

TECHNOLOGY BUSINESS INCUBATORS AS ENGINES OF GROWTH: TOWARDS A DISTINCTION BETWEEN TECHNOLOGY INCUBATORS AND NON-TECHNOLOGY INCUBATORS

TIAGO RATINHO, RAINER HARMS & AARD GROEN

Nikos, Dutch Institute for
Knowledge Intensive Entrepreneurship, University of Twente
Postbox 217
7500 AE Enschede
The Netherlands

email: tiago.ratinho@utwente.nl; r.harms@utwente.nl; a.j.groen@utwente.nl

Abstract.

Business incubators are an increasingly popular tool for promoting job and wealth creation. Yet given the heterogeneity of incubation models, it is not always clear how incubators operate, what their main characteristics are and how can they best contribute to job and wealth creation. If technology is central in promoting economic growth and new firm creation the crucial mechanism in transferring new knowledge to markets, then technology incubators have the biggest potential to contribute to economic growth. We define technology incubators by their strategic choices in terms of mission, linkages to universities and geographical location. We investigate their nature by comparing the levels of business services provision, selection criteria, exit policy and tenants' characteristics. Our sample includes 12 incubators located in six Northwestern European countries and a total of 101 incubated companies. Data were collected in both incubators and among their tenants. Results show that technology incubators provide more tenants with their services, select younger companies and practice stricter exit policies. Additionally, they tend to attract more experienced teams of entrepreneurs. Our main contribution is a better understanding of the technology incubators impact against the remainder population of business incubators. We speculate that incubators not focussed in incubating technology might not be contributing to company creation at all. Further, the low levels of service provision are both a product and a consequence of slack selection criteria and weak exit policies. Finally, we discuss the implications of our findings to business incubator managers, policy makers and prospective tenants.

Keywords: Business Incubators, Technology Incubation, Business Support, Entrepreneurship, Economic Growth

1 Introduction

Explaining, modelling and controlling economic growth has long been an ambition of researchers, practitioners and policy makers (Landes, 1998; Maddison, 2001; Smith, 1776). In the 1950s, Robert Solow first attempted to explain economic growth (Solow, 1956) by putting technical progress central in the creation of wealth of advanced economies. Today, the notion that technology change is responsible for economic growth is widespread (Romer, 1990). According to this view, growth is driven by technological change created endogenously and intentionally by purposed investments in the creation of knowledge. More recently, Audretsch (2007) suggested the mechanism through which new knowledge is brought to the market, creating new products and services, is entrepreneurship. This definition, presuming the creation of new firms, is in line with the traditional view of entrepreneurship (e.g. Low and MacMillan, 1988). The larger of technology based firms, more externalities will be in generating and exploring new knowledge and therefore the faster the economy will grow. It becomes apparent that promoting economic growth should include appropriate tools for supporting creation of new knowledge. Further, all mechanisms able to transform that output into new marketable products and services should also be among the policies to create jobs and wealth.

One of the most famous initiatives to bridge the gap between the creation of new knowledge and marketing new products and services is the Small Business Innovation Research (SBIR). The SBIR program started in 1982 as a direct instrument to stimulate technological innovation among small business in the United States (Wessner, 2008) and link universities to public and private markets. Also, SBIR is a tool for promoting commercialization of innovation within the private sector, which is mostly achieved by the creation of firms (Wessner, 2008). In fact, a significant number of firms would not have started without the SBIR initiative (Audretsch et al., 2002). Business incubation assumes itself to bridge the same gap yet having a significant difference compared to the SBIR.

Business incubators (BI) are organizations which support actively the process of creation of new companies. Governments have been vigorously supporting business incubators in the past decades as tool to promote economic growth (Adkins, 2002; EC, 2002). BIs provide nascent and fledgling companies with an array of services such as infrastructure, business support and access to networks (NBIA, 2007; OECD, 1997; UKBI, 2007). The basic mechanism behind BI operation is similar to that of SBIR - to bridge the gap between the creation of new knowledge and marketing new products and services. However, BIs go further by guiding the new firms during their early stages of development.

BIs can be differentiated along various lines. For example, Grimaldi and Grandi (2005) divide BIs according to whether they are privately or publicly owned. Others attempts have been made using more dimensions to characterize types of BIs, such as strategic choice (Carayannis and von Zedtwitz, 2005), service portfolio (von Zedtwitz and Grimaldi, 2006) or management features (Aerts et al., 2007; Clarysse et al., 2005). However, the outcomes of BIs in terms of job and wealth creation are not present in any of these typologies. In fact, most of these studies lack a business incubation theory lens (Hackett and Dilts, 2004).

The strong theoretical and empirical link between innovation and economic growth suggests that BIs particularly focused on the support of technology based firms could be an effective policy tool. Previous differentiations do not capture so much the idea of technology business incubators (TIs). The closest category would be the university-based BIs (Grimaldi and Grandi, 2005; von Zedtwitz and Grimaldi, 2006), in which provision of both tangible and intangible assets is conceptualized. Although TIs have also deserved some attention of

researchers, studies seldom operationalize the process of business incubation or business incubation features (cf. Chan and Lau, 2005; Colombo and Delmastro, 2002; Mian, 1996, , 1997)¹. This contributes to the poor understanding about the differences between TIs and non technology based business incubators (NTBI).

We set out to investigate the differences between TIs and NTBIs based on characteristics of the incubators themselves. The comparison will be made using specific business incubation dimensions, such as provision of infrastructure, business support and access to networks. We will also investigate their selection strategy as well as tenant firms' characteristics. The underlying assumption is that TIs' effects on economic growth are only possible if they cater for tenants' needs.

This paper is structured as follows. We start by discussing characteristics of BI in general and TI in particular. Also, we provide a solid theoretical lens to business incubation. After outlining our definition of TI, we describe the empirical setting, the operationalization of key variables and the method of analysis. After presenting the results, we discuss them furthering explanation for the differences between the types of BIs. Finally, we discuss the managerial implications for business incubators, policy makers and prospective tenants.

2 The Nature of Business Incubators

2.1 What are technology business incubators?

Both practitioners and academics have put forth definitions of business incubators (Table 1) (Bergek and Norrman, 2008; EC, 2002; Hackett and Dilts, 2004; Hansen et al., 2000; Merrifield, 1987; NBIA, 2007; OECD, 1997; Peters et al., 2004; Phan et al., 2005; UKBI, 2007). Two key common features can be distilled. First, BIs focus on the support of nascent and young companies promoting their growth and maximizing their chances of survival. The main goal is that these supported companies will survive and thus contribute to creating jobs and wealth. Second, the support services are targeted to firms' needs and consist of physical infrastructure, business support services and access to networks.

TIs are a special type of BI focused on supporting technology based ventures (OECD, 1997). Knopp (2007) lists TIs among the most frequent self-reported categories within the North American population of BIs. We define TI as the BIs which fulfil at least two of the following criteria. First, a clear mission statement endorsing the creation of technology based new ventures. BIs strategically oriented this way are more likely to incubate technology based ventures than their counterparts. Second, TIs have strong links to a research oriented university or other research centres. Such BIs are closer to sources of new knowledge and therefore more likely to help creating and supporting technology based companies. Lastly, TIs are geographically close to a university campus or other research centres. These BIs are more likely to nurture university spin-offs due to their location (Audretsch et al., 2005). These three criteria ensure that TIs are closer to bridge the gap between knowledge creation and markets. Furthermore, TIs will be more prone to engage in technology transfer and therefore have a significant contribution to job and wealth creation.

2.2 Dimensions of business incubation

Business incubation has three fundamental dimensions: infrastructure, business support and access to networks (e.g. Barrow, 2001; Smilor and Gill, 1986). As aforementioned, most work on BI is atheoretical (Hackett and Dilts, 2004). We will improve the current theoretical

foundation of BIs providing arguments *why* BI can have a potential effect on incubatee survival and performance. This will, in its turn, have a positive impact on economic growth.

Table 1 – Definitions of Business Incubation

National Business Incubation Association. Business incubation is a business support process that accelerates the successful development of start-up and fledgling companies by providing entrepreneurs with an array of targeted resources and services. These services are usually developed or orchestrated by incubator management and offered both in the business incubator and through its network of contacts. A business incubator's main goal is to produce successful firms that will leave the program financially viable and freestanding. These incubator graduates have the potential to create jobs, revitalize neighborhoods, commercialize new technologies, and strengthen local and national economies (NBIA, 2007).

United Kingdom Business Incubation. Business Incubation is a unique and highly flexible combination of business development processes, infrastructure and people, designed to nurture and grow new and small businesses by supporting them through the early stages of development and change (UKBI, 2007).

European Commission. A business incubator is an organization that accelerates and systematises the process of creating successful enterprises by providing them with a comprehensive and integrated range of support, including: Incubator space, business support services, and clustering and networking opportunities.

By providing their clients with services on a 'one-stop-shop' basis and enabling overheads to be reduced by sharing costs, business incubators significantly improve the survival and growth prospects of new start-ups.

A successful business incubator will generate a steady flow of new businesses with above average job and wealth creation potential. Differences in stakeholder objectives for incubators, admission and exit criteria, the knowledge intensity of projects, and the precise configuration of facilities and services, will distinguish one type of business incubator from another (EC, 2002).

Organisation for Economic Co-operation and Development. Technology incubators are a specific type of business incubator: property-based ventures which provide a range of services to entrepreneurs and start-ups, including physical infrastructure (office space, laboratories), management support (business planning, training, marketing), technical support (researchers, data bases), access to financing (venture capital funds, business angel networks), legal assistance (licensing, intellectual property) and networking (with other incubators and government services) (OECD, 1997).

Infrastructure

The concept of business incubation is inextricably tied to infrastructure (Phan et al., 2005). Infrastructure is often associated with space and shared resources. Space is generally an office rented to tenants at or below market prices. In addition, BIs often have small production facilities or mixed units available to their tenants. Provision of space is critical to business incubation. Empirical evidence suggests it as the most beneficial feature to tenants (Chan and Lau, 2005), particularly for those in early stages of development. General shared resources such as reception, clerical services, meeting rooms, conference rooms or car parking (EC, 2002; McAdam and McAdam, 2008) are often offered together with the space. Specialized shared resources such as laboratories or research equipment can also be part of the BI's infrastructure (Grimaldi and Grandi, 2005).

This typical BI setting providing space together with shared resources impacts nascent firms on many levels. First, overhead costs are reduced for the tenants. BIs provide their tenants

with services they probably would not have easy access to if located elsewhere. Car parking, meetings rooms, reception services are examples of this. Also, the burden of planning, setting up and costing a series of individual providers is inexistent when tenants enter this kind of ready to use office. Second, tenants located inside a BI display a signal of quality and increase their external credibility and legitimacy. All BIs have more or less extensive selection procedures. This means that being accepted to a BI signals the nascent firm as promising in terms of growth. This external legitimacy has a positive impact on young firm's survival even in situations of resource scarcity (Singh et al., 1986). Finally, putting firms under the same roof and sharing significant parts of the infrastructure increase the chances of synergies between them to arise. Knowledge sharing, formal alliances, buyer-seller relationships are examples of these.

The rationale for infrastructure can be found in the economies of scale. BIs tend to have high setup costs, but much lower operating fixed costs and declining marginal costs. After a certain space has been built, the operating costs of BI consist mainly on the shared resources discussed above. The costs of providing one more tenant with the infrastructure (space and shared resources) decrease as the number of tenants increases. To a lesser extent, economies of scope are also present when establishing and managing a BI. In fact, BIs often bundle infrastructure provision to reduce their number of services available within their infrastructure portfolio. Tenants normally pay rent for office space *including* shared resources such as parking, meeting rooms and cleaning; shared resources often cannot be paid separately from infrastructure.

Business support

New firms often lack experience such as necessary management processes and organizational routines to cope with sudden environmental shifts. This results in a higher death propensity, particularly in early stages. This “liability of newness” has been extensively studied since Stinchcombe coined the term in his 1965 seminal work (e.g. Brüderl and Schussler, 1990; Henderson, 1999). The liability of newness can be reduced by external credibility (Singh et al., 1986), as discussed in the infrastructure section. In addition, business support such as experienced advice can provide valuable help geared towards accelerating the venture's learning curve. By enjoying business support services, the incubatees will be able to make better and faster decisions, which results in higher firm performance (Eisenhardt, 1989). Furthermore, training sessions on relevant topics can contribute to increase the ventures' human capital and therefore have a potential impact on their development and performance (Colombo and Grilli, 2005; Davidsson and Honig, 2003).

Business support is an integral part of business incubation and arguably its most complex dimension. Previous work on business support identified four typical services: coaching, training, business plan support and direct subsidies. Coaching is often referred as the most important service business incubators can provide to their tenants (Hansen et al., 2000; Mian, 1996). Within a coaching program, each incubatee is assigned one coach when admitted to the incubator, either free of charge or for a fee. Meeting with the coach can be compulsory or on demand. BIs which do not possess in-house coaching expertise may facilitate access to a coach through their network of contacts. Coaching has already been found in literature as critical to tenants' timely graduation (Peters et al., 2004) and as having an impact on firm development (cf. Robson and Bennett, 2000).

Training is often available within BIs (Aerts et al., 2007; Barrow, 2001). Training tools are less interactive and customized than coaching sessions. Training tools range from a training

session on a specific topic to newsletters or access to common communication platforms. Peña (2004) found training within BIs to have a positive influence on tenants' performance. Writing a business plan is a conventional activity for nascent companies. Also, young start-ups often need to update their business plans as this is an often seen tool to gain access to potential investors (e.g. Delmar and Shane, 2003). BIs were found to provide assistance in business plan writing, particular when they include idea development in their activities (Peña, 2004). Lastly, BIs can also provide direct subsidies to companies (Peña, 2004).

Access to networks

Access to professional business services or financial resources via networks of professional contacts is also part of the incubator concept (Bøllingtoft and Ulhøi, 2005; Hansen et al., 2000). Access to networks stimulates external collaborations. Yet the incubation management should only connect tenants to the adequate networks of suppliers, customer or investors after carefully understanding their needs (Lee and Osteryoung, 2004). Empirical evidence suggests that access to networks is critical for the development of tenant companies (McAdam and McAdam, 2008). Access to financial resources is often offered by business incubators (Aerts et al., 2007). Connections with business angel networks and venture capital firms are important means of providing financial resources during early stages of tenants' development.

The concept behind the idea of compensating for a lack of resources using networks is social capital (e.g. Portes, 1998). New firms seldom have access to established networks to compensate their lack of human and financial resources. Previous work provided empirical evidence of the important role of social capital in building human capital (Coleman, 1988) and its impacts on firm performance (Davidsson and Honig, 2003; Yli-Renko et al., 2001). Accessing professional business services via networks is commonly out of reach for new young firms. For instance, a venture trying to gain access to professional advice on a specific field of IP expertise might fail to do so because it does not have enough financial means to pay high consultancy fees.

New firms often need external finance for development. Typical source of capital for new firms are business angels, venture capital firms or public subsidies (Clarysse and Bruneel, 2007). Among those, venture capital has an important influence on the professionalization of the venture. Venture capitalists typically have a control function, supervising the firm's activities to ensure their own investment as well as a support function to support the growth of their portfolio companies. As a result, venture capitalists contribute to the firm's development by covering their financial needs as well as professionalizing organizational structure and managerial processes (Hellmann and Puri, 2002).

2.3 Incubatee selection strategy

Selection criteria and exit policy are among the most important management features of business incubators. (Aerts et al., 2007; Lumpkin and Ireland, 1988). These procedures impact the population of incubated companies as well as the effectiveness of the process of incubation itself. New firm's needs vary according to their development (e.g. Kazanjian, 1988; Vohora et al., 2004). Therefore, the more heterogeneous the population of a BI is, the more difficult it will be to provide them all with the appropriate business support portfolio and access to a useful network of contacts. Selection criteria typically include financial ratios (liquidity, profitability), personal traits of the entrepreneurial team (skills, experience) and market factors (business plan, innovativeness of product or service) (Aerts et al., 2007;

Lumpkin and Ireland, 1988). More recently, Aerts et al. (2007) found that the more balanced the selection process is in terms of those selection factors, the better tenants will perform.

3 Research Design

3.1 Empirical setting

We investigated a total of 12 BIs located in six Northwestern European countries. All BIs were part of Nensi – North European Network of Service Incubators, an EU funded project which ran from 2005 until 2008. Based on our definition of TI, we found 5 TIs and 7 NTBIs which allowed us to have two equally large groups of BIs (Table 2).

The TIs in our sample have similar characteristics. All of them were founded by universities and are still located within their premises. The exceptions are Emergence and the TechnologiePark Münster which are located closely to university campus and research institutions. However, these two TIs were explicitly established to support regionally the creation and development of high-tech companies. All TIs show a clear mission towards the support of technology based ventures. NTBIs in our sample are also similar among themselves. Promoted by other organizations than research universities and located in urban locations, NTBIs do not show any particular focus on supporting technology based ventures. The exception is the BTC which is located close to a university campus and has among its shareholders a technical research-oriented university. Yet its mission is not clearly directed at supporting new technology based ventures but rather service companies (Table 2).

3.2 Methodology of data collection

During the Nensi project, we collected data on both business incubators as well as their tenants (for a detailed description of both questionnaires and the monitoring tool see Jenniskens, 2006). The questionnaire sent to business incubation managers included questions on their mission, strategy, focus, stakeholders, university linkages and location. Furthermore, other information on operational features such as tenants' profile, cost structure and business services portfolio was also part of the survey. We triangulated our data with complementary data gathered during site visits as well as compiled information in the public domain (Yin, 2003). Site visits included interviews with the incubation managers and other key staff. These interviews were semi-structured and the script based mostly on the analysis of the returned questionnaires. This allowed us also to clarify response in the questionnaires and to confirm some of the data already collected by alternative wording of the same questions (Fowler, 1995).

The questionnaire sent to tenants contained questions on the several dimensions of business incubation. An initial version of the tenants' questionnaire was used as script for semi-structured interviews to tenants of a selected BI. This procedure enabled us to assess the time needed to fill out the questionnaire as well as to correct some ambiguities in the questionnaires (Dillman et al., 2008). We asked tenants about the availability of infrastructure, business support services and access to networks within their respective BI. Demographic data such as age of venture, age at entry, sector of activity and teams' experience was also collected. Data on tenants was collected by incubator staff. We asked the incubation managers or other key staff within the incubator to manage the data collection process in each incubator. This way we covered a bigger sample of tenants and saved time during data collection. The incubator managers were duly prepared by the first author to carry

Table 2 – Typology of the researched business incubators

Country	Incubator	Mission statement	University linkages	Location	Focus
Netherlands	BTC	“Focus on knowledge intensive companies and organizations specialized in “high-tech” or high value services” (quotes on the original)	The University of Twente (research university) and Saxion (applied sciences university) are among the shareholders.	Campus / Business and Science Park	Mixed use
	Campus Business Centre	No clear mission found. Campus assumes itself as office rental while mentioning network of professionals for providing support to early stage ventures.	Owned and promoted mostly by ROC van Twente (Regional Educational Centre)	Urban	Mixed use
	Masterdam Ondernemers Centrum	Masterdam positions itself in bridging the gap between the education at ROC ASA and companies.	Owned and promoted mostly by ROC ASA (Regional Educational Centre)	Campus	Mixed use
UK	EPIC - Eliot Park Innovation Centre	No clear mission found. If you are a technology and knowledge based small to medium sized enterprise then EPIC is the ideal environment for you to grow and develop, although all enquiries are considered”	Promoted by Coventry University Enterprises, a for profit subsidiary of Coventry University.	Urban	Mixed use
	EMIN - Innovation Centre	Focused in supporting high-tech new ventures.	Founded by DeMontfort University (research university)	Campus	Technology based
	EMIN - Sparkhouse Studios	“Help new-start businesses grow and develop by providing them with the best possible advice and support available”. Focus in the field of creative industries.	Founded by the University of Lincoln.	Campus	Technology based
Ireland	DCEB - Guinness Enterprise Centre	“To provide incubator space (...) to new and established small businesses, primarily in software services oriented businesses, light hi-tech prototype engineering and international/technological traded services, E-commerce, multi-media, internet and mobile software development”	No linkages found.	Urban	Mixed use
	DCEB - iCELT	No specific mission found for the business incubator. The BI is however “home to a number of knowledge intensive start-up companies working in the areas of finance, education and	Founded and promoted by the National College of Ireland (teaching oriented university)	Campus	Mixed Use

Country	Incubator	Mission statement	University linkages	Location	Focus
		learning technologies”.			
	DCEB - Terenure Enterprise Board	“To provide practical, realistic support and training to all members in the community, with priority for disadvantaged members.”	The Community Enterprise Society Limited is a voluntary organisation with charitable status established in 1984.	Urban	Mixed use
France	Emergence	Emergence was created as a “tool (...) for company creation, aimed at supporting young technology based companies to start, develop and survive.”	Although geographically located close to Universities and Research Centers, the centre is not formally connected to any.	Campus / Business Park	Technology based Focused on young ventures
	Normandie Incubation	Housing and support of “innovative enterprise creation projects based in Lower Normandy.”	Founded by the University of Caen Lower Normandy, the National Graduate School of Engineering in Caen and the one public research laboratory.	Campus	Technology based Focused on pre starters
Germany	TechnologiePark Münster	“Promotion of innovations and technologies and the consultancy in the formation and growth of technology-oriented firms.”	Although geographically located close to Universities and Research Centers, the centre is not formally connected to any.	Urban	Technology based

this task and counted on his constant support while collecting data. From the initial call to 354 companies, 101 returned valid questionnaires (29%) (Table 3).

Table 3 – General characteristics and data availability of the researched business incubators

Country	Incubator	Year of Foundation	Size (m ²)	# companies	# valid answers	
Netherlands	BTC	1982	4700	68	11	16%
	Campus Business Centre	2005	5000	49	18	37%
	ROC ASA	2006	300	10	4	40%
UK	CUTP - EPIC - Eliot Park Innovation Centre	-		17	2	12%
	EMIN - Innovation Centre	2001	640	18	6	33%
	EMIN - Sparkhouse Studios	2003	320	10	6	60%
Ireland	DCEB - Guinness Enterprise Centre	1997	4000	67	7	10%
	DCEB - iCELT	2004	1300	13	3	23%
	DCEB - Terenure Enterprise Board	1985	750	25	6	24%
France	Emergence	1995	650	16	13	81%
	Normandie Incubation	2000	300	19	14	74%
Germany	TechnologiePark Münster	1985	6900	42	11	26%
Total				354	101	29%

3.3 Variables

Business services

BI services were operationalized using dummy variables for each service within each dimension discussed in section 2.2. We investigated a total of nine business incubation services. In the questionnaires, we asked tenants about the availability of each of the nine services. We interpret positive answers as available services which are therefore used. Tenants who report not knowing whether the service is available are certainly not using it. *Infrastructure* was measured asking tenants about availability of space and shared resources. Under *business support services* we put internal coaching, training, business plan writing and direct subsidies. *Access to networks* was measured using the variables external coaching, brokerage and seed/venture capital.

Selection criteria and exit policy

Selection criteria and exit policy were captured by using two variables for each. Selection criteria can be proxied by the entry age of tenants. Different entry age of tenants reflects different strategic orientation of the BIs. For instance, accepting older tenants implies a focus on supporting companies already established while admitting younger tenants means the BIs focuses on nascent companies. Additionally, we included a question on the difficulty to get accepted within the BI (dichotomous variable). This will approximate the extension of the selection procedure. Similarly, exit policy can proxied by the current tenants' age. For entrance, older tenants imply a weak exit policy resulting in housing companies beyond the incubation age. Additionally, we asked tenants whether they know when to leave the incubator. Negative answer can be translated in lack of exit policy.

Tenants' characteristics

Finally, we enquired on characteristics of the entrepreneurial teams. These include experience (in years), specific preparation in entrepreneurship, whether the company was founded by a team, current number of employees and if any member of the team had previous experience in starting businesses.

4 Results

An important finding of this study is that TIs and BIs differ in two of those dimensions while being similar on the other. TIs provide almost all their tenants with the infrastructure, business support services and access to networks while NTBIs only exhibit this in the infrastructure dimension. In fact, both types of incubators provide all their tenants with infrastructure, both space and some kind of shared resources. In the business support and access to networks dimensions, TIs show better levels of provision of services to their tenants than NTBIs. Although not covering the entirety of tenants, TIs provide business support services to around 90% of their population of housed firms. Similarly, TIs provide 90% of their tenants with access to network services. The exceptions are direct subsidies (business support) and seed/venture capital (access to networks) which are provided to less than 80% of the tenants.

NTBIs score lower on both business support and access to networks dimensions. Business support services are provided to less than 70% of housed firms. Only training scores higher (77.5%); direct subsidies score much lower, however (48.4%). In terms of access to networks, only brokerage is provided to TIs' comparable levels (more than 80%). External coaching and seed/venture capital are provided to less than half of NTBIs' tenants. We performed nonparametric independence tests to investigate whether the differences are statistically significant. We found that, apart from infrastructure services and brokerage, levels of provision of services in any dimension are statistically significant ($p \text{ value} \leq 0.05$) (Table 4).

Table 4 – Service availability in the researched business incubators

Service (%)	N	TIs (N=50)	NTBIs (N=51)	p value
Infrastructure				
Space	101	100.0	100.0	n.s.
Shared resources	101	100.0	100.0	n.s.
Business support				
Internal coaching	79	93.9	71.7	≤ 0.05
BP support	59	88.5	60.6	≤ 0.05
Training	73	93.9	77.5	≤ 0.05
Direct subsidies	49	78.4	48.4	≤ 0.05
Access to networks				
External coaching	67	90.5	50.0	≤ 0.01
Brokerage	58	90.5	81.1	n.s.
Seed/venture capital	51	76.5	38.2	≤ 0.05

Table 5 – Employment, selection criteria, exit policy and entrepreneurial teams' background in the researched business incubators

	N	TIs (N=50)	NTBIs (N=51)	p value
Employment	99	3.08	3.33	n.s.
Selection criteria				
Average entry age (years)	100	0.76	3.02	≤ 0.01
% of not difficult entrance	86	28.0	64.7	≤ 0.05
Exit policy				
Average current age (years)	101	3.02	5.45	≤ 0.05
% of knowing when to leave	98	34.7	16.3	≤ 0.05
Entrepreneurial teams background				
% team start	100	72.0	42.0	≤ 0.01
% serial entrepreneurs	96	29.2	29.2	n.s.
% entrepreneurship preparation	99	40.0	46.9	n.s.
Average accumulated years of experience (years)	92	21.0	14.0	≤ 0.1

Results also show statistically significant differences in selection criteria and exit policy variables between TIs and NTBIs (Table 5). TIs tend to select younger companies (average entry age = 0.76 years) and use a more sophisticated selection procedure. This is shown by the reduced proportion of their tenants who found it not difficult to get accepted (28.0%). Also, a larger proportion of companies is aware of when to leave the BI (34.7%) and tend to graduate timely (average current age = 3.02 years). Conversely, NTBIs select much more mature companies (average entry age = 3.02 years) which do not have any difficulty in getting accepted. 64.7% of NTBIs' tenants found it not difficult at all to get accepted within the incubator. Furthermore, tenants do not have any obligation to leave (only 16.3% know when to leave the BI) and are, on average, much older than the typical incubated company (average current age = 5.45 years). All differences are statistically significant (p value ≤ 0.05).

In terms of tenants' experience and background, our results show that TIs are attracting significantly more entrepreneurial teams than single entrepreneurs (p value ≤ 0.01), who also have more accumulated experience (p value ≤ 0.1). Yet no statistically significant differences are observed in terms of specific entrepreneurship background or experience in founding prior businesses. Finally, employment is approximately the same on average among both TI and NTBI tenants. The difference is not statistically significant.

5 Discussion of results

Starting from the proposition that TIs can contribute to economic growth, we compared TI and NTBI according to their business support strategy and their tenant selection strategy. Statistically significant differences were found in every incubation dimension apart from infrastructure (both premises and shared resources) and brokerage, a service part of the access to networks dimension. It is not surprising that both types of BIs provide the same level of infrastructure. Although the concept of virtual incubation has been gaining notoriety as a way to support new ventures without physical premises (Nowak and Grantham, 2000), most BIs are still property based (Phan et al., 2005). Additionally, our survey was only administered to companies who were physically located within the incubators. To our knowledge none of the BIs in our sample had any virtual incubatees besides the ones located within the physical space (cf. Durão et al., 2005). The fact that brokerage was also not statistically significant suggests that NTBIs provide the same level of brokerage as TIs. In other words, NTBIs act at least as good brokers, providing the relevant contacts to their tenants.

We also investigated the differences in selection strategy. Results show that TIs differ significantly from their counterparts. TIs have stricter and more sophisticated selection procedures while showing also exit policies in line with typical BIs' benchmarks (EC, 2002). The fact that NTBIs have less strict selection criteria and slack exit policies can be the reason behind the observed lower shares of tenants using services. Firms' needs vary throughout their various stages of development (Kazanjan, 1988; Vohora et al., 2004). Not surprisingly, NTBIs housing older tenants show different patterns of service usage than TIs housing younger ones tenants. BI services are especially designed to support companies during their first states of development. Due to strong industry associations, such as the NBIA in the United States or the UKBI in the United Kingdom, it is likely that BIs establish the same kind of services. Unfortunately, this might happen regardless of specific contingencies of each BI and its target population of tenants. Services such as coaching are crucial for nascent companies, become less important for start ups and potentially lose its utility for more mature companies (McAdam and McAdam, 2008). Services such as seed/venture capital, writing business plan are only meaningful for nascent companies. Still, NTBIs still have significant

proportions of tenants using other more general services such as training and internal coaching. This suggests that NTBIs might have a diverse portfolio of tenants in terms of age and stage of development.

The reason behind weak selection criteria and slack exit policies might be the built-in potential conflict between the profitability of a property based BI and the longer term goals of support technology based ventures (OECD, 1997). In our sample, most NTBIs are owned and promoted by private organizations and therefore less likely to value technology based venture creation activities above generating revenue. This is also visible in the average age of tenants. Most NTBIs are less than 10 years old which leads us to think that selection criteria and exit policies were never exclusively focusing in technology based ventures. In fact, it is known that some BIs accept accountants, financial services and insurance companies (OECD, 1997) while showing a reduced number of the type of companies they claim providing support to (Quintas et al., 1992; Ratinho, 2007).

TIs attract more experienced people in terms of work experience as well as a bigger share of entrepreneurial teams as opposed to single entrepreneurs. The differences between serial entrepreneurs and specific entrepreneurial preparation are not statistically significant. The positive role of teams in technology based firms has been extensively discussed (e.g. Colombo and Grilli, 2005). It would be therefore expectable that TIs, which focus specifically in supporting technology based ventures, would end up having more entrepreneurial teams than NTBIs. Similarly, it has been shown that TIs attract more experienced entrepreneurial teams' (Colombo and Delmastro, 2002). The average number of employers of tenants is only marginally higher in NTBIs than it is in TIs. This is unsurprising since it is likely that younger companies grow faster than more mature ones. At the same time, it might mean that companies within NTBIs are not actually growing. The infrastructure of a BI is typically designed for small nascent companies offering office space for small entrepreneurial teams. Therefore, NTBIs' tenants do not grow because they are located within a BI; or due to their sluggish growth combined with slack exit policies, they are still located within a BI.

6 Conclusions and Implications

Our results point that the contribution of TIs to economic growth is bigger when compared to the rest of the BI population. This is a direct result of their better internal functioning: they provide almost the entirety of their tenants with business services. These high levels of provisions of services increase the chances of survival and enhance the growth perspectives of their tenants. Furthermore, companies housed within TIs are more likely to be technology based and access more new knowledge since they are closely linked institutionally to sources of knowledge creation. Further, our study suggests that there is a strong differentiating effect of choosing a certain strategic positioning for the BI. This impacts some of its most fundamental operational characteristics such as levels of service providing and tenants' profile.

Our results have implications for BI managers, prospective tenants and policy makers. BI management has to take in account the impact of managerial practices in the population of tenants as well as in the consequent levels of business services provision. Well defined selection criteria and strong exit policies are determinant to the share of companies willing and needing to enjoy every dimension of business incubation beyond infrastructure. If older and diverse tenants are present, business services are, arguably, less needed. BI management

might look for alternative strategies to provide business support services to the tenants who still need them to some extent (outsourcing instead of in-house expertise, service level agreements, among others). Prospective tenants have also now an improved understanding on the profile of BIs to look for, according to their stage of development and need for business support services. Not all firms will need an TI environment to develop. Finally, policy makers can also better design BIs and their features according to specific policy aims. When economic growth through transferring of new knowledge to markets using new firms, TIs are bound to be better tools than their counterparts, NTBIs.

References

- Adkins, D. (2002). *A Brief History of Business Incubation in the United States*. Athens, Ohio: National Business Incubation Association.
- Aerts, K., Matthyssens, P. and Vandenbempt, K. (2007). Critical role and screening practices of European business incubators. *Technovation*, 27(5), 254-267.
- Audretsch, D. B. (2007). *The Entrepreneurial Society*. New York: Oxford University Press.
- Audretsch, D. B., Lehmann, E. E. and Warning, S. (2005). University spillovers and new firm location. *Research Policy*, 34(7), 1113-1122.
- Audretsch, D. B., Link, A. N. and Scott, J. T. (2002). Public/private technology partnerships: evaluating SBIR-supported research. *Research Policy*, 31(1), 145-158.
- Barrow, C. (2001). *Incubator: A Realist's Guide to the World's New Business Accelerators*. West Sussex, UK: John Wiley & Sons Ltd.
- Bergek, A. and Norrman, C. (2008). Incubator best practice: A framework. *Technovation*, 28(1-2), 20-28.
- Bøllingtoft, A. and Ulhøi, J. P. (2005). The networked business incubator--leveraging entrepreneurial agency? *Journal of Business Venturing*, 20(2), 265-290.
- Brüderl, J. and Schussler, R. (1990). Organizational Mortality: The Liabilities of Newness and Adolescence. *Administrative Science Quarterly*, 35(3), 530-547.
- Carayannis, E. G. and von Zedtwitz, M. (2005). Architecting gloCal (global-local), real-virtual incubator networks (G-RVINS) as catalysts and accelerators of entrepreneurship in transitioning and developing economies: lessons learned and best practices from current development and business incubation practices. *Technovation*, 25(2), 95-110.
- 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.
- 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(2), 183-216.
- Coleman, J. S. (1988). Social Capital in the Creation of Human Capital. *The American Journal of Sociology*, 94, S95-S120.
- Colombo, M. G. and Delmastro, M. (2002). How effective are technology incubators?: Evidence from Italy. *Research Policy*, 31(7), 1103-1122.
- Colombo, M. G. and Grilli, L. (2005). Founders' human capital and the growth of new technology-based firms: A competence-based view. *Research Policy*, 34(6), 795-816.
- Davidsson, P. and Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing*, 18(3), 301-331.
- Delmar, F. and Shane, S. (2003). Does business planning facilitate the development of new ventures? *Strategic Management Journal*, 24(12), 1165-1185.

- Dillman, D. A., Smyth, J. D. and Christian, L. M. (2008). *Internet, Mail, and Mixed-mode Surveys: The Tailored Design Method* (3rd ed.): John Wiley & Sons.
- Durão, D., Sarmento, M., Varela, V. and Maltez, L. (2005). Virtual and real-estate science and technology parks: a case study of Taguspark. *Technovation*, 25(3), 237-244.
- EC. (2002). *Benchmarking of Business Incubators, Final Report*. Brussels.
- Eisenhardt, K. M. (1989). Making Fast Strategic Decisions in High-Velocity Environments. *The Academy of Management Journal*, 32(3), 543-576.
- Fowler, F. J. (1995). *Improving Survey Questions: Design and Evaluation*. Thousand Oaks: Sage Publications.
- Grimaldi, R. and Grandi, A. (2005). Business incubators and new venture creation: an assessment of incubating models. *Technovation*, 25(2), 111-121.
- Hackett, S. M. and Dilts, D. M. (2004). A Systematic Review of Business Incubation Research. *The Journal of Technology Transfer*, 29(1), 55-82.
- Hansen, M. T., Chesbrough, H. W., Nohria, N. and Sull, D. N. (2000). Networked incubators: Hothouses of the New Economy. *Harvard Business Review*, 78(5), 74-84.
- Hellmann, T. and Puri, M. (2002). Venture Capital and the Professionalization of Start-up Firms: Empirical Evidence. *The Journal of Finance*, 57(1), 169-197.
- Henderson, A. D. (1999). Firm Strategy and Age Dependence: A Contingent View of the Liabilities of Newness, Adolescence, and Obsolescence. *Administrative Science Quarterly*, 44(2), 281-314.
- Kazanjian, R. K. (1988). Relation of Dominant Problems to Stages of Growth in Technology-Based New Ventures. *The Academy of Management Journal*, 31(2), 257-279.
- Knopp, L. (2007). *2006 State of the Business Incubation Industry*. Athens, Ohio: National Business Incubation Association.
- Landes, D. S. (1998). *The Wealth and Poverty of Nations: Why Some Are so Rich and Some so Poor*. New York, NY: W. W. Norton & Company, Inc.
- Lee, S. S. and Osteryoung, J. S. (2004). A Comparison of Critical Success Factors for Effective Operations of University Business Incubators in the United States and Korea. *Journal of Small Business Management*, 42(4), 418-426.
- Low, M. B. and MacMillan, I. C. (1988). Entrepreneurship: Past Research and Future Challenges. *Journal of Management*, 14(2), 139-161.
- Lumpkin, J. R. and Ireland, R. D. (1988). Screening practices of new business incubators: the evaluation of critical success factors. *American Journal of Small Business*, 12(4), 59-81.
- Maddison, A. (2001). *The World Economy: A Millennial Perspective*. Paris, France: OECD Development Centre.
- McAdam, M. and McAdam, R. (2008). High tech start-ups in University Science Park incubators: The relationship between the start-up's lifecycle progression and use of the incubator's resources. *Technovation*, 28(5), 277-290.

- Merrifield, D. B. (1987). New business incubators. *Journal of Business Venturing*, 2(4), 277-284.
- Mian, S. A. (1996). Assessing value-added contributions of university technology business incubators to tenant firms. *Research Policy*, 25(3), 325-335.
- Mian, S. A. (1997). Assessing and managing the university technology business incubator: An integrative framework. *Journal of Business Venturing*, 12(4), 251-285.
- NBIA. (2007). Business incubation FAQ. Retrieved 28.05.2008, from http://www.nbia.org/resource_center/bus_inc_facts/index.php
- Nowak, M. J. and Grantham, C. E. (2000). The virtual incubator: managing human capital in the software industry. *Research Policy*, 29(2), 125-134.
- OECD. (1997). *Technology Incubators: Nurturing Small Firms*. Paris: Organisation for Economic Co-Operation and Development.
- Peña, I. (2004). Business Incubation Centers and New Firm Growth in the Basque Country. *Small Business Economics*, 22(3), 223-236.
- Peters, L., Rice, M. and Sundararajan, M. (2004). The Role of Incubators in the Entrepreneurial Process. *The Journal of Technology Transfer*, 29(1), 83-91.
- Phan, P. H., Siegel, D. S. and Wright, M. (2005). Science parks and incubators: observations, synthesis and future research. *Journal of Business Venturing*, 20(2), 165-182.
- Portes, A. (1998). Social Capital: Its Origins and Applications in Modern Sociology. *Annual Review of Sociology*, 24(1), 1-24.
- Quintas, P., Wield, D. and Massey, D. (1992). Academic-industry links and innovation: questioning the science park model. *Technovation*, 12(3), 161-175.
- Ratinho, T. (2007). *The Role of Science Parks and Business Incubators in promoting Innovation: the Portuguese Case*. Unpublished MSc Thesis, Superior Technical Institute, Technical University of Lisbon, Lisbon.
- Robson, P. and Bennett, R. (2000). SME Growth: The Relationship with Business Advice and External Collaboration. *Small Business Economics*, 15(3), 193-208.
- Romer, P. M. (1990). Endogenous Technological Change. *The Journal of Political Economy*, 98(5), S71-S102.
- Singh, J. V., Tucker, D. J. and House, R. J. (1986). Organizational Legitimacy and the Liability of Newness. *Administrative Science Quarterly*, 31(2), 171-193.
- Smilor, R. W. and Gill, M. D. J. (1986). *The new business incubator: linking talent, technology, capital, and know-how*. Toronto: Lexington Books.
- Smith, A. (1776). *Wealth of Nations* (1901 ed.). New York, NY: Cosimo, Inc.
- Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, 70(1), 65-94.
- UKBI. (2007). What is Business Incubation? Retrieved 28.05.2008, from <http://www.ukbi.co.uk>
- Vohora, A., Wright, M. and Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research Policy*, 33(1), 147-175.

- von Zedtwitz, M. and Grimaldi, R. (2006). Are Service Profiles Incubator-Specific? Results from an Empirical Investigation in Italy*. *The Journal of Technology Transfer*, 31(4), 459-468.
- Wessner, C. W. (2008). *An Assessment of the SBIR Program*. Washington, DC: The National Academies Press.
- Yin, R. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks: Sage Publications.
- Yli-Renko, H., Autio, E. and Sapienza, H. J. (2001). Social Capital, Knowledge Acquisition, and Knowledge Exploitation in Young Technology-Based Firms. *Strategic Management Journal*, 22(6/7), 587-613.

¹ Exception include Mian (1996) and Chan & Lau (2004) who provide different operationalizations of incubation. Yet Mian did not include intangible services such as coaching or venture capital as part of the analysis; Chan & Lau assess jointly incubators managers, graduate firms and tenants on their perception of success factors of university based incubators.