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Incubators as Tools for Entrepreneurship Promotion in Developing Countries

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Incubators as Tools for Entrepreneurship Promotion in Developing Countries

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Abstract

This paper reviews the literature on incubators in developed and developing countries. We show that the concept of incubators has evolved in time according to market and firm needs. Contemporary successful incubators are profit-oriented, provide a wide range of services, focus more on intangible business services, and employ qualified managers and support staff. By drawing lessons from country experiences we assess the appropriateness of incubators as a tool for entrepreneurship promotion in developing countries. The main weaknesses of incubators in developing countries are: (i) focus on tangible services rather than intangible services, (ii) dependence on government, (iii) lack of management and qualified personnel, (iv) lack of incubator planning and creativeness in solving problems. Most successful incubators display a creative and innovative character in approaching problems of tenant companies. This is of course correlated with the quality of the incubator management staff. Moreover, incubators reflect the institutional set-up, creativity, and policy innovativeness in a society. Therefore policy on incubators should be well-integrated with other policies for entrepreneurship promotion and economic development, such as education and institutional deregulation.

Keywords: incubators, developing countries, technology

JEL classification: M13, O31, O32

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Incubators encourage firms to become innovative and competitive. Such a mission can be pursued only if incubators themselves become competitive, business-oriented, and innovative.

ANPROTEC	National Advanced Technology Enterprise Promoter Entity
BDS	Business development services
BIC	Business innovation centre
CPI	Corporate private incubator
EDC	Entrepreneurship development cell
EU	European Union
GDP	Gross domestic product
IASP	International Association of Science Parks
ICT	Information and communication technology
IPI	Independent private incubator
IPR	Intellectual property rights
KOSGEB	Small and medium enterprises development organization
MOST	Ministry of Science and Technology
NBIA	National Business Incubation Association
NITS	Núcleos de Inovação Tecnológica
NSTED	National Science and Technology Entrepreneurship Development Board
PACTI	Industry Technological Training Support Programme
PNI	National incubation support program
R&D	Research and development
SEBRAE	Micro and small business support services
S&T	Science and technology
SME	Small and medium enterprise
STEP	Entrepreneurs Park
TBI	Technology business incubator
TEKMER	Technology Development Centres
TORCH	High Technology Industry Development Centre
UBI	University business incubator
UK	United Kingdom
UN	United Nations
US	United States
URP	University research park

1 Introduction

Researchers, industry experts, and government officials increasingly highlight the role that small and medium enterprises (SMEs) play in creating income and employment. Because of their flexible structure SMEs quickly adapt to changes in the economic environment and technology and as such small firms are the cornerstone in policymaking regarding new venture and job creation. For instance, about 94 per cent of all firms are small (<100 employees) in the United Kingdom (UK) and Japan (Doi and Cowling 1998); 93 per cent of all European Union (EU) firms have less than 10 employees (European Commission 2000); Chinese small firms account for about 90 per cent of all firms and about 67 per cent of all firms with any Science and Technology (S&T) activity (Lundin et al. 2006); micro enterprises (< 10 employees) make up 96 per cent of the all firms and employ over 45 per cent of the economically active population in Peru (Jäckle and Li 2006). Many politicians believe and economists have the intuition that new possibilities for growth, innovation, and job creation will come from new ventures (Wennekers and Thurik 1999). However, small and new ventures have several disadvantages that most entrepreneurs face. They cannot benefit from scale economies both from the output and input side. Small size is an important constraint for process and product innovations, which are the core of recent competitiveness (European Commission 2001). Moreover, difficulties in gaining access to tangible and intangible resources, limited access to scientific knowledge, poor management skills, and lack of know-how hamper survival rates among (high tech) new ventures (Allen and Rahman 1985; Smilor and Gill 1986; Miller and Cote 1987; Nowak and Grantham 2000; Gassman and Becker 2006; Peters et al. 2004)¹. These drawbacks that are common to entrepreneurs and new ventures in most developed countries are exacerbated in developing countries due to additional impeding factors, such as lack of human capital, high macroeconomic volatility, and poor functioning formal institutions.

Incubators provide an attractive framework to practitioners in dealing with the difficulties in the process of entrepreneurship summarized above. They can be considered as a remedy for the disadvantages that small and new firms encounter by providing numerous business support services and they are useful in fostering technological innovation and industrial renewal (Allen and Rahman 1985; Smilor and Gill 1986; Allen and McCluskey 1990; Mian 1996a). They can be viewed as a mechanism (i) to support regional development through job creation (Allen and Levine 1986; Mian 1997; Thierstein and Wilhelm 2001; Roper 1999), (ii) for new high tech venture creation, technological entrepreneurship, commercialization, and transfer of technology (Mian 1994, 1997; Phillips 2002; McAdam and McAdam 2008), (iii) an initiative to deal with market failures relating to knowledge and other inputs of innovative process (Colombo and Delmastro 2002). Studies have showed that one third of new firms do not survive the third year and about 60 per cent do not survive the seventh year (OECD 2002). This number considerably falls to 15–20 per cent among incubator tenants (Bruton 1998; Adegbite 2001; Lalkaka 2002; Abetti 2004). For these reasons many countries have increasingly been engaged in establishing incubators. It is estimated that there are around 3500 incubators worldwide, one third are located

¹ Most of the problems that entrepreneurs face are underpinned in the market failure argument which justifies the need for incubators. However incubators can be driven by other theoretical approaches such as the real options view and the resource based view. For a summary of these different approaches see Hackett and Dilts (2004a).

in North America, about 30 per cent in Europe, and the remaining 40 per cent in developing countries of which most are in Brazil and China.

This paper's purpose is to discuss the rationale for the adoption of incubators in developing countries. As such the discussion elaborates questions, like what particular benefits can incubators provide for entrepreneurs and small companies? What factors (resources) are important in a successful incubator model? Can developing countries sufficiently harness tangible and intangible resources for the success of incubators?

The structure of the paper is as follows. Section 2 provides a thorough review of the literature on the impact of incubators on entrepreneurship and economic development. We focus on the indicators that are used to assess the performance of incubators and summarize the evaluation results that have been conducted so far. This section also provides a novel typology of incubators and argues that the concept of incubators has evolved over time contrary to what current literature claims (e.g. Grimaldi and Grandi 2005). In Section 3, we provide country case studies to illustrate different approaches in developing countries. In Section 4 we briefly discuss the requirements for successful incubation in developing countries. Section 5 evaluates the overall appropriateness of the incubator model for developing countries and identifies questions for further research.

2 Review of the incubators literature

It is appropriate to classify the growing literature on incubators into two broad categories. The first set of studies deals with the theory of the incubators and the incubator model and seeks answers to questions, such as how incubators are formed, what their aims are, how they are planned, and how they are managed (e.g. Similor and Gill 1986; Allen and McCluskey 1990; Nowak and Grantham 2000; Grimaldi and Grandi 2005; Aernoudt 2004; Leblebici and Shah 2004; Becker and Gassmann 2006). The second set of studies evaluates incubators regarding certain factors that define success indicators. These papers mainly focus on whether incubators have achieved their economic and technological goals in supporting entrepreneurs and small companies and their wider goals in encouraging creation of new firms and jobs and establishing an entrepreneurial society (e.g. Mian 1996a; Colombo and Delmastro 2002; Peters et al. 2004; Rothaermel and Thursby 2005a, 2005b; Aerts et al. 2007; McAdam and McAdam 2008). Section 2.1 focuses on the former set. The latter is discussed in section 2.2.

2.1 Brief history and typology of incubators

The main focus in this study is the concept of (technology) incubators. There are many derivatives that spun out from the concept of science parks and incubators. For this reason it is better to define both at this stage. The International Association of Science Parks (IASP) defines a science park as: '...an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions'. To enable these goals, a science park (i) stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies, and markets, (ii) facilitates the creation and growth of innovation-based companies through incubation and spin-off processes, and (iii) provides other

value-added services together with high quality space and facilities. For instance, University Research Park (URP) is a derivative of this concept. The main differences are the contractual and/or formal ownership or operational relationship with a university and the focus on transfer of technology and promotion of R&D under university-industry partnership. On the other hand National Business Incubation Association (NBIA) defines business incubation as ‘...a dynamic process of business enterprise development which: (i) nurture young firms; help them to survive and grow during the start-up period when they are most vulnerable, (ii) provide hands-on management assistance, access to financing and orchestrated exposure to critical business or technical support services, and (iii) offer entrepreneurial firms shared office services, access to equipment, flexible leases, and expandable space—all under one roof’. The most important element that identifies incubators from the rest of similar establishments is that, it provides high level business support/management services under one roof for entrepreneurs and new ventures that have (medium) high level technological focus to create synergy (e.g. Allen and McCluskey 1990; Aerts et al. 2007).²

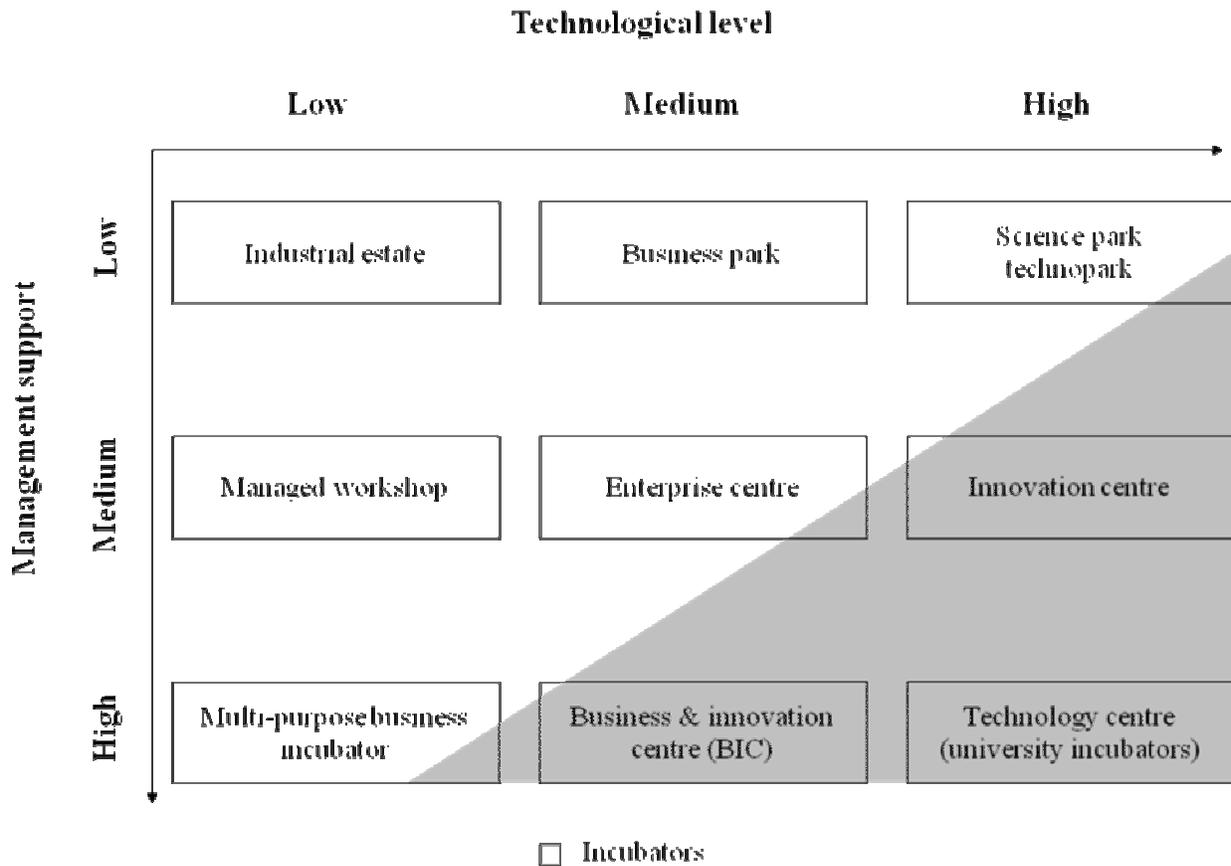
As stated before, this paper covers the literature on incubators. We do not provide detailed definitions of other forms, such as technopark, industrial parks, technopolis, etc. All these establishments share similar characteristics and vary on relatively minor points. The differences between various definitions and forms could easily be analysed with the help of Figure 1 where different derivatives are placed on a continuum from low to high management support services and from low to high technological level. Most of the contemporary incubators originate from multipurpose business incubators and business centres that have been established in the 1970s. These days incubators have a highly selective admission criteria and provide hands-on business and management assistance for new ventures that are higher in technological continuum and have a high potential to generate revenue and create jobs. The incubator, as understood in the current terminology, is represented in the gray shaded area in Figure 1.

2.1.1 Development of the incubation idea

It is widely accepted that the first incubator was created by Joseph Mancuso in Batavia, New York in 1957 on a former Massey–Ferguson facility (Leblebici and Shah 2004; O’Neal 2005). The incubator movement was initiated by the managers of the incubators in the United States (US) through a series of conferences in the mid-1980s sponsored by the US Small Business Administration (Allen and McCluskey 1990). Incubators differed from the existing industrial parks and estates as the focus shifted away from real estate development and subsidized rents to value-added business services (O’Neal 2005). These developments finally led to the foundation of NBIA in 1985, with 40 founding members. Figure 2 depicts the number of incubators established in the developed and developing world in five-year intervals starting from the 1960s.

² This is also what differentiates incubators from business development services (BDS) such as training, capacity building, fund raising, etc. BDS could be provided by any company or institution for profit or not for-profit. However providing these services under one roof is only a tool for incubators to achieve new venture and technology creation and create synergies.

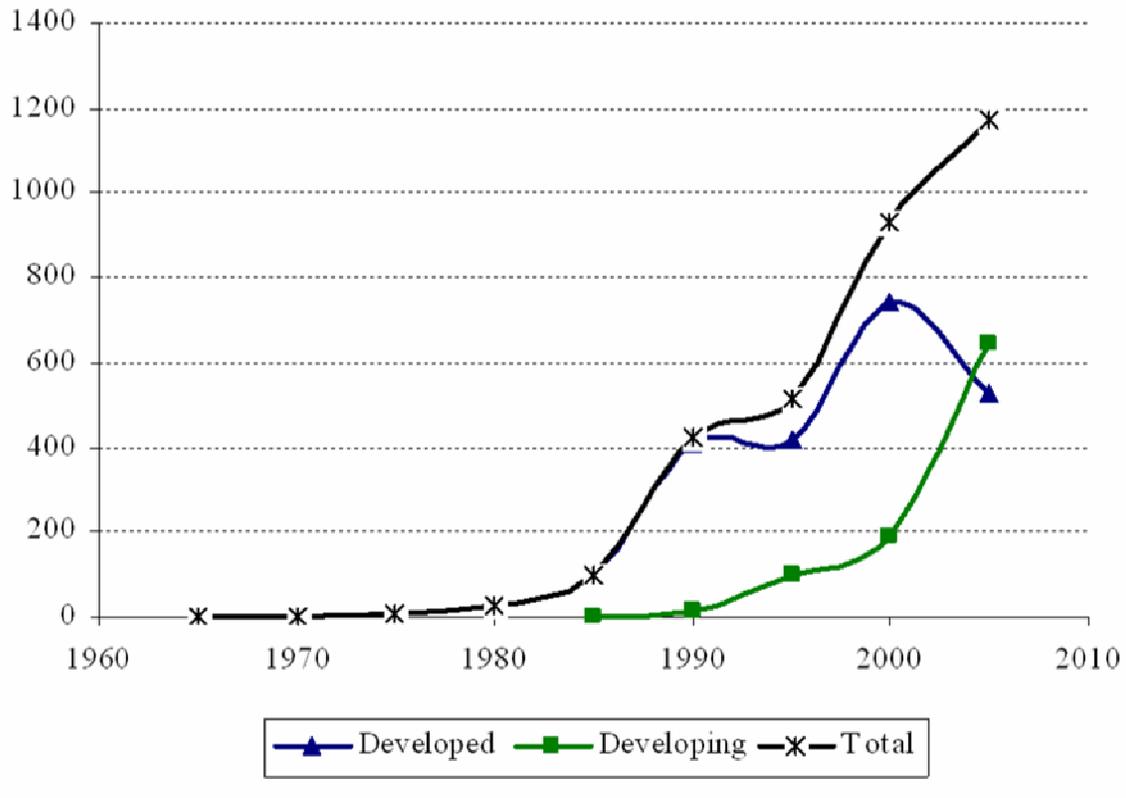
Figure 1: Identifying incubators among other forms of similar establishments



Source: European Commission (2002): 6.

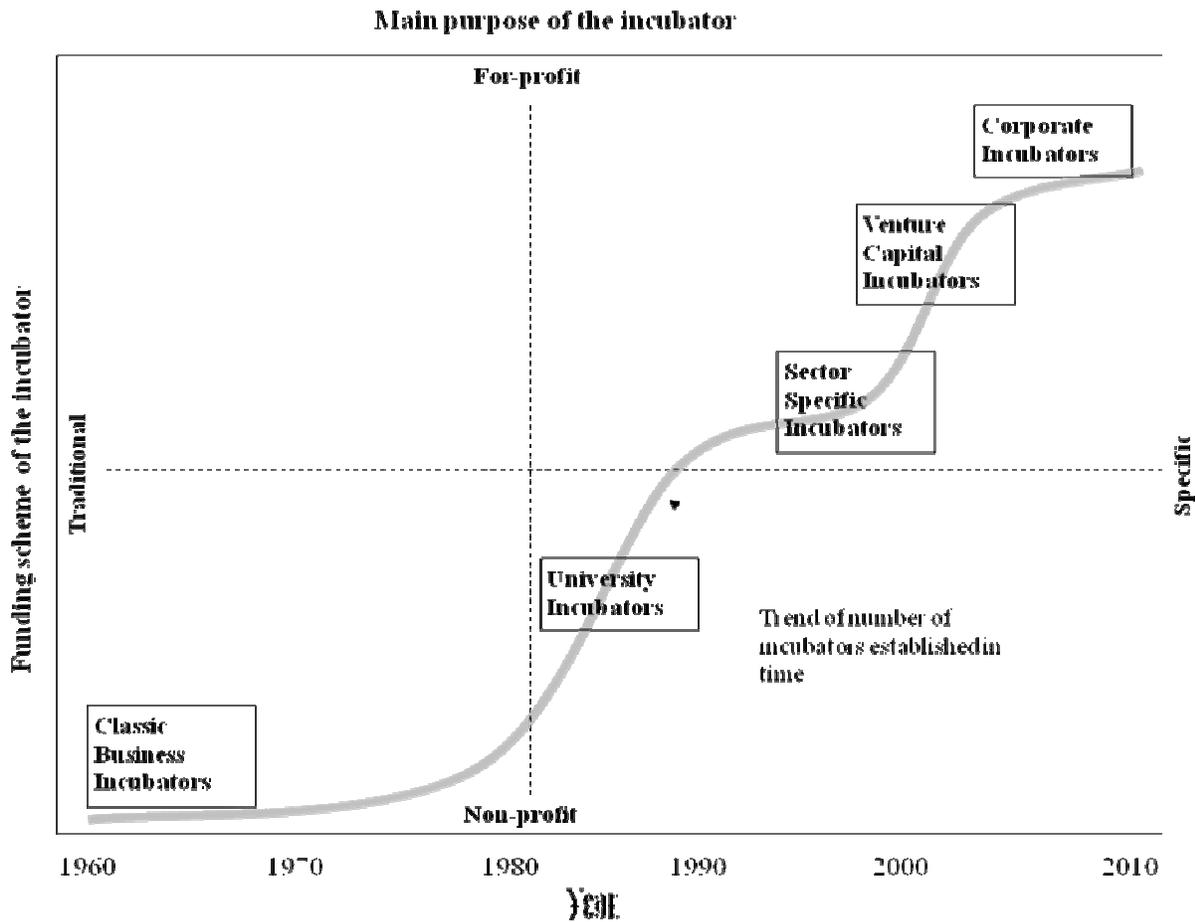
One can categorize incubators either according to their funding scheme (sponsors) (e.g. Becker and Gassmann 2006) or according to their main objectives (e.g. Aernoudt 2004). Despite numerous typologies in a similar manner, there is still no theoretical study that aims at merging these two seemingly separate typologies. This paper makes an attempt in this direction. The basic framework is presented in Figure 3. The vertical dimension locates incubators on a continuum from non-profit to for-profit. The horizontal scale represents incubator objectives ranging from traditional (new venture creation, job creation, economic development) to specific (transfer of technology, sector-specific objectives). The gray line represents the total number of incubators established through time as depicted in Figure 2. Leblebici and Shah (2004) identify the period 1960–84 as the origin of the industry.

Figure 2: Number of incubators established in developed and developing world



First generation incubators aimed at job creation and new venture creation that are catalysts for economic development (Hackett and Dilts 2004b; Aernoudt 2004; Leblebici and Shah 2004). For instance, the first phase of growth (10 per cent yearly growth rate on average) of the incubators in the US between 1984 and 1990 was a reflection of the economic downturn of the US economy. After a slow diffusion of incubators from the 1960s to 1984, during the first phase of growth, massive public funding was directed to incubators as a remedy for unemployment and firm failure (Leblebici and Shah 2004). The movement toward creating university technology incubators and the favourable image of incubators enhanced this trend. The number of incubators rose to 400 only in the US and industry experts estimated about 1000 incubators around the world by 1990 (Allen and McCluskey 1990). These factors played quite an important role in sustaining incubators as an important tool for promoting entrepreneurship. In this period most incubators were publicly financed and most aim at economic development by industrial renewal and creating jobs.

Figure 3: Typology and the evolution of incubators



The incubation industry reached a level of maturity in the following five-year period. In the mid-1990s the number of newly established incubators in developed countries slowed down. This was mainly because of the problems in the incubation process. Most incubators were providing similar low quality management advice and business support services without any exit restrictions. The credibility of incubators was restored in the second half of the 1990s which could be labelled as a deepening of the industry. The development of the new high tech economy stimulated this process and led to the creation of sector-specific incubators (Hackett and Dilts 2004b) and virtual internet incubators that aimed at stimulating networking among high tech start-ups (e.g. Nowak and Grantham 2000).³ Another factor that enhanced this second growth wave was the adoption of the concept in many developing countries such as China, Brazil, India, Malaysia, and Turkey as can be seen in Figure 2. One third of the existing incubators in developing countries were established from the early 1990s to 2000. It is now estimated that

³ There are three other factors that played a role in this trend as suggested by Hackett and Dilts (2004b): (i) the Bayh-Dole Act in the US that reduced the risk and uncertainty of commercializing publicly funded research, (ii) the Intellectual Property Rights (IPR) system and the recognition of the role of R&D and innovation, and (iii) the commercialization of bio-medical research. The collapse of the dot.com market slowed this trend and wiped off virtual incubators. However, the general trend in the industry was not affected from this development.

around 40 per cent of all existing incubators are in developing countries (European Commission 2002).

2.1.2 Financing incubators

The next generation incubators are expected to be for-profit and sector-specific. The founder and the first director of the NBIA, Carlos Morales, argues that for-profit incubators are expected to grow to about half the total number of all incubators in the coming years (paraphrased in Nowak and Grantham 2000). Becker and Gassmann (2006) show the increasing trend of corporate incubators with a thorough typology of for-profit incubators. For-profit incubators could be organized as independent entities or they could operate under a parent corporation. Their major purpose is to generate a revenue for their owners which could be done in various ways such as charging fees for services provided or the incubator could invest in the businesses of individual tenants. For-profit incubators also support corporations in achieving technological as well as economic goals such as developing innovative products and processes. Given the market failure argument behind establishing incubators the label 'for-profit' might sound odd. However, the idea of for-profit incubators is compatible with the market failure argument. New and small ventures have problems to reach resources, funding, and knowledge. Firms may select to receive assistance for specialized services provided by an incubator but in return have to give up shares or pay for these services. In this case all the services are provided and organized within an incubator and the only difference is that services have monetary costs. The benchmarking study in EU countries shows that for-profit incubators constitute about 25 per cent of all incubators in Europe, ranging from 38 per cent in Italy to 18 per cent in France (European Commission 2002). In the US this number is about 15–20 per cent.

In developing countries most incubators are still funded by the government and the for-profit idea is yet to develop. There is no clear cut information on how much governments spend on incubators because most funding available for incubator promotion is integrated to other major funding programmes.⁴ For instance, many incubators are supported by the EU through EU structural funds and regional development funds. International institutions such as the World Bank and UNDP have only a modest role in financing incubators in the developing world.⁵ However, a recent initiative led to the establishment of *infoDev* managed by the World Bank specifically aiming at the promotion and establishment of incubators in developing countries. The programme aims at stimulating innovation in developing countries by establishing incubators that assist new technology-oriented ventures especially in Information and Communication Technology (ICT), (Scaramuzzi 2002).⁶ Section 4 gives more information regarding how incubators are financed in developing countries.

⁴ For instance, in the UK £50 million are yearly available via the Government National Innovation Fund. However, how much exactly is spent on incubators is not clearly documented. In a recent speech the new US president Obama declared that US\$250 million will be invested in business incubation each year.

⁵ It is known that UNDP has supported incubator projects in several countries, including Turkey, Romania, Egypt, Uzbekistan, Colombia, and Pakistan. Regional development banks such as the Asian Development Bank also supported incubation projects for instance in the Kyrgyz Republic.

⁶ For more information and a list of projects that are supported by *InfoDev* see <http://www.infoDev.org/businessincubation>

2.1.3 Incubation is an evolutionary idea

As stressed earlier this paper suggests that the definition and the forms of incubators have evolved through time according to the need of the firms and the economic climate. Figure 3 reflects this with a rough correlation between the introduction of new incubator models and the number of incubators established each year. In this sense we contradict to Grimaldi and Grandi (2005) who identified two incubating models comparing four types of incubators: Business Innovation Centres (BICs), University Business Incubators (UBIs), Independent Private Incubators (IPIs), and Corporate Private Incubators (CPIs). Model 1 aims at reducing start-up costs for new ventures anchored in old economy targeting local markets by providing various business support services. Model 2, on the other hand, aims at accelerating start-up process of aggressive, high value-added, high tech companies by providing both technological and management assistance. They argue that the emergence of the second model does not represent a linear evolving process or an improvement of Model 1. Our view is more in line with Leblebici and Shah (2004) who argue in narrative theory perspective that the concept of non-profit incubators in the 1970s has been re-invented in the late 1990s for the new techno era. The long term evolution of incubators reveals that the concept has evolved from a simple tool for economic development into a high tech, sector-specific and increasingly profit-oriented tool to promote entrepreneurship.

2.2 Value-added contributions of incubators

There are a number of studies in the literature that evaluate the usefulness of the incubators by assessing their value-added contributions. Appendix table A1 lists scholarly articles that assess incubator performance for various countries. One fact that makes the assessment challenging is the selection of appropriate criteria. On what grounds can an incubator be labelled as successful? Answering this question requires a brief summary of the aims of establishing incubators. Incubators are established and supported for different reasons:

1. *To reduce start-up and early stage operational costs, and the risk of doing business by providing a protective environment for start-ups.* (Similor and Gill 1986; Allen and Rahman 1985; Allen and McCluskey 1990; Lalkaka 2002; Hannon 2005). Most incubators offer managerial and administrative assistance as well as physical infrastructure to their tenants. Previous studies showed that incubator services are important for tenant firms (Mian 1997). For instance, Adegbite (2001) argues that one of the main reasons behind the low performance of Nigerian incubators is poor and insufficient incubator services. Especially managerial assistance could be an asset to entrepreneurs who lack managerial skills.
2. *As a means of regional (technology) development policy.* Incubators were used as an effective policy tool in various countries for reducing unemployment, new job and venture creation. See for instance, Thierstein and Wilhelm (2001) for the German case, Frenkel et al., (2008) and Roper (1999) for the Israeli case and Abetti (2004) for the case of Finland.
3. *Enhancing university-industry collaboration via university incubators.* Especially in the mid-1990s incubators were established with the aim of increasing commercialization of research and transfer of technology. See for instance, Mian (1996a, 1996b, 1997);

Phillips (2002) and Rothaermel and Thursby (2005a, 2005b) for the US case; McAdam and McAdam (2008) for the UK and Ireland. University incubators also serve as a role model for university students and act as an in-house (part-time) employment opportunity for students (see Akçomak and Taymaz (2007) for the Turkish case).

4. *Stimulating networking among firms* (e.g. Sweeney 1987; Allen and McCluskey 1990; McAdam et al. 2006). Tenant firms and entrepreneurs can benefit from peer groups effects. The idea is based on synergies among entrepreneurs who share similar problems, businesses and work environment. For instance, Hansen et al. (2000) argue that among the existing incubator models, the networked incubator (incubators in which networking is organized and deliberately fostered) is likely to be more successful. In a similar manner, Hughes et al. (2007) argue that firms' success is related to strategic networking not to their mere presence in an incubator. Tenant firms network to access resources and to acquire knowledge.
5. *Reversing or preventing brain drain*. For instance, in Israel high tech incubators were effectively used as a tool for absorbing immigration (Roper 1999; Frenkel et al. 2008). Between 1989 and 1995 more than 11.000 high skilled scientists and engineers emigrated from the former Soviet Union some of which were employed in incubator firms. Incubators can also help scientists to commercialize their work and to increase the financial means of scientific research. For instance, one particular goal of the Zelenograd Scientific and Technology Park in Russia is to make scientific work financially worth while to gain scientists back. Russian science has faced a within country 'brain drain' in the sense that most Russian scholars gave up scientific research for more profitable non-scientific work such as managing western retail stores in Moscow (Bruton 1998). Similarly, China established 'Innovation Parks for Returned Scholars' to attract talented researchers and students who live abroad. Various subsidies are provided for returned scholars to set up high technology-oriented businesses in China (Chandra 2007).

Table 1: Summary findings of the literature assessing incubator performance

	Survival	Sales growth	Employment growth	Innovativeness
Physical infrastructure	+	+ / O	O	O
Management support	+ / O	O	O	O
Administrative support	+ / O	O	O	O
Incubator image	+	+ / O / -	O	O
Financial support	+ / O	+ / O	+ / O	O
Networking with university	O	O	O	+ / O
Networking with business	+ / O	+ / O	+ / O	+ / O

Notes: (+) positive effect, (-) negative effect, (O) no particular effect.

By looking at the above list of diversified goals it is not easy to assess incubator success. One issue, we have mentioned earlier, is the criteria for performance. Is it survival of the firm, generation of employment, growth of sales revenue, or innovativeness? Such indicators have been employed previously in assessing the performance of incubator tenants (see Table 1). So far there has not been a consensus among researchers regarding which indicators to focus on. Another related issue is the goals of the stakeholders. Different parties with different objectives are involved in an incubator and a success indicator for one stakeholder may not be an indicator of success for another one. For instance, in a university incubator, the survival rate is an important concern for the incubator management, therefore, a high survival rate can be considered as a success criterion. However, if this is not accompanied by an increase in the employment of graduates of the university in which the incubator is located, it may be considered as a failure from the university's point of view. Moreover, since the opportunity cost of incubation is unknown it is very hard to determine whether an incubator is successful or not. Given the above goals we summarize the findings of the literature assessing the performance of incubators in Table 1.

The findings of this literature for various countries are presented in Appendix table A1. We, therefore, highlight several points that have emerged from these studies. First, most evaluation studies are conducted in developed countries. There are only a few studies that quantitatively evaluate incubator experience in developing countries (e.g. Hsu et al. 2003; Akçomak and Taymaz 2007). Second, qualitative (case) studies tend to be more optimistic regarding the usefulness of incubators. Most studies argue that lowering start-up costs and providing assistance increase the likelihood of survival and create ventures and jobs. However, this is only one part of the study as no such information is collected concerning what would otherwise have happened if the entrepreneurs decided not to locate the firm in an incubator. Statistics show that survival rates are much lower in general for off-incubator firms. However, some studies report evidence that do not support overall statistics. For instance, in Germany it was found that only 3 per cent of firm owners would not have started their business without the existence of incubators (Tamasy 2007). Similarly, among a sample of 48 incubator firms only two stated that the company would have not existed if it were not located in an incubator (Akçomak and Taymaz 2007). On the other hand quantitative studies tend to report mixed evidence on performance indicators such as firm sales and employment growth and innovativeness. Researchers generally agree that incubators do have an impact on employment and sales growth. However, incubators are not found to be stimulating innovativeness in terms of patents, product, and process innovation. For instance, in a study to assess the technology transfer and commercialization of research arguments Phillips (2002) found that technology business incubators are only marginally beneficial and the level of technology transfer is much lower than expected. Third, there are only a couple of studies that pursued longitudinal analysis (Rothaermel and Thursby 2005a, 2005b). To assess the impact of incubators thoroughly, information on after-incubation is crucial. Unfortunately data availability significantly hinders this type of analysis. Finally, almost all studies assessing the performance of incubators are based on assessing firms rather than the incubator itself. However, the differences between firms within an incubator and between on- and off-incubator could reflect the motivations of the firms as well as the benefits of an incubator (Löfsten and Lindelöf 2002).

For instance, it may be the case that incubated firms perform better regarding economic or technological indicators because entrepreneurs of these firms might be more qualified (e.g. Pena 2004).

3 Country cases

This section provides experiences of four developing countries in business incubation. We have chosen China and Brazil because these two countries together host about 1000 incubators and are ranked third and fourth respectively (in terms of number of incubators) following the US and Germany. To match China and Brazil we have selected India and Turkey. China and India are two emerging developing countries that are comparable in terms of their size, GDP growth, and potential they provide for future development. On the other hand Brazil and Turkey are accepted to be two promising emerging market economies and display certain similarities such as institutional landscape towards democracy, fully functioning market economy, macroeconomic instability, etc. All four countries (i) have to promote entrepreneurial risk-taking culture, (ii) have inhibiting institutional obstacles to entrepreneurship, (iii) have underdeveloped venture capital markets, and (iv) face similar difficulties in managing incubators. Given these, the evolution of incubators, their goals, incubation models and financing structure display considerable differences among countries. Appendix table A2 summarizes the incubation experience in four countries in comparison to the US.

3.1 Brazil

Brazil has more than 30 years of experience in incubation. The Brazilian incubator movement took off in the 1980s with the collapse of the military regime and the emergence of democratic institutions. The first incubator was established in 1986 and within 10 years this number increased to 40. The growth of the incubation business was rather slow in the first decade mainly due to inconsistencies between the national programme and the commitments to grow. According to an early assessment by Lalkaka and Bishop (1996) most incubators were located in a university or a research institute and more than 80 per cent of the tenants were spin-offs from academia and other companies. Universities played a vital role in establishing incubators. More importantly, they promoted the idea of incubation until incubators were accepted as a tool to promote entrepreneurship. In this sense one can argue that incubators in Brazil flourish as a product of a bottom-up process (Etzkowitz et al. 2005; Chandra 2007). At this initial stage the main weaknesses of the incubators were poor relations with the academic personnel and insufficient business support services. There were cases where incubators did not provide business support and consultancy services at all. Moreover some incubators provided very poor physical and operational infrastructure. These problems were exacerbated by institutional constraints to entrepreneurship, such as bureaucracy and insufficient risk-capital funding. Because of such deficiencies the idea of incubators as a tool to promote entrepreneurship emerged and developed slowly complementary to other instruments, such as Micro and Small Business Support Services (SEBRAE) that has various support mechanisms for small firms; Núcleos de Inovação Tecnológica (NITS) that aims to assist researchers in the transfer of technology and intellectual property; and the Ministry of Science of Technology that coordinated activities to provide small scale financial support and venture funds for small and new technology-oriented ventures. The need for a national business incubation strategy made the

Industry Technological Training Support Programme (PACTI) to cooperate with the National Advanced Technology Enterprise Promoter Entity (ANPROTEC) to establish a sustainable strategy to support business incubation. The incubation industry lacked a national strategy for quite a long time. This deficiency, contrary to expectations, established a flexible environment that produced different incubator models for different aims and helped Brazil to create a less costly development model (Etzkowitz et al. 2005). These efforts in the mid-1990s supporting the concept of incubation paid off quickly. Between 1995 and 1997, 33 new incubators were established which outnumbered the cumulative number of incubators that were established since 1986. There are now about 400 incubators operating in Brazil. More than half of these incubators are technology business incubators. According to Almeida (2005) in 2003 there were over 1000 tenant firms with more than 15.000 employees.⁷ The latest figures from ANPROTEC show that the mortality rate of incubated firms is 7 per cent compared to about 50 per cent within new ventures that are not incubated (Oliveira and Menck 2008).

Incubators in Brazil are generally linked to universities and financed by various governmental and non-governmental sources, such as the National Incubation Support Program (PNI) that supports the creation of new incubators and assists the existing ones to expand, private companies and the Federation of Industries. For instance, the Federation of Industries in São Paulo is actively involved in operating about 10 incubators (Chandra 2007). The active contribution of various actors (for-profit, non-profit, and universities) is a distinct feature of Brazilian incubators because in most other developing countries incubators are mainly backed by the government. Therefore incubators in Brazil are reflections of synergies (a triple helix) among the university, industry, and the government (Etzkowitz et al. 2005). This synergy even had repercussions indirectly on innovation in general. For instance, the Innovation Law in 2005 that significantly improved transfer of technology and commercialization of research is an indirect product of this synergy.

Another interesting feature of incubators in Brazil is the innovative approaches to incubation models. Local needs and the attempts to alleviate poverty shaped the emergence of different incubators and incubation models significantly. Many incubators were established as a remedy to unemployment aiming solely at job creation especially in traditional sectors such as agricultural equipment, furniture, and textile. There are even incubators that are specialized to foster entrepreneurship in cultural activities such as music, art, and cinema industry (Scaramuzzi 2002). Recently, PNI has initiated a very interesting programme that aims at sharing information, experience and expertise among incubators. According to this programme older and reputable incubators are asked to help smaller incubators (Chandra 2007). In other words, older incubators will incubate younger incubators. There are various other interesting and innovative programmes and schemes concerning incubation in Brazil.

3.2 China

China is a relatively newcomer to the incubation business. The first incubators were established in the late 1980s but the growth of the industry has been tremendous. In the first ten years 100 incubators were established incubating about 1400 firms. The recent estimates show that there

⁷ ANPROTEC webpage <http://www.anprotec.org.br/>

are now more than 500 incubators in China sheltering over 600,000 employees (Chandra 2007). China has displayed an outstanding success regarding the expansion of the incubation programme. As in most other cases the government played a predominant role. Incubators in China offer services such as low cost office space, business support services and networking opportunities. However they are much bigger in size compared to their counterparts elsewhere (Scaramuzzi 2002). An average incubator shelters 60 to 70 firms and it is not surprising to see incubators with more than 150 new ventures (Harwit 2002).

The entrepreneurs in China, like in any other developing country, lack financial resources and managerial skills. However, in the Chinese case there are two additional barriers to entrepreneurship: (i) the financial and institutional system which is solely dominated by the government, (ii) the risk-averse cultural values. The risk-averse culture not only inhibits new venture formation but also affects seed fund decisions of the banking and financial sector. The Chinese incubators have to overcome typical barriers to entrepreneurship and on top of that have a mission to transform societal values towards a risk-taking entrepreneurial culture. In this sense the Chinese government used incubators as a policy instrument to create markets especially for high technology products. Incubators in China are financially supported by the government via the Torch High Technology Industry Development Center (TORCH), under the Ministry of Science and Technology (MOST). TORCH is heavily involved not only in constructing incubators with modern infrastructure and equipment but also in operating these incubators. The government provides generous seed capital funds for start-ups and funds for R&D and innovation for small and new technology-oriented firms. But the main reason behind locating firms in incubators is the low cost services such as low rent, which can be 50 per cent below market rent and discounts on infrastructure (Harwit 2002).

What makes the Chinese case special is the emphasis on innovation and technology. The incubation industry is strategically designed to play role in China's transition to a high technology-driven market economy (Harwit 2002). As an illustration, the incubator policy was a core ingredient in the 10th five year plan (2001–05) of MOST. US\$6 million was provided only for constructing incubators (Chandra 2007). As of 2002 about 40 per cent of the high tech firms in development areas were housed in incubators (Harwit 2002). The Chinese experience lacks sound and quantitative assessment but the estimates show that the transformation rate of scientific achievements into production increased on average from 30 per cent to 70 per cent. Moreover the survival of high tech ventures increased from 30 per cent to 80 per cent because of incubation. Currently there are various types of incubators with different models some of which are innovative in set-up, such as the incubators for returned overseas scholars that aim to provide finance and assistance for scholars who live abroad but who plan to implement their creative ideas in China (Ling et al. 2007).

A particular weakness of the Chinese incubation programme is the dependence on the government. As stressed above incubators are financed and managed to a greater extent by the government and this dependency hinders self-sufficiency of incubators in China. Incubators are required to reach self-sufficiency in three years but they seldom accomplish this target. In some cases this dependency even affects the market orientation and behaviour of tenant firms. Because the exit criterion is not implemented strictly most firms tend to linger around and continue their risk-averse structure (Harwit 2002; Chandra 2007). Moreover, incubators who depend on the

government are found to be less active in providing a variety of internal and external financial services (Chandra et al. 2007). Another weakness of the programme is the focus on the 'hardware' aspect (Lalkaka 2002). The government has invested a massive US\$1.6 billion to construct incubators. However the intangible services that are provided by the incubators are poor in quality and management skills of the managers—most of who are government officials and have no market experience—are low. The size of the incubators is another factor that reduces the quality of the services. Harwit (2002) reports cases where this poses serious problems as it is not easy to provide similar concern for all tenants if the incubator has about 100 tenants.

3.3 India

India has about 8 scientists and technical personnel per 1000 population. This number is very low when compared to countries such as Russia (113) and South Korea (22). However, the absolute numbers are more revealing to understand the potential of India: there are about 10 million technical personnel which is almost 10 times bigger than most countries. Starting from the 1950s the Indian government has initiated several programmes and policies to leverage this talent, such as establishing prominent universities and research institutes, providing tax exemptions to new ventures, improving financial and venture capital markets, and the establishment of National Science and Technology Entrepreneurship Development Board (NSTED) in 1982. However, it is still not possible to argue that India is optimally benefiting from this large talent pool. It is true that India has build a massive science, technology, and research network composed of hundreds of universities, laboratories, and institutes but the reflection of this to entrepreneurship and new venture creation has surprisingly been limited. Most entrepreneurs lack necessary capabilities to manage a business, have problems in networking even at the regional level and last, but not least, lack financial resources. Despite improvements, the financial institutions provide capital on stringent conditions, such as high lending interest rates and demand of 110 per cent collateral security. This leads to a financing gap which discourages entrepreneurs. Incubators could therefore be a stimulus in turning talents and new ideas in to new ventures.

The incubator movement in India took off in the late 1980s as a complementary policy tool aiming at promoting entrepreneurship and stimulating new venture creation. The take off in the 1980s was slow because the first incubators were financed by the United Nations (UN) but lacked government support (Lalkaka 2002). This trend has been continuing since then and it seems that the incubator movement is not picking up in India. Currently there are about 50 incubators in India (15 of which are Technology Business Incubators) when compared to about 400 incubators in China and about 300 in South Korea. Higher education institutes are hesitant to support incubators and it is not easy to raise public awareness on the role that incubators could play. There are recent initiatives of the Department of Science and Technology together with other programmes like Entrepreneurship Development Cell (EDC) and Science and Technology Entrepreneurs Park (STEP) to set up more incubators (Saravanan 2007). These recent initiatives proposed by the government are (i) incubation funds that provide seed money to entrepreneurs, (ii) tax exemptions for services provided by technology and business incubators, (iii) priorities for incubated enterprises in financial markets, (iv) supporting the establishment of incubators in the fields of chemicals and biotechnology (implemented by the Department of Biotechnology). It is best to complement these efforts with campaigns that promote the concept of incubators. For

instance, the global forum on business incubation commenced in Hyderabad in 2006 hosting 300 practitioners from 60 different countries which was a successful promotion attempt to raise awareness.

Beside the government of India and the UN, the World Bank is also active in the incubation industry. *InfoDev*, a partnership of international development agencies, have been financially supporting five incubators countrywide: (i) IndiaCo (Mumbai), (ii) TREC-STEP (Tiruchirappalli), (iii) SRISTI (Ahmadabad), (iv) TeNeT (Chennai), and (v) VIT-TBI (Tellore). The amount of the grant reaches up to US\$1.1 million. Incubators under this scheme function like any other technology business incubator. They offer office space, ICT facilities, and other incubator services to their tenants. Moreover, it is possible in some cases to receive financial assistance in the form of seed funding directly from the incubator (*InfoDev* 2008).

What makes India rather an interesting case is that incubators constitute only a small part in a set of policy instruments to promote entrepreneurship. By means of various different programmes and mechanisms organized by the NSTED more than hundred thousands of people, researchers and students have received training in entrepreneurship since the beginning of the 1990s (Saravanan 2007). By any standards this is a big number and an applauding achievement. There is not a study, to our knowledge, that assesses the achievements of such policy instruments. The estimates and limited evaluation studies show that the incubated firms grow much faster than their non-incubated counterparts and the survival rates is about 80 per cent compared to only about 40 per cent for new ventures that are not incubated.⁸ Effort should be put in conducting sound assessment which could be a valuable asset for practitioners and policymakers worldwide.

3.4 Turkey

SMEs (99 per cent of all firms) possess an important place in the Turkish economy. Having realized this fact the government authorities have employed various policy tools to assist SMEs such as direct financial support, R&D subsidies, and tax allowances. As a policy tool in this direction, the incubator movement in Turkey started in the 1990s with a particular interest in technology business incubators (TBIs). The concept of an incubator was appealing because the risk of establishing and maintaining a high technology business is manifold in an environment characterized by macroeconomic instability such as Turkey.

Incubators in Turkey are established by KOSGEB, which is a non-profit, semi-autonomous organization (under the Ministry of Industry and Trade) with the objective of improving the conditions of SMEs and enhancing their competitive capacity. Within the body of KOSGEB, there are three different schemes that can be identified as an incubator: Enterprise Development Centres that function as traditional incubators, Incubators Without Walls, and Technology Development Centres (TEKMERS) that function as university incubators. TEKMERs aim (i) to help people who are trained in scientific and technological fields to become entrepreneurs, (ii) to foster the creation of new technology-based enterprises, (iii) to foster commercialization of R&D, (iv) to strengthen university-industry cooperation, (v) to assist other policy initiatives that focus on the diversification of regional economic activities.

⁸ From the presentation of R.M.P. Jawahar, Executive Director of Tiruchirappalli Regional Engineering College–Science and Technology Entrepreneurs Park (TREC-STEP). Accessible at <http://www.infodev.org/en/Publication.34.html>

TEKMERS select entrepreneurs/firms after an assessment of their projects on the basis of technological orientation and innovativeness. Therefore the majority of the incubator tenants are limited liability firms that are specialized in computer, software, electronics, medical appliances, and automotives. As of 2008, a total of 650 firms have benefited from incubator services, most of which are new technology-oriented ventures. Currently there are about 40 different types of incubators, 15 of which are technology incubators. Incubators provide office space and necessary supplies and equipment to tenant firms. Moreover firms can benefit from diversified financial assistance initiatives. These include (i) a support (in the form of loan) up to about 120.000 Euros for supplies, equipment, and prototype development, (ii) initiatives ranging from professional consultancy support to rent support, without repayment up to a total of about 30.000 Euros. Apart from these support schemes, firms can take advantage of the facilities provided by the universities where the incubator is located. However, the chief advantage of incubators is that firms receive considerable amount of tax reductions.

In 2003, the performance of incubator firms was evaluated by means of conducting a questionnaire in six incubators in Ankara and Istanbul (Akçomak and Taymaz 2007). The study was based on a matched sample technique, comparing incubator firms with firms located elsewhere in terms of employment growth, sales revenue growth, and innovativeness.⁹ The main findings of the study are summarized below.

The incubator firms were found to perform better than their counterparts located elsewhere regarding employment growth and sales revenue growth. The majority of the on-incubator firms stated an *increase* or *no change* in employment. On the contrary, one-third of off-incubator firms faced a decrease in employment. A considerable part of this increase is due to employment from the local market. For instance, 75 per cent of the firms stated that there is at least one employee who graduated from the university where the firm was located in. Similarly, 29 out of 48 firms have at least one entrepreneur (founder of the firm) who graduated from the university in which the firm is located. This favourable situation also holds for growth in sales revenue. More than 60 per cent of the incubator firms faced an increase in their sales revenue. This ratio was much lower in firms located elsewhere. Unfortunately, the study found no statistically significant difference between on- and off-incubator firms regarding innovation (owning trademarks, patents, product, and process innovation, etc.).

What makes incubator firms more successful in growth of employment and sales revenue? Three factors explain this difference. First, it might be the case that on-incubator entrepreneurs are more qualified which makes the firms they establish more successful. Second, financial opportunities and incubator services provided by the incubator may determine the success. Third, incubator firms are more likely to interact with other firms and universities and therefore can benefit more from network externalities. The findings reveal that entrepreneur characteristics and networking do not explain the differences between on- and off-incubator firms. Incubator firms are better linked to universities, but most of the interaction is in the form of informal contacts

⁹ The study was an attempt to evaluate the early phase of Turkish experience in technology business incubation. Information on 48 on-incubator (60 per cent response rate) and 41 off-incubator firms was collected by face-to-face interviews to compare and to contrast the firms that benefit from incubator services with those that do not. The data set also comprises data regarding 78 on-incubator and 61 off-incubator entrepreneurs that established these firms.

and could easily be explained by proximity to university location. Concerning the second argument, financial support is found to be critical for incubator firms. The detailed interviews revealed that unwillingness and insufficient capabilities of firms, complexity of the application procedure and deficiencies in the implementation hinder the full impact of the financial support mechanisms. An overall assessment of all incubator services show that 60 per cent of the firms found incubator services critically important for the survival of the firm. However, the main reasons of locating the firm in an incubator are the university's image and tax benefits. Incubator services and networking opportunities are surprisingly among the least important reasons. The absence of venture capital initiatives, low levels of business networking, lack of marketing initiatives, and inadequate business support mechanisms appear to be among the major problems of the incubators in Turkey. The main source of funding in the start-up stage is own capital accumulation of the entrepreneur. Venture capital and spin-off processes are vital for the long term success of incubators but there is little improvement in venture capital markets in the last decade. The low level of business networking and interaction is one of the main weaknesses of incubators in Turkey. Only 10 per cent of the on-incubator firms stated that the reason for locating the business in an incubator is to network with similar firms. Unfortunately, enhancing business networking in incubators in Turkey is not an easy task because firms do not consider networking as an essential strategy. Entrepreneurs deliberately chose not to network with other firms due to reasons of secrecy, protection of sensitive information, and critical personnel. Last but not least, one of the main deficiencies of the entrepreneurs in incubators is their lack of experience in management. Most firms in incubators do not have viable business plans and the management support from the incubator deemed insufficient.

4 Requirements for successful incubation

The requirements for a successful incubation process could easily be analysed in a simple demand-supply framework. The entrepreneurs and new ventures constitute the demand side. The entrepreneurial actors lack managerial and marketing (and to a certain extent technological) know-how and demand (specialized) tangible and intangible services, administrative support, easier access to resources, and access to business networks. The agents on the supply side are the stakeholders in incubators: who is establishing incubators and for what reasons? We already have tried to answer these questions that also define the location and the type of the incubator. Business communities, local governments, and universities support new ventures and provide business services and technological assistance through incubators for different purposes. The success depends on elements of supply (exogenously), i.e. the management and funding of incubators, quality of services provided, clear cut defined strategies and purposes, and elements of demand (exogenously), i.e. how receptive are the entrepreneurs for capability building. However in most cases the success depends on how well the sponsors and incubator management can meet the specialized demand from the entrepreneurs.

In the previous sections we have reviewed the literature evaluating incubators and presented four country examples from the developing world. What can we learn from these experiences? How should an incubator policy be organized to lift effectiveness? In this section we summarize the

requirements for successful incubation by giving short examples from experiences from the developed and developing world.¹⁰ Eight points are identified for successful incubation.

- *The purpose and the mission of the incubator should be clear:* In order to provide useful assistance incubators should know their mission clearly (Lalkaka and Bishop 1996; Kim and Ames 2006). Incubators are established for different purposes from transfer of technology to job creation. Moreover incubators can be sector-specific assisting firms only in bio-technology, for instance. Knowing the mission clearly is important for the incubator manager to provide the right service mix for entrepreneurs. It is also vital for the selection of firms, entry-exit decisions and their implementation. Countries should not set up incubators without a strategic plan just for the sake of establishing incubators.
- *Incubators should set clear selection, entry, and exit criteria:* Various studies have reported that the existence of clear criteria for selection and especially entry is positively associated with the success of the incubator. (e.g. Hackett and Dilts 2004b; Totterman and Sten 2005). There are many cases in developing countries that report problems in the implementation of this very simple rule. For instance, country studies for China (Chandra 2007), Nigeria (Adegbite 2001), Malaysia (Yunos 2002) and Turkey (Akçomak and Taymaz 2007) have stated that most incubators fail to meet this criteria. In China and Nigeria this problem is exacerbated because tenant firms tend to remain in the incubator even though the incubation period has expired. This is also true for Turkey. There are even arguments that the incubation period should be flexible to maximize firm benefit because a longer incubation period might have negative impact on some tenant firms (e.g. Hytti and Maki 2007). Incubation provides a secure environment and may obstruct firms to develop certain skills, such as competition and marketing which are generally acquired by learning by doing.
- *Incubator managers should be qualified, preferably with a business experience:* Managerial capacity and skills of incubator managers and staff are critical for the success of the tenant firms and the incubator. In almost all developing countries this is major problem. The incubator managers are not qualified (Kim and Ames 2006), do not have a business background (Lalkaka 2002) and are not business-oriented (Tamasy 2007). Because of such reasons, incubators are not able to provide the right service-mix for their tenants. They are also not able to embed firms into networks and have difficulties in evaluating and developing the business plan of their tenants. There is a supply shortage of qualified managers especially in countries where the incubator movement was fast such as China and Korea. The popularity of incubators increase the demand for managers but it is not possible to train and generate qualified incubator staff at the same speed (the Korean case, for instance).
- *Monitoring firms is essential for success:* Monitoring and screening tenants to assess whether they are on the right track and whether they meet their targets is essential for incubation (Hackett and Dilts 2004b; Aerts, et al. 2007). Tenant firms could be assessed

¹⁰ For a good attempt in this direction see Kim and Ames (2006). Success factors and best practices reported in various studies conducted by the OECD, NBIA, researchers and practitioners are summarized in this study.

on their performance regarding employment, sales growth, financial position, innovativeness, etc. Regular monitoring reveals the state of firms, their specific needs, and their success potential. It is the manager's job to be pro-active in monitoring. Firms should be evaluated carefully on the basis of their management skills and financial strength before getting admitted to an incubator. This is an easy solution to minimize firm failure (Aerts et al. 2007). Monitoring is also one way to assess the progress of the entrepreneur.

- *Services that are provided by the incubator should be strategically selected:* Incubator services (facilities and technical support) help entrepreneurs to avoid start-up cost and in some cases avoid start-up bureaucracy (e.g. the case of Brazil). There are direct and indirect externalities from pooling resources that increase efficiency. For instance, facilities are shared by tenants so money can be invested in other useful activities (e.g. Hackett and Dilts 2004b, Chan and Lau 2005). Incubators should strategically select the services provided and monitor their use. Asking in a self-evaluation what services are mostly used is not a sufficient criterion to determine the right service-mix to be offered for tenant-companies. Services that are not provided can be essential for firms (Allen and Rahman 1985), thus monitoring should also address services that are not provided to see whether there is need for such services. Self-assessment is important to reveal where the incubator stands.
- *Intangible services are much more important than tangible services:* Most incubators in developed countries provide intangible and specialized services for tenant firms (e.g. networking strategy, assistance in making business plans, marketing, etc.). In developing countries the emphasis is on tangible services, such as office space, infrastructure, and laboratories. This does not mean that these services are not important. On the contrary, in developing countries tangible services are of utmost importance. However, in many cases (e.g. China, Malaysia, Nigeria, and Turkey) there has not been an optimal mix between tangible and intangible services that are offered by the incubators. Given the needs of the contemporary world, incubators should be able to provide quality and specialized intangible services.
- *Networking adds value only if it is a deliberate strategy:* Sheltering firms and entrepreneurs under one roof does not guarantee beneficial effects from network externalities. Networking should be a deliberate strategy of the incubator and the tenant firms. Only in such a case one can talk of synergies (e.g. Hansen et al. 2000; Bollingtoft and Ulhoi 2005; Chan and Lau 2005; Totterman and Sten 2005; Hughes et al. 2007). Some studies have reported drawbacks of excessive networking and overflow of information. For instance, in a case study in Ireland, McAdam and Marlow (2007) found that being in close proximity to each other might have adverse affects on secrecy (e.g. copying and stealing ideas). In a similar manner, Akçomak and Taymaz (2007) report that tenant firms were hesitant to share sensitive information with other firms in the incubator. Most of these firms were micro firms with less than five employees and firms fear that their projects could be copied by the other firms by transfer of critical personnel and stealing ideas, for example. In these circumstances, trust is a critical factor that enables information exchange.

- *The incubator should be able to self-sustain its operations:* In most developing countries incubators are dependant on government funding one way or another. Tenant firms are expected to be self-sustaining after spending three or four years in an incubator. Given this one could also expect incubators to become independent. Self-sustenance requires networking, strategic planning and diversified funding sources and forces incubators to become more business-oriented. Just as incubators force entrepreneurs to become more competitive, the government may facilitate (or induce if necessary) incubators to become self-sustainable.

5 Discussion and concluding comments

The experiences of developed and developing countries in supporting incubators reveal that contemporary successful incubators provide a wide range of services, focus more on intangible business services, employ qualified managers and support staff, and are more profit-oriented. To match the needs of the current market economy and the requirements of the firms the concept of incubators has been re-invented continuously and has evolved through time. We have further assessed the appropriateness of incubators as a tool for entrepreneurship promotion in developing countries. The main weaknesses of incubators in developing countries are: (i) the focus on tangible service, (ii) the reliance on government both in terms of promotion and funding, (iii) the lack of qualified personnel and skilled managers, (iv) the *lack* of planning and creativeness in solving problems and providing services.

The first three of the above could easily be observed in many developing countries but are not that easy to tackle. These problems are, so to say, endogenous to the system. For instance, the provision of high quality tangible services requires highly skilled managers and personnel which in turn depend on the supply of incubators and the general policy on education and training. The government can chose to invest lavishly on creating incubators but this investment has an opportunity cost which could well be a forgone investment on skilled personnel in innovation management. Hence the incubation industry would end up with less skilled personnel who are not productive and knowledgeable in providing intangible resources.

The framework above is a simple example and could easily be complicated and extended. For example, the case of Korea fits well to this framework. The extreme increase in the number of incubators created a shortage for experienced managers and had a bad impact on the quantity and quality of the services provided by the incubators. The Chinese experience is another good example of policy inconsistency. Salaries of around 300 Euros per month at Fudan University makes self-employment tempting for university researchers. In some cases researchers spent more than three fourth of their time in incubators to develop their businesses and to generate a better income at the expense of teaching and research activities (Harwit 2002). This might seem acceptable if it helps to reach the target of increasing commercialization of research, however it has formidable drawbacks on the quality of education. Hence there is a need for an optimal policy regarding incubators. The bottom point is that the incubator policy should be integrated in a framework of policies for entrepreneurship promotion in particular, and innovation and economic development in general. Incubators reflect the institutional set-up, creativity, and policy innovativeness in a society. Policy on incubators is neither a quick fix (e.g. Allen and McCluskey 1990) nor a sole cure for all problems regarding entrepreneurship (e.g. Autio and

Klofsten 1998). Therefore it is not appropriate for policymakers who seek for fast short run solutions.

The mere existence of incubators cannot guarantee people to become entrepreneurs and cannot induce networking among firms. Therefore it is best to complement incubator policy with policies that encourage entrepreneurship. Take the issue of education for instance. In most developing countries, especially in China, the risk-averse culture hinders entrepreneurship. In such an environment investing in education policy to create a more receptive environment that would promote creativity and entrepreneurship might be a better option than investing in incubators blindly. In a similar manner, in most developing countries financial institutions are also risk-averse and venture capital markets are underdeveloped, therefore entrepreneurs heavily rely on personal funds. Moreover, there are institutional and bureaucratic barriers that deter entrepreneurship. In such an environment improvements in financial institutions is the first-best solution to start promoting entrepreneurship.

Given the evolution of the concept of incubators the policy towards incubators needs to be flexible and innovative itself. There is no problem in implementing incubator models that are borrowed from developed countries as long as they are modified according to the economic climate, values, and the institutional landscape of the receiving country, and firm and sector-specific needs. Most successful incubators display a creative and innovative character in approaching problems of tenant companies. Incubators encourage firms to become innovative and competitive. Such a mission can be pursued only if incubators themselves become competitive, business-oriented, and innovative. There are cases where innovative models of incubators emerge as a response to local needs. The social incubator and the incubators specialized on art and culture in Brazil, and the returned scholar incubators in China are good examples of novel incubator models. If we accept that innovation creates value-added, the incubators in developing countries have to be innovative themselves to achieve their goals. Assessing incubator performance is not a simple task. The literature presents conflicting findings (Tables 1 and 2). Sound evaluation necessitates good data but data gathering is costly. However, evaluation should be a routine task of incubator management rather than being a once for all luxury. It is the only way to assess the quality of the services provided to tenant firms. Another reason that makes evaluation hard is the opportunity cost of incubation. As in the Chinese case, creating incubators needs enormous investment which could be invested in another policy tool that also promotes entrepreneurship. For instance, in India incubators are not very popular but NSTED organizes different programmes to train thousands of researchers and students to become entrepreneurs.

An incubator is an institution as well as a tool to promote entrepreneurship and creating institutions is a first-best but costly solution (e.g. Bowles and Gintis 2002). Nevertheless, Rodrik (2008) argues that appropriate institutions for developing countries could well be second-best institutions that do not resemble institutions in developed countries. These could even be a mix of formal or informal institutions, if such an environment is conducive to investment, entrepreneurship, and innovation. Previous works of Fafchamps (2004) in Ghana and McMillan and Woodruff (1999) in Vietnam constitute good examples of such situations. They both show that what sustains economic transaction is relational contracting (trust, reputation, personal contacts) not formal legal institutions. In such cases where formal institutions are not binding,

the appropriate policy may well be strengthening these informal environments rather than setting up formal institutions which may be costly to establish and maintain (Rodrik 2008). To conclude, setting up incubators is a viable but not the sole tool to promote entrepreneurship and innovation. This could be achieved in various other ways and developing countries should seek novel and innovative policy tools as well as modify and adapt the already existing ones.

Appendix table A1

Summary of findings of the literature assessing incubators

Country	Study, year	Sample and methodology	Indicator for success	Findings
US	Allen and Rahman (1985)	12 incubators, 56 firms, Response rate (RR) 44%. Descriptive analysis.		Physical services (work space, equipment, etc.), advertising and marketing services, risk management and insurance and government grants are rated as most useful for survival. 87% of the entrepreneurs stated that they would have started their business without the incubator.
US	Fry (1987)	76 firms, RR 51%. Descriptive analysis. Comparison with control group.		Incubator firms are more active in planning (business planning, mission statement, strategic plan, budgets, etc.) than non-incubator firms. Most incubators provide such services but this is more in the form of encouragement and only half of the incubator managers actively participate in the planning of the tenants.
US	Allen and McCluskey (1990)	127 incubators, RR 70%. Regression analysis (dependent variables: log of jobs created and firms graduated).	For real estate incubators percentage of occupancy. For others jobs created and firms graduated.	Occupancy rates around 50% show that incubators are not strong real estate ventures. Old incubators with accumulated expertise are more successful than the others. Incubators that admit light manufacturing firms are more successful in job creation. None of the business support services have significant impact on jobs created and firms graduated.
US	Mian (1996a)	Case study of six university incubators and 47 firms. RR 32%. Qualitative and quantitative assessment.	12 business services and 10 university related services assessed for their usefulness.	Shared office services are more useful than business services, such as assistance on applying for grants, marketing, accounting, etc. Incubator firms benefit from university image, student employees and university labs and infrastructure. Incubator services have added value contributions.
US	Mian (1996b)	Case study of two university incubators in University of North Carolina and Case Western Reserve.	12 different dimension to assess success in creating new enterprises.	Sales of firms increase by about 10 and employment by 4 times within 4 years. Physical infrastructure, student employees and faculty consultants are the most important services provided by the incubator (university). University incubator services have positive impact on growth and survival of tenant firms.
US	Mian (1997)	Case study of four university incubators and 29 firms. RR 35%. Qualitative and	Firm survival and growth and contributions to universities	Firms in all four incubators indicate impressive sales and employment growth rate (150% and 35%, respectively). Incubator firms benefit from university image and universities receive public attention due to press coverage and visits to university campus. Student employees are found to

		quantitative assessment.	mission.	be the most beneficial source for firms.
Finland, Helsinki	Autio and Klofsten (1998)	Case study of two incubators to assess their management policies.		Incubators are embedded in local context and their success could only be analyzed in the local settings. 'Success stories' cannot be generalized. Practitioners should be careful in adopting policies that are found to be important in other incubators.
Switzerland	Thierstein and Wilhelm (2001)	Case study for 9 incubators in Switzerland. Short surveys in 40 incubators. RR 63%.		The regional economic development aim is missing. This can be partially explained by the fact that contrary to most countries incubators in Switzerland are privately owned in most cases.
Nigeria	Adegbite (2001)	Case study of 7 industrial (business) and technology business incubators.		Neither the business nor the technology incubators achieved their primary goals. Weaknesses: lack of objectivity in admission, insufficient support services. There are organizational difficulties as the incubators are operating under the ministry. and poor funding.
Israel	Shefer and Frenkel (2002)	Quantitative evaluation of 21 incubators and 109 firms.	Firm survival, obtaining funding for projects after graduation.	86.4% of the projects in the last 3 years graduated from the programme and 78% of them were able to secure financial support after graduation. The incubator manager's skills and the selection and the monitoring of projects are essential for success.
Italy	Colombo and Delmastro (2002)	45 incubator firms (RR 20%) are matched with 45 similar firms that are outside the incubators. Quantitative analysis on matched sample.	Differences in employment growth and innovative activity (number of patents, copyrights, etc.)	Italian incubators are successful in attracting high skilled entrepreneurs. However, there are no significant differences between on- and off-incubator firms regarding their innovative output. The on-incubator firms outperformed off-incubator firms in employment growth, education of the workforce, participation in EU-sponsored projects and establishing formal cooperative relations.
Taiwan	Hsu et al. (2003)	Comparison between firms in ITRI incubator (16 firms 50% RR) and firms in other incubators (34 firms 16% RR).	Satisfaction with business support services and effect of clustering.	ITRI incubator tenants are more satisfied with incubator services when compared to firms in other incubators. It was found that industrial clustering is important for the development of the incubator which implies that complementarities are important in local economic development.
Finland	Abetti (2004)	Case study of 5 incubators among 16 incubators in Finland. A general assessment for	Survival rates and job creation, sales growth.	The survival rates reach to 95%. The incubators receive little funding from the government but are able to create high skilled cost effective jobs (government subsidy per created job is 6,450 € which is much less than the welfare costs per person in Finland). Average sales growth rose by 160%

		the Helsinki region.		per year during and after incubation.
Hong Kong	Chan and Lau (2005)	Case study of 6 incubator firms. Qualitative assessment.		Rental subsidies and office spaces are found to be critically important for entrepreneurs. The training programmes are also found to be useful for incubator tenants. On the contrary firms indicate that they do not gain benefits from clustering.
Spain (Basque country)	Pena (2004)	Quantitative evaluation 114 firms in 9 incubators.	Sales growth, employment growth, and profit growth.	Human capital of the entrepreneurs has significant impact on sales and employment growth. Most incubator services have no impact on performance indicators.
US and Korea	Lee and Osteryoung (2004)	Questionnaire for firms, graduate firms and incubator managers in Korea and US (only university incubators). RR 62% and 45%, respectively.	Perceived importance of 14 items measuring critical success factors of incubators.	There is significant difference between US and Korean respondents regarding the role of incubators strategy (clarity of goals, management, entry exit policies, business plans, etc.) on the performance of the incubator. Respondents from US give more importance to these factors. Financial support and business networking have more perceived importance than other factors.
US	Peters et al. (2004)	Secondary data on 43 US incubators. Additional survey for managers.	Number of graduate firms.	Graduation rates are higher in incubators that offer coaching (training and educational workshops) and that provide an accessible network (consultants, scientists, customers, other business firms, etc.). Non-profit incubators are found to be more successful than other incubator types regarding the number of firms graduated.
Israel	Rothschild and Darr (2005)	Case study. 49 interviews with entrepreneurs, workers, and incubators staff.	Social links (formal and informal) are conducive to firm development.	Entrepreneurs argue that affiliation with the incubator gives a reputation and (scientific) credibility to the firm and hence helps firms to access business networks and more importantly funding.
Brazil	Etzkowitz et al. (2005)	Case study based on detailed interviews. Qualitative assessment.		The most important finding is that incubators allowed Brazil to create a less costly development strategy that took advantage of resources, such as academic, available elsewhere.
Finland	Totterman and Sten (2005)	Case study of 3 incubators (3 managers, 9 tenants and 9 post-incubated		Incubator support and networking is important for firms to benefit from incubator resources. Incubator managers should focus on strategic business networking rather than only providing infrastructure and physical

		tenants).		capital to entrepreneurs.
US	Rothaermel and Thursby (2005a)	Panel data for 79 firms in Advanced Tech. Dev. Centre and Georgia Institute of Technology 1998–2003.	Firm survival	The effect of a university link (licensed technology, faculty as a senior management, informal links.) reduces the likelihood of failure but increases the incubation period. These effects become stronger if the inventor is the founder of the firm and/or take part in the management of the firm.
US	Rothaermel and Thursby (2005b)	Panel data for 79 firms in Advanced Tech. Dev. Centre and Georgia Institute of Technology 1998–2003.	Total revenues, total funds obtained, venture capital funding obtained and firm survival	The effect of two mechanisms are investigated (i) transfer by a licence to university, (ii) backward citations of incubator firm patents to university patents or publications. Holding a licence is important for firm survival but does not have significant effect on other performance indicators. The absorptive capacity of the firm measured by backward citations is more important in explaining firm performance.
UK	Wynarczyk and Raine (2005)	Surveys in 17 incubators. Quantitative and qualitative evaluation.		Incubators do play an important role in nurturing business and creating jobs. The hands on support provided by the incubator and advisors are found to be vital for firm survival especially in the early stages of the business.
Italy	von Zedwitz and Grimaldi (2006)	Case study of 15 incubators. Qualitative assessment.	Success of incubator as regards to services provided	Incubator services should be type-specific and the portfolio of the services provided should match with the objectives of the incubator. The incubator management should be sufficiently experienced to match service needs to incubator purpose.
Korea	Kim and Armes (2006)	Information on 150 incubator managers (RR 40%). Qualitative assessment of incubators and managers.		Qualified incubator managers tend to provide better and specialized services; use wider range of support services and establish wider support networks. The rapid growth in the incubation business created a shortage of managers and hence had a negative impact on the success of incubators.
US and Finland	Studdard (2006)	Survey of 52 firms. RR 18%. Quantities analysis.	New products, technological competence, reputation.	Knowledge acquired by interacting with the incubator manager has no effect on new product development, technological competence and sales cost but it enhances the reputation (defined as increased credibility and marketing reference) of the firm.
US and Europe	Gassmann and Becker	47 interviews. In addition 77 firms from the EC benchmarking		Both the incubator and the ventures benefit from resource and information flows at the initial phase. The main corporation benefits at the second phase from intangible and tacit knowledge coming from the for-profit

	(2006)	survey		incubators and the firms.
China	Chandra et al. (2007)	Case study of 12 incubators. Interviews with managers.		The fact that most incubators are large in size, high tech-oriented and rely on government funding made incubators dependent on government and weakened their capability toward market-oriented incubation.
Israel	Avnimelech et al. (2007)	Firm level quantitative assessment (3747 firms). Descriptive analysis.	Firm survival.	Venture capital (VC) and incubator programme are complementary. VC firms' failure rate is lower than incubator firms' failure rate. Closure rates are lower for firms that were established in an incubator and received seed funding (19% compared to 36%).
Europe	Aerts et al. (2007)	Data from European Commission benchmarking study. 107 incubators. RR 18%.	Survival rates.	Tenants' survival rate is positively correlated with the availability of a more balanced screening process. Reliance on one screening process (market, financial, management screening) is positively related to high failure rate. Incubators role in supporting entrepreneurial spirit by any means is critical for firm survival.
Finland	Hytti and Maki (2007)	131 high tech firms (average RR 83%).		Firms that are young and have growth potential benefit more from the incubator services. Older firms tend to be less satisfied with services. Incubation period should be optimal and flexible according to firm needs.
UK	Hughes et al. (2007)	Interviews with 211 incubator firms within a population of about 1000 firms. Cluster analysis to classify firms.	Product innovation, radical innovation, competitive performance.	Firms are classified to 4 groups according to their capabilities, determination to access resources and to acquire knowledge. Firms that deliberately pursue goals in networking are more successful than others. Strategic networking is a crucial factor behind success and in its absence incubator services may not be important at all.
Ireland	McAdam and Marlow (2007)	Case study of one university incubator. Detailed interviews with 12 entrepreneurs.		Incubator facilities, its credible status and networking opportunities are found to be important for tenants. However, firms were hesitant to share sensitive information and being close proximity to each other might have adverse affects (secrecy, copying idea, etc.). Trust is a critical factor that enables information exchange.
Turkey	Akçomak and Taymaz (2007)	Matched sample assessment of 48 incubator firms (RR 60%).	Sales growth, employment growth and innovativeness.	There are differences between on- and off-incubator firms in terms of sales and employment but not in innovativeness. Tangible incubator services and seed funding explain this differential.

Ireland and UK	McAdam and McAdam (2008)	18 university incubator firms over 36 months.	Tangible incubator resources are important for the development of the firm in the early stages. Among a set of factors networking and clustering are rated to be the most important factor behind firm success.
Germany	Schwartz and Hornyh (2008)	37 expert interviews in sector-specific incubators (media). Descriptive.	Availability of specialized equipment and facilities are crucial for the survival of media firms, sector-specific knowledge and know-how. Networking is constrained in the incubator because companies more or less compete in the same sector.
Israel	Frenkel et al. (2008)	12 incubators (6 private and 6 public). Surveys with incubator managers, 60 firms.	Both private and public technology incubators promoted technological entrepreneurship among the immigrants from US and former USSR. Firms in private incubators seem to benefit from networking with (international) strategic partners and academia. But private incubators cannot fully substitute public incubators.

Appendix table A2

Comparisons between developing countries regarding incubator policies

	BRAZIL	CHINA	INDIA	TURKEY	US
Number of incubators	400	500	50	40	1000
Strategic focus	Mixed. Foster entrepreneurship, reduce unemployment transfer of technology	High tech focus. Foster entrepreneurship	High tech focus but also traditional incubators to create ventures and jobs	High tech focus but also traditional incubators to create ventures and jobs	Mixed. Transfer of technology, economic development
Emergence and evolution	Bottom-up	Top-down	Top-down	Top-down	Bottom-up
Scale	Small (average 15–20 firms per incubator)	Big (average 60 firms per incubator) and bigger	Small and smaller (< 10 firms per incubator)	Small (average 15–20 firms per incubator)	Small and some larger incubators
Incubator funding	Government, business, universities	Government	Government	Government	Government, business, universities especially for-profit

Incubator services	Tangible and (poor) intangible	Mostly tangible and poor intangible	Tangible and (poor) intangible	Tangible and (poor) intangible	Tangible and intangible with a focus on specialized services
Tenant entry/exit	Clear criteria and implementation	Criteria is not clear and poorly implemented (especially exit criteria)	—	Criteria is clear. Implementation: entry good but exit poor	Clear criteria and implementation
Incubator management	Strong	Poor	Poor	Modest	Strong
Role of government	Modest level	Very active	Present	Active	Low rather supportive
Role of university	Very active	Present	Present	Active	Very active
Institutional environment	Developing	Weak but developing	Weak but developing	Developing	Developed
Culture	Risk-averse	Risk-averse	Risk-averse	Modest risk-taking	Risk-taking

Note: Partially adapted from Chandra (2007).

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