, this depends on the characteristics of the SP or BI. For instance, the sectors of activity of tenants of a given SP or BI are not good or bad per se; yet the type of services available and the existence of laboratories will yield a better performance to SPs and BIs that house R&D-based companies. The same happens with the analysis of the origin of companies; university-based SPs and BIs are expected to have a higher share of spin-off companies.

4.2. Case studies

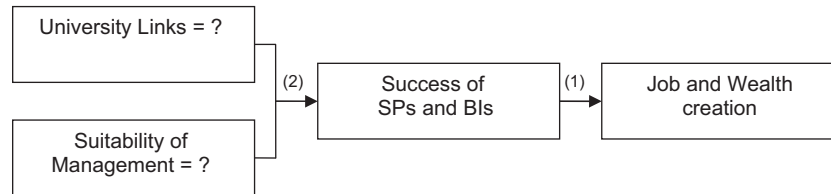
The methodology chosen was to build multiple case studies (Yin, 2003). Data were collected using written questionnaires, open phone interviews to management of each SP and BI. Given the limited time for research, we focused on surveying only the general or operational manager of each SP or BI. Other secondary data, such as newspapers, practitioners' newsletters and other unsorted sources of public information were also used. Despite our focus on characteristics of SPs and BIs, we triangulated data interviewing a sample of tenants of each SP and BI, in order to achieve higher accuracy of the information surveyed (Yin, 2003). The same methods were used to survey management of both SPs and BIs, and their tenants.

The questionnaires enquire on the SP or BI characteristics, such as year of foundation, founders, shareholders, employers, profile of tenant companies. Also, we investigate particularly about some of the indicators conventionally claimed to ascertain performance, such as number of graduate companies, employment creation, turnover (Amirahmadi and Saff, 1993; Colombo and Delmastro, 2002; Hackett and Dilts, 2004; Mian, 1997; Phan et al., 2005). Additionally, we surveyed some of the operational features of the SPs and BIs, such as strategy, selection criteria, self-assessment

Table 1

Ratios of SPs and BIs in selected European countries.

Country	SPs	BIs	Pop (million) (Eurostat, 2008)	Ratio (SP/million hab)	Ratio (BI/million hab)
Finland (SPICA, 2008b)	30	58	5.3	5.66	10.94
France (Chordá, 1996; SPICA, 2008b)	4	66	63.4	0.06	1.04
Greece (Sofouli and Vonortas, 2007; SPICA, 2008b)	7	3	11.2	0.63	0.27
Italy (SPICA, 2008b)	24	42	59.1	0.41	0.71
Portugal (2006)	12	13	10.6	1.13	1.23
Spain (APTE, 2008; SPICA, 2008b)	20	24	44.5	0.45	0.54
Sweden (SPICA, 2008b)	30	31	9.1	3.30	3.41
UK (UKSPA, 2003)	55	220	60.8	0.90	3.62

**Fig. 1.** Schematic representation of the research model. (1) Proposition: effective SPs and BIs contribute to job and wealth creation, (2) Research Question: What are the underlying determinants for the success of SPs and BIs?**Table 2**

Characteristics of SPs and BIs associated with their expected impacts.

Characteristics	Expected impact on
Number of companies	Growth (jobs, turnover of tenants)
Space available	Graduates
Promoters	Origin of companies
Founders	
Universities and R&D institutions present	
Strategy	
Selection criteria	
Services	
Existence of laboratories	Sector of activity

criteria (see Appendix I for details). The open phone interviews were conducted always after analysing the written questionnaire. Although there was no script, the interviews were semi-structured as they were based on the unclear and unanswered questionnaires' questions. This allowed us also to confirm some data already collected by alternative wording of the same questions (Fowler, 1995).

These case studies can be categorised as exploratory (Yin, 2003) since our research question aimed to derive the underlying determinants for the success of SPs and BIs. However, we also drew a framework to qualitatively define success of SPs and BIs looking at a number of questions in our questionnaire (Appendix I) duly complemented with the information gathered during phone interviews. The individual case studies are the main part of Ratinho's exploratory study (Ratinho, 2007).

5. Data and results

We set out to study the whole population of Portuguese SPs and BIs, given their reduced absolute number. This phenomenon is quite recent in Portugal and therefore we group each SP and BI by development stage.

5.1. Data gathering

Portugal has currently 12 SPs and 13 BIs. Although some could not be surveyed, we still find useful to mention them in order to describe the entirety of the current SPs and BIs population in this paper:

- Members of Tecparques (Portuguese Association of Science and Technology Parks) that are not yet operating: (i) Parque de Ciência e Tecnologia do Porto in the Porto Region constituted as a legal person but with no premises at the time of research; (ii) Tecnopólo de Coimbra, scheduled to start operating in late 2006; and (iii) Algarve STP, at a later stage of implementation, has already started supporting some incubation activities with premises to be located on the campus of the University of Algarve (Tecparques, 2006);
- Business Incubators without significant activity at the time of research or in the process of closure: (i) AIBAP – Incubadora do Beira Atlântico Parque whose successive postponing of inauguration promoted the separation of the association, creating ABAP, now responsible for the management of Biocant Park; (ii) CEISET – Centro de Empresas e de Inovação de Setúbal and NIT – Negócios, Inovação e Tecnologia, both closing.

Furthermore, data were not disclosed by all institutions. We were unable to survey or interview Oficina da Inovação (BI) and Madan Parque (SP with BI) and therefore any reference to these institutions henceforth relies on information in the public domain. We also note that two SPs have BIs inside (Madeira Tecnopólo and Tagus Park) and, although they exist legally as independent institutions, we analysed them jointly (SP with BI facilities). They share both physical space and management teams. All questionnaires and phone interviews were conducted between January and May 2006 and the remainder data collected between December 2005 and August 2006.

5.2. General outlook of Science Parks and Business Incubators in Portugal

The SP and BI phenomenon is quite recent in Portugal, dating from the beginning of the 1990s. However, since the late 1990s, a new wave of SPs and BIs has been observed. The population of Portuguese SPs and BIs has many common features: (i) promoted collaboratively by local or regional authorities, universities and private organisations (companies, industrial associations, etc.); (ii) proximity to cities and located in urban areas; (iii) funded predominantly by public funds (either from the EU, national government or local authorities) and enjoying extra funding via national incentives programs or EFRD for operational costs; (iv) apart from two, all SPs and BIs are generalist housing and incubating companies in any sector of activity (Tables 3–5).

In fact, such features (apart from funding) are in accordance with NBIA's latest yearly assessment of North American BIs (NBIA, 2007). The lack of specific governmental policy in this area led to a failure in establishing a model for setting up SPs or BIs and therefore they exhibit differences in their evolution. Categories related to different stages of development can be observed:

- **Developed (8)**, although some were going through major changes at the time of research: Tagus Park, Lispolis, Madeira Tecnopólo, PTM/A, Tecmaia, NET and IPN Incubator. Tecmaia and NET are currently expanding. Tagus Park is inaugurating the expanded area in the main building and has planned the urbanisation of 90 ha. IPN Incubator was in the process of formal separation from IPN, a research institution linked to the University of Coimbra. We consider them developed given that they have operated in a stable way for some years.
- **Just Starting (3)** are Biocant Park, Tagus Valley and OPEN. Although Tagus Valley had its official inauguration some years ago, only in 2006 does it seem to be flourishing and finally carrying on with the planned setting up of the park. The same is happening with OPEN; originally planned in 1997, and launched in 2005, it still did not have any tenant company at the time of research. Biocant Park had also been recently inaugurated although it already had a research centre established in its premises. In the cases of Tagus Valley and OPEN some future effects will be speculated.
- **Developing (4)** represents the remainder, i.e., CiDEB, ParkUrbis, Sogist and IEUA. Inaugurated recently at the time of research (apart from Sogist), all of these infrastructures were still developing and trying to position themselves according to their environment: ParkUrbis was considering a thematic focus in health sciences. CiDEB was going through a split to establish two thematic incubators instead of the current one. IEUA was also still trying to define itself, introducing major changes as well as revisiting some ideas from the early years of operation. Sogist was never actually developed (its premises were never occupied significantly) and stated that 2006 was its decisive year to decide whether to continue.

Keeping in mind these differences and based on the analysis of all the detailed case studies (Ratinho, 2007), we will present the major lessons that can be distilled from the Portuguese case study.

6. Lessons learned: the underlying determinants for the success of SPs and BIs

The general outlook yields mostly similarities in both groups. Yet the observed differences among them are enough to explain

performance differentials and derive the underlying determinants for their success.

6.1. University links

Most Portuguese SPs and BIs have some kind of linkage to universities or other centres of knowledge production (Tables 3 and 4). For SPs, it is typical that both types of institutions share the same location while BIs are normally owned by associations that bring together, among others, universities and both private and public R&D institutions. Yet differences within the university linkages can explain differences in performance. We explored university links using three underlying determinants: need for universities, commitment and nature of the university.

6.1.1. The need for universities

Despite the formal linkage or sharing the same space, the effectiveness of the university links is more important (Colombo and Delmastro, 2002). In other words, geographical proximity is not a driving force for the strength of the links or university–industry cooperation (Vedovello, 1997). In our cases, this transpires from the origin of companies (Table 3). For instance, NET does not have any university or R&D institution in its premises but reported incubating several academic spin-offs (Ratinho, 2007). Conversely, Sogist is strongly linked to one of the biggest universities in Portugal (the University of Porto, which is also one of the shareholders and held, at the time of this research, the presidency of the board of administrators) and did not incubate any academic spin-offs. Far from these extremes in intensity of university links, Tagus Park has a research-oriented university campus in its premises and strong links to R&D institutions and still does not exhibit a significant number of university spin-offs. In fact, Tagus Park is outnumbered in relative terms by Tecmaia in housing spin-off companies (Table 5).

6.1.2. Institutional commitment

Continuing with the examples of Tagus Park and Tecmaia, both SPs house a significant number of mature high technology and relocated companies while not showing a significant number of academic spin-offs (Table 5). The absence of academic spin-offs might be a reflexion of the role of the university itself in promoting such activities as an integral part of a professorship or a research career. However, such career incentives were observed in CiDEB (Table 6) in terms of including mentorship to incubated companies in regular activities of the university's academic staff.

6.1.3. Science and technology do make a difference

The universities' or R&D centres' institutional links not only have to be effective, but also have to be active in scientific and technological fields. We are not advocating the primacy of science and technology over different areas of knowledge but it is clear that to promote a successful science and technology park, science and technology production comprising both fundamental and applied R&D activities are essential. Hence, it is not surprising that Madeira Tecnopólo/CEIM barely house any academic spin-off companies (only one at the time of research). Although University of Madeira has facilities located inside the SP, its most prominent research centre is in the field of economics (UMa, 2006). It therefore transpires that the nature of that university contributes to the reduced number of science and technology-based companies on park (Table 5). Conversely, IPN Incubator possesses the optimum conditions to house academic spin-offs and that is in fact observed. It is owned and managed by IPN, a university-based research centre in the fields of automation, informatics,

Table 3
Main characteristics of Science Parks in Portugal.

Science park	Location	Foundation	Companies	Universities in the SP	R&D institutions in the SP	Main sectors of activity	Services provided
Biocant Park	Cantanhede, Centre	2006	4	No	BIOCANT – Biotechnology Innovation Centre	Biotechnology 100%	Management support Administrative support Training Access to venture capital
Lispolis	Lisbon, Lisbon and Tagus Valley Region	1993	90	No	INETI – National Institute of Engineering, Technology and Innovation AFTEM – Associação para a Formação Tecnológica em Engenharia Mecânica e Materiais)	Services 41%, IT and related 31%, consultancy 19%	Administrative support
Madeira Tecnopólo	Funchal, Madeira	1997	26	University of Madeira	CITMA – Madeira's Science and Technology Centre AREAM – Regional energy and Environment Agency	Services 46%, IT and related 35%, consultancy 15%	Management support Administrative support Marketing Venture capital access Graphical design
ParkUrbis	Covilhã, Centre	2005	9	No	No	IT and related 66%, biotechnology 11%, services 11%, production 11%	Management support Administrative support Marketing Technology transfer in implementation
PTM/A	Almada, Lisbon and Tagus Valley Region	1994	22	No	No	Services 68%, consultancy 27%	Accountancy Management support Administrative support Venture capital access, via idea contest
Tagus Valley – Tecnopólo Vale do Tejo	Abrantes, Centre	2004	6	No	No	Production 43%, consultancy 29%, analysis and testing 14, training 14%	Administrative support
TagusPark	Oeiras, Lisbon and Tagus Valley Region	1995	164	Technical Superior Institute - Technical University of Lisbon	ISQ – Quality and Welding Institute (ranked 6th in business R&D expenditure in Portugal) INESC – Computer and System Engineering Institute IEFP – Training and Employment Institute	IT and related 48%, Universities, R&D centres and public institutions 21%, services 13%, other 10%	Accountancy Management support Administrative support Marketing Consultancy Training Venture capital access
Tecmaia	Maia, North	2001	41	No	IPVE – Portuguese Viticulture and Enology Institute CEIIA – Centre for Excellence and Innovation in the Automotive Industry	IT and related 29%, other 24% (automotive, optoelectronics, materials, fluid mechanics), services 17%, consultancy 17%, biotechnology 7%	Accountancy Management support Administrative support Marketing Venture capital access Information access

Table 4
Main characteristics of business incubators in Portugal.

Business incubator	Location	Foundation	Companies	Main sectors of activity	Universities or other R&D institutions linkages	Services provided
CEIM	Funchal, Madeira	1997	12	IT and related, consultancy, services	Located inside Madeira Tecnopólo	Administrative support
CiDEB	Porto, North	2000	23	Biotechnology, environment, agro-alimentary	Located in side the Biotechnology School, it is wholly owned by the Portuguese Catholic University (private university)	Management support Administrative support Marketing Venture capital access Graphical design
IEUA	Aveiro, Centre	1997	17	Consultancy, biotechnology, IT and related	Wholly owned by a R&D institute associated to the University of Aveiro	Accountancy Management support Administrative support Venture capital access, via idea contest
Ipñ Incubator	Coimbra, Centre	1996	52	IT and related, consultancy, services, biotechnology, production, analysis and testing	Wholly owned by a R&D institute associated to the University of Coimbra	Accountancy Management support Administrative support Marketing Consultancy Training Venture capital access
Net	Porto, North	1989	117	Consultancy, biotechnology, manufacturing, services, IT and related	Universities among the minor shareholders	Accountancy Management support Administrative support Marketing Venture capital access Information access
Open	Marinha Grande, Centre	2005	0	No tenants	Universities among the minor shareholders	Not established
Sogist	Porto, North	2001	6	IT and related	Two universities own the incubator and the University of Porto chairs the board of directors	Administrative support

Table 5
Origin of companies in SPs and BIs (only presented the cases in which data was available).

Science park	Start-up		Uni Spin-Offs		R&D Institutions Spin-Offs		Branches		Relocated		Others		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
BioCant Park	1	25	1	25	0	0	0	0	2	50	0	0	4
Lispolis	47	52	2	2	1	1	12	13	28	31	0	0	90
Madeira Tecnopólo	13	50	0	0	0	0	0	0	7	27	6	23	26
PTMA	21	95	0	0	0	0	0	0	1	5	0	0	22
Taguspark	40	24	4	2	5	3	15	9	65	40	35	21	164
Tagusvalley	3	43	0	0	0	0	0	0	3	43	1	14	7
TecMaia	10	24	4	10	2	5	8	20	8	20	9	22	41
Total SP	135	45	11	6%	8	1	35	6	114	31	51	12	354
Business Incubator													
Ceim	11	92	1	8	0	0	0	0	0	0	0	0	12
IEUA	1	17	2	33	1	17	1	17	0	0	1	17	6
IPN	1	7	7	50	3	21	0	0	0	0	3	21	14
Sogist	6	100	0	0	0	0	0	0	0	0	0	0	6
Total BI	19	50	10	26	4	11	1	3	0	0	4	11	38
Total	154	39	21	5	12	3	36	9	114	29	55	14	392

materials, geotechnical and pharmaceuticals. The situation of Tagus Valley is also illustrative. It is not expected to be particularly successful in terms of academic spin-offs and attracting science and technology-based companies, if its strategy

remains unchanged. With no links to universities or research centres in the fields of science or engineering (Table 6), it is highly unlikely that such kind of firms will be established or even relocated there.

Table 6

Lessons distilled from exploratory individual case studies (adapted from Ratinho, 2007).

Science park	University links	Suitability of management
BioCant	Thematic focus Existence of R&D institution within the park Promoted by research universities (University of Coimbra and University of Aveiro)	Renting of laboratorial space as well as office space Initiatives to attract qualified human capital to the park and the region
Lispolis	Urban development project No significant universities or R&D institutions present	Focus in real estate
Madeira Tecnopólo	Links to a teaching university with no significant science technology and engineering knowledge production	Broad scope of activities: managing SP, exhibition centre, events, development of urban area Mismatch of services and tenants verbalised needs Technology screening in both academia and local industry to foster new technology transfer activities
Parkurbis	Urban development project	Laboratories accessible to tenants Networking events
Tagus Park	Multifunctional urban project including research laboratories, R&D institutions, big companies and urban development infrastructure, e.g., hotel and swimming pools No presence of universities or R&D institutions Linked to a small teaching high education institution	Competence centre aiming at introducing the SP as a one stop shop No focus in regional strengths terms of sectors of activity present in the region
Tagus Valley	Urban development project No significant R&D institutions present	Focus in regional strengths in terms of sectors of activity
Tecmaia		
Business Incubator		
CiDEB	Incubator is part of the Portuguese Catholic University (private university) Organisational alignment between incubator and university providing incentives for professorship in participating in the incubator activities	One-to-one mentoring in both technical and managerial skills Ad hoc training for entrepreneurs
IEUA	Owned and located inside a research university	Companies did not report services provided as being critical to their development Customised services to tenants in different stages of development Adaptive selection criteria to promote complementary services in-house and foster inter-tenants contacts
IPN Incubator	Strong links to a research university and regional industry Located inside an R&D institution	Customised services Well-developed selection procedure
NET	No particular links to any university or R&D institution	To be established Office space rent Mismatch of services Lack of skilled people in the incubator
OPEN PTM/A Sogist	Strong links to industry and its R&D technological centre No operational links to any university or R&D institution Linked, owned and managed by two of the most prominent universities of the region	

6.2. Suitability of management

Our research confirmed the role of management as critical for the success of SPs and BIs (Aernoudt, 2004; Grimaldi and Grandi, 2005; Lee and Osteryoung, 2004; Löfsten and Lindelöf, 2002). Aerts et al. (2007) also refer to specific tools, such as adequate screening process in BIs as important features in these infrastructures. While these authors underline the importance of management they do not provide examples of good management or what may be considered suitable management tools. We explored suitability of management using three underlying determinants: management profile, services provided and innovative ideas.

6.2.1. The management profile

Management of SPs and BIs requires specific expertise (IASP, 2002; Lee and Osteryoung, 2004) since it involves complex processes such as technology transfer (McAdam et al., 2005) and business development processes (UKBI, 2007). Furthermore, SPs and BIs are often part of a regional economic development strategy (Hackett and Dilts, 2004; Phan et al., 2005) and have to satisfy demands of several diverse shareholders (Amirahmadi and Saff, 1993; Massey et al., 1992; Quintas et al., 1992). In a recent conference held at the European Investment Bank (EIB) in Luxembourg, a round table constituted of managers of European SPs highlighted the critical role of management from the very beginning of any SP operation (EIB, 2006). As practitioners, their perception is that a SP manager has to combine the profiles of a scientist, a politician and a businessman being able to communicate effectively and interact with

several different actors of the local and regional system of innovation.

Apart from scale, the management profile for SPs and BIs does not differ greatly. This integrated management profile is particularly important in the population of Portuguese SPs and BIs. Most infrastructures are owned by local or regional authorities, universities or other knowledge production institutions as well as private institutions. Tagus Park, Biocant Park and IPN Incubator illustrate well this holistic view applied to SP and BI management:

- Tagus Park is an urban project gathering the three views in its management. First, policy, as it is part of a wider regional development plan. Second, science, as the university's involvement shows (a campus located within and the creation of joint-venture laboratories). Third, business, as the orientation towards markets and the attraction of anchor companies suggest (e.g. the park is home to Microsoft's Portuguese headquarters and entire business units of a private bank (Ratinho, 2007)).
- Biocant Park combines as shareholders a significant number of important actors of the regional system of innovation. Furthermore, it was able to attract Portuguese prominent biotechnology companies (the focus of the park) to harness the potential arising from the already established in-park R&D centre.
- IPN Incubator is strongly linked to a university via one research institution (owned partially by the University of Coimbra). However, its nature is rather different than that of CiDEB's or

IEUA's since the BI is open to all kinds of projects. It is also the precursor to the SP project in development in the city. So far, IPN Incubator has followed an effective strategy and succeeded in incubating companies and also in fostering commercial links between them.

Conversely, Sogist, PTM/A, Tagus Valley and Madeira Tecnopólo do not evidence an effective way of incorporating policy, science and business orientation in their management:

- Sogist is partially owned and managed by the University of Porto and it is based on the premises of an engineering school in the same city. Yet it was described by its former tenants as not significant to their development, not having provided anything else than space at high prices and poor logistic services (see Table 6). The policy view was disregarded by Sogist's management who did not promote internally its incubator. The BI was never full so far and tenants reported lack of activities and inexistence of a network of contacts. Furthermore, management was not sufficiently business-oriented, as the current lack of tenants and internal activities at the time of research suggests. Previous tenants also classified rent and services' costs (such as networking or consultancy) as unaffordable for companies at their stage of development.
- PTM/A showed the same disarticulation in terms of combining effectively policy and science issues. The existence of a nearby SP carrying also business incubation activities (Madam Parque, not surveyed), in a more attractive location (inside the university campus) was clearly overlooked by the management of both infrastructures and has potentially contributed to the failure of this SP. Seemingly, after its set-up, the need to profit from the premises deviated completely from any scientific orientation, transforming PTM/A in an office renting space.
- Tagus Valley is located in a region that does not gather the conditions for the success of scientific ventures. Also, it does not have any linkages to knowledge production institutions. In terms of policy, the existence of a significant regional cluster of automotive companies (DPP, 2002; GEPE, 2002) is disregarded in terms of legacy and preferential sectors of activity for business incubation or relocating companies in the park.
- Lastly, Madeira Tecnopólo, gave priority to policy issues promoting regional development and urban revitalisation more than business incubation or technology transfer activities (Table 6).

6.2.2. The services

The need for services is also shared by SP managers. In the EIB conference on SPs (EIB, 2006), the round table panel highlighted four value-added services that should be provided to tenant companies: (i) incubation schemes; (ii) shared infrastructure for work and leisure; (iii) flexible premises allowing companies of all sizes to dwell in; and (iv) promotion of tenants through the image and reputation of the park. Looking to our evidence in terms of services provided, it is clear that IPN Incubator and CiDEB have the leading position:

- IPN Incubator developed several models of incubation that include services adapted to tenants' needs. Currently, IPN can support ventures in its premises and virtually. The latter mode is basically a contract of specialised consultancy services provision with access to the incubator's network (Table 6). Furthermore, a special model of incubation for graduate companies is used to keep people together by sharing the same information system. The package of services includes

space and its maintenance, consultancy (both internal of through an external network), internal activities to promote links between tenants and access to venture capital (Table 4);

- CiDEB supports ventures mostly by granting them access to academic and business mentorship in biotechnology and business (Table 6). This university-based incubator has an integrated approach, creating also the right incentives for entrepreneurs, internal and external mentors to collaborate in supporting new venture. The package of services includes flexible space, access to university's knowledge via libraries, academic staff, internal and external mentoring, access to venture capital and customised training for entrepreneurs.

In the other extreme, we find Sogist and Madeira Tecnopólo. In both cases, we observed a mismatch between services provided to companies and their actual needs, as reported by previous tenants. Yet every surveyed company found the space and administrative support provided to be of value.

- In Sogist, the incubation contract was the main constraint to companies. Both management and previous tenants describe the incubation contract as inappropriate as it contemplated 1 year of lease reverting to shareholding capital, if both parties agreed. Unsurprisingly, after 1 year, successful companies did not agree on transferring shareholding capital to Sogist while unsuccessful ones looked forward to have a capital increase. As a result, Sogist has not acquired shares of any incubated company.
- Madeira Tecnopólo's incubation program itself is the cause of dissatisfaction in tenants' words. Most companies are admitted after winning a regional award. Each entrepreneur is then awarded with services valid for only a year. These services are rigid and cannot be exchanged for anything else than meeting rooms, communications and consultancy. The foremost criterion of admission is the existence and soundness of business plans of projects. Business support needs do not remain unchanged throughout the venture's development (McAdam and McAdam, 2008). Hence, it is possible that the available services will only be useful some time after the venture's selection.

6.2.3. Innovative ideas

We also found useful to include innovative ideas to compare management practices. Tagus Park's project for establishing a competence centre that combines all the existing competencies within the park's firms in order to be able to cope with the demands of new customers is a very good example (Table 6). Park's management expressed intent to cater for client's requests as a whole, indirectly promoting synergies among tenants. Another good example comes from IEUA and its supplier program that allows tenants to combine their orders for services (such as rent-a-car, travel agency, office material) to enjoy reduced prices. Further innovative management ideas include the gradual shift of selection criteria that enabled links among IPN Incubator's tenants or Biocant Park's establishment of an incentive program for attracting companies and also skilled human capital to the region to develop applied research in biotechnology.

7. Discussion and further research

We set out to investigate the efficacy of SPs and BIs in promoting economic growth in converging countries. This proposition will only be true if SPs and BIs are successful in their operation. As a result, we also researched the underlying determinants for success of SPs and BIs, already grouped in two

main categories based on the extant literature. Concerning *university links*, our research points that the mere proximity and formal links between SPs/BIs and universities impacts less for their success than the scope and intensity of those linkages. Previous work list university linkages as having a role in the performance of SPs and BIs (Hackett and Dilts, 2004; Phan et al., 2005) and already speculated the influence of the nature of such linkages (Colombo and Delmastro, 2002). Our findings suggest that such role should be more than just proximity or formal linkages, confirming also Vedovello's findings (1997), but go further defining the scope for such linkages in terms of which type of universities should the SP or BI be preferably linked to. Concerning the *suitability of management*, our findings confirm its crucial role in the success of a SP or BIs (Aernoudt, 2004; Grimaldi and Grandi, 2005; Löfsten and Lindelöf, 2002) but go further in discussing which practices enhance management effectiveness. Chief among these is perhaps providing business services to tenant firms that are targeted to their actual needs (Aabo, 2009). Most Portuguese SPs and BIs are owned by combinations of local, regional and national authorities, universities and other centres of knowledge production, chambers of commerce and private real estate developers. This, in fact, is typical of this kind of infrastructures worldwide (Amirahmadi and Saff, 1993; Castells and Hall, 1994; EC, 2002; UKSPA, 2003). Not surprisingly, the objectives and interests of each promoter and shareholders are often contrasting (OECD, 1997). Our research confirms this struggle between the shareholders for governance of SPs and BIs but goes further proposing a management profile for these institutions that potentially reconciles shareholders interests.

Our contribution assists converging economies to plan and operate SPs/BIs. Yet within converging economies there is a spectrum of country-based economic levels. For instance, we compared the converging economies of Portugal and Greece to EU newcomers such as the Czech Republic or Poland. The latter seem in fact to be on the same converging track that the former were years before. Yet, while converging, all these economies are different and, for instance, Poland is still lagging behind Portugal in terms of infrastructure and other innovation performance indicators (EIS, 2008).

We highlight two main research streams that can arise from our research, which are the importance of location and timing. Most of Portuguese SPs and BIs are located around urban centres that are more likely to have also centres of knowledge production as well as exhibit higher economic growth. It is reasonable to assume that SPs or BIs located around developed urban centres will have less difficulty in bringing together all relevant actors of the system of innovation than similar institutions located elsewhere. Yet we do not have enough data in our study and such analysis would shift the focus of this paper to regional development issues. Timing also arises as an important not investigated variable. Although the underlying determinants for success are mostly related to SP's and BI's intrinsic features, some surrounding characteristics have to be met to enable performance. Similarly to location, investigating such relation would shift our focus to issues such as regional planning and innovation policy. Further research is needed to investigate the importance of these variables as well as their impact on the lessons learned through our study.

An alternative perspective of our findings suggests that the success of SPs and BIs is buttressed on planning issues and operational features. In this case, the determinant issue when planning a SP or BI is to ensure university links while when operating one, suitability of management is crucial. Future research should focus separately on any of these issues in order to investigate in more detail management best practices and planning best practices.

8. Conclusions

The main research proposition was to investigate whether SPs and BIs are tools for economic growth in converging economies. The best we can say is that their contribution is modest. The figures in terms of company creation are minimal and could, at best, have a local impact. As most of the Portuguese population of SPs and BIs are located in urban densely populated areas, this effect is even more diluted. Furthermore, the results concerning their operational performance are not astonishing. Apart from the cases of excellence (TagusPark and Biocant Park as Science Parks; IPN and CiDEB as Business Incubators), most Portuguese SPs and BIs were not planned and are not working towards the creation and development of new ventures. As a result, their contribution to job creation and economic growth is barely visible. This conclusion is of particular importance to converging economies. Policy-makers, urban planners and SPs/BIs promoters within those countries and regions should be aware of the limited impact these institutions have as tools for convergence.

Our analysis does not show conspicuously any better model but rather practices and intrinsic features of SPs and BIs. In fact, our results are independent from the ownership and promoters of the SP, focusing on operational issues such as management and university linkages. This is also in accordance with previous work since we provided evidence that property-based organisations housing jointly knowledge production institutions and firms is a not a sufficient condition for the creation of new companies (Quintas et al., 1992). In fact, a closer look at Massey et al.'s seminal work in the UK (Massey et al., 1992) suggests that the Portuguese model for SPs and BIs is still based of the traditional view of a linear system of innovation (Hansson et al., 2005; Phillimore, 1999).

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Appendix I

See Table A1.

Table A1
Questionnaires used in the survey.

Question	Science parks	Business incubators
A. General characterisation		
1	Name	Name
2	Year of foundation (first operational company)	Year of foundation (year of first company incubated)

Table A1 (continued)

Question	Science parks	Business incubators
3	Founders (private, university, regional authority, others)	
4	Size (total area, occupied area, employees of the park, employees in the park, number of companies, annual turnover)	
5	How long did it take to set up?	
6	What was the origin of funding for the setting up of the science park?	(EU, National, Private, etc.)
7	Sectors of activity of tenant companies (consultancy, biotechnology, manufacturing, services, ICT and related, testing/analysis, others)	Sectors of activity of tenant companies (consultancy, biotechnology, manufacturing, services, ICT and related, testing/analysis, others). Both incubated and graduated
8	Presence of universities within the park (if yes, list them)	Affiliation with universities (if yes, list them)
9	Presence of other institutions of research and development within the park (if yes, list them)	Affiliation with state institutions of research and development or state laboratories (if yes, list them)
B. The local and regional context of the Science Park		
10	Presence of other Science Parks in the region (if yes, list them)	Presence of incubators in the surrounding areas (if yes, list them)
11	What is the main Research and Development strategy for the region in which this Science Park is located?	What is the economic development and growth strategy for the region in which the incubator is located?
12	To what extent did the legal framework, the regulatory mechanisms or government support contribute to the development of this park?	To what extent did the legal framework, the regulatory mechanisms or government support contribute to the development of this incubator?
13	How would you classify the accessibility? (road, train, bus, air, public transportation)	
14	Is there any economic activity particularly important in the area (nearest city or region)? If yes, how has it impacted the strategy?	
C. The Science Park		
15	Who owns the park/business incubator? (please state all the shareholders and their capital shares)	
16	Management, if different from ownership (please state the composition of the management committee)	
17	What is the professional background of the management team? Consider the administrative, executive and operational members	
18	Origins of current tenants (please include the number of companies) (start-up, other R&D institutions spin-offs, relocated firms, universities spin-off, branch of existing firm, other)	
19	What is the strategy? Consider, for instance:	
	i) objectives?	
	ii) specific markets.	
	Were there any major changes in the last years? Summarize them	
20	What are the incentives and the conditions within the incubator for companies?	
21	What services does the science park/incubator provide to tenant companies?	
22	Is there any kind of state aid in covering the operational costs of the science park/incubator?	
23	What evaluation criteria does the park/incubator use for selecting a company?	
24	Does the park/incubator have any performance self-assessment criteria? If yes, which?	
25	What formal agreements exist between the park/incubator and Universities or other Research and Development Institutions? Give some examples, if possible	
26	Does the park/incubator have partners? If yes, list them by sectors of activity and geographical location. (if necessary, annex documents like: official agreements, membership statements, external certifications, etc.)	
27	Figures of tenant companies (average dimensions, average number of employees, R&D expenditure, annual turnover, overall number of patents, average number of patents per year) Educational level of tenant companies' employees (please include the number of people within each level) (Ph.D., Masters, Graduates, High School, Elementary School)	
28	Briefly describe the history of the park/incubator in terms of number of companies and occupational rates by filling the table on the right and adding any other comments considered necessary. (Please choose two intermediate years of operation in which there were major changes) (number of companies, total available area, occupied area)	
29	Just for the companies that have already left the park/incubator, briefly describe your history, considering:	
	i) average stay;	
	ii) reasons for leaving (bankruptcy, fusions, acquisitions, etc.);	
	iii) number of employees;	
	iv) annual average turnover.	
30	Briefly describe how the space is granted to the companies by filling in the table on the right and adding any comments you find necessary. (Monthly prices for rent/lease and sell; comparison to local averages)	
31	Is there a bureau of intellectual property protection? How does it work?	
32	Is there a Business Incubator in this science park? Can you briefly describe it?	Is there a Science or Industrial Park associated to the incubator? Can you briefly describe it and provide some information, like name, location, contact, ...?
D. The first company		
33	Which was the first company? (name, activity, Type of Company (start-up, relocated, branch, etc.), Space occupied, Other (funding, brief description of the company, etc.),)	
34	In general, how would you assess the role played by the first firm established?	

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EBN – European Business Innovation Centres Network. <http://www.ebn.be>.
 Observatory of European SMEs (retrieved May 2006) <http://www.eim.nl/eng/index.cfm/13,0,90.html> (retrieved May 2006). Further information can be found in http://ec.europa.eu/enterprise/enterprise_policy/analysis/observator_y_en.htm.

Science Parks and Business Incubators Internet Resources

Tecparques – Portuguese Association of Science Parks. <http://www.tecparques.pt>
Biocant Park. <http://www.biocantpark.com/>
CEIM – Madeira Company and Innovation Centre (Centro de Empresas e Inovação da Madeira). <http://www.ceim.pt/>
CiDEB. <http://www.esb.ucp.pt/cebi>
IEUA – University of Aveiro Business Incubator (Incubadora de Empresas da Universidade de Aveiro). <http://ie.web.ua.pt/>
IPN Incubato. <https://www.ipn.pt/si/incubadora/>
Lispolis. <http://www.lispolis.pt>

Madan Parque. <http://www.madanparque.pt>
Madeira Tecnopólo. <http://www.madeiratecnopolo.pt>
NET. <http://www.net-sa.pt/>
OPEN. <http://www.open.pt/>
ParkUrbis. <http://www.parkurbis.pt/>
PTM/A – Technological Park of Mutela/Almada (Parque Tecnológico da Mutela/Almada). <http://www.caixadimagens.pt/ptma>
Sogist. <http://www.sogist.pt/>
Tagus Park. <http://www.taguspark.pt>
Tagus Valley. <http://www.tagusvalley.net/>
Tecmaia. <http://www.tecmaia.pt/>