Technology Business Incubators in China and India

A Comparative Case Study

Tang, Mingfeng; Baskaran, Angathevar; Pancholi, Jatin; Muchie, Mammo

Published in:
African Journal of Science, Technology, Innovation and Development

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

African Journal of Science, Technology, Innovation and Development
Vol. 3, No. 2, 2011
pp. 248-290

Technology Business Incubators in China and India: A Comparative Case Study

Mingfeng Tang[*], Angathevar Baskaran[**], Jatin Pancholi[***] and Mammo Muchie[****]

Abstract

We present a comparative case study of Technology Business Incubators (TBIs) in two major emerging economies in Asia - China and India. We employ an integrative

[*] Associate Professor, South-Western of Finance and Economics University, 55 Guanghuacun Street, 610074 Chengdu, China Email: tang@swufe.edu.cn

[**] Senior Lecturer, Middlesex University Business School, The Burroughs, London NW4 4BT, UK. Senior Research Associate, the Institute for Economic Research on Innovation, Tshwane University of Technology, Pretoria, South Africa. Email: a.t.baskaran@mdx.ac.uk.

[***] Senior Lecturer, Middlesex University Business School, The Burroughs, London NW4 4BT, UK. Email: j.pancholi@mdx.ac.uk.

[****] DST/NRF Research Professor of Innovation and Development at the Institute for Economic Research on Innovation, Tshwane University of Technology, Pretoria, South Africa (SARCHI); DIR, Aalborg University; Senior Research Associate in the SLPTMD, Oxford University, QEH, UK. Emails: mammo@ihis.aau.dk and MuchieM@tut.ac.za

analytical framework that combines three broad categories of indicators (originally developed by Mian, 1997): Management policies and practices; Services and their impacts; and Performance outcomes; with the national system of innovation (NSI) concept. At the micro (TBI) level, we mainly focus on: objectives, structure and governance of incubators, selection of tenants, funding for incubators and tenants, services provided by incubators, and performance outcomes. We attempt to identify similarities and differences between the two systems, explore the reasons for performance differences, and draw policy implications. Our study shows that the differences between the TBIs in China and India are mainly due to the differences between the NSIs of China and India, as major components of NSI such as macroeconomic conditions, national S&T policy framework, industrial structure and the nature of financial institutions have played significant role in shaping the nature and rate of TBIs development in both countries. This suggests that building and strengthening the NSI is imperative to achieve positive and high outcomes in the growth and performance of TBIs; and specific and strong measures to develop TBIs alone may fail to produce desired outcomes, if the NSI is weak.

Keywords: Entrepreneur development, High-tech incubators, Start-up business, Technology business incubators, China, India.

JEL Classification: O30, O31, O33, O53.

Abbreviations:

DSIR	Department of Scientific and Industrial Research
DST	Department of Science and Technology;
GIC	General Insurance Corporation of India;
HI	Host Institution;
ICICI	Industrial Credit and Investment Corporation of India;
IDBI	Industrial Development Bank of India Limited;
IFCI	The Industrial Finance Corporation of India;
IVCF	Indian Venture Capital Fund;
IIBI	Industrial Investment Bank of India;

LIC Life Insurance Corporation of India;

MOST Ministry of Science & Technology;

NIF National Innovation Foundation;

NSI National System of Innovation;

NSTEDB National Science & Technology Entrepreneurship Development Board;

NTBF New Technology Business Firms;

OECD Organisation for Economic Co-operation and Development;

SEBI Securities and Exchange Board of India;

SIDBI Small Industries Development Bank of India;

SOEs Sate Owned Enterprises;

STPs Software Technology Parks;

STEPs Science & Technology Entrepreneurs Parks;

TBIs Technology Business Incubators;

TDDP Technology Development and Demonstration Programme;

TDIP Technology Development and Innovation Programme;

TDPU Technology Promotion, Development and Utilization Programme;

TePP Technopreneur Promotion Programme;

TFCI Tourism Finance Corporation of India Ltd;

UNCTAD United Nations conference on trade and development;

UTI Unit Trust of India.

1. Introduction

Fostering innovative and high-tech small firms has become an important national policy in many countries, both developed and developing. It is now widely accepted that managing innovation involves developing appropriate learning abilities to drive new knowledge creation, accessing resources (e.g. human and financial), coordinating activities from research and development (R&D) to market, and creating synergies among them (e.g. Rein, 2004); developing effective collaborations (Knudsen, 2007); and disseminating knowledge within and outside the innovative organisation, gathering information with respect to the external environment (customers, suppliers, technology developers) combined with information diffusion and processing activities designed to ease the decision-making process (Riel et al., 2004). If these issues are crucial and difficult to manage for existing firms, they are even more complex to manage and critical for new innovative ventures/ start ups. One of the policy measures taken by many countries to help the start-ups to manage this complex process was setting up the Technology business incubators (TBIs).

In this paper we analyse and compare the TBIs and their environments in China and India employing an integrative analytical framework that combines three broad categories of indicators (originally developed by Mian, 1997): Management policies and practices; Services and their impacts; and Performance outcomes; with the national system of innovation (NSI) concept to identify and understand the similarities and differences and the factor contributing towards these.

First, we review the literature on TBIs -- various understandings of TBIs, the critical success factor approach and comparative studies. Second, we discuss our analytical framework which makes the link between TBIs and NSI. Third, we briefly discuss the research methodology. Fourth, we present our analysis and findings. Finally, we draw some conclusions and make some recommendations for policy and future research.

2. Literature Review

Various Understandings of Technology Business Incubators (TBIs)

Early incubator studies are primarily descriptive, generally tracing different understandings of business incubator concepts and functions (e.g. Allen, 1985; Allen and Levine, 1986; Smilor and Gill, 1986). They mainly suggest that an incubator must have a physical plant with low market rents, shared service, logistical support, and business consulting services. They also link effectively: talent, technology, capital and know-how to leverage entrepre-

neurial talent; accelerate the development of new technology-based firms, and speed up the commercialization of technology. Since the 1990s, researchers have begun to complete the concept by describing the role and services of business incubators. That is, incubators hatch new ideas by providing new ventures with physical and intangible resources and speed up new ventures' establishment and increase their chances of success. They help entrepreneurs develop business and marketing plans, build management teams, obtain venture capital, and provide access to professional and administrative services (Von Zedtwitz and Grimaldi, 2006). Counselling interactions with incubator management help ventures to gain business assistance whereas networking interactions with incubator management help ventures to gain technical assistance (Scillitoe and Chakrabarti, 2010). So, over the years, perceptions and concepts of business incubators have evolved over the years from the initial focus on physical space with basic facilities to value-added services and systematic incubation process (e.g. Matt and Tang, 2010).

The Critical Success Factors Approach to TBI

The second stream of business incubator studies focus on the critical success factors of TBIs. Successful new technology business firms (NTBF) are widely viewed as one of the driving forces in the growth of local, regional, and national economy and innovation capability building. Increasingly, creation of NTBF has become part of Science & Technology policies in many countries. Studies of TBIs began in the 1980s (Mian, 1996a), and they mainly focused on the critical success factors influencing TBI efficiency (e.g. Allen, 1985; Allen and Levine, 1986; Smilor and Gill, 1986; Campbell et al., 1988; Mian, 1991, 1994; Chan and Lau, 2005; O'Neal, 2005). Mian (1991, 1994) developed a framework for assessment of TBIs by providing a checklist for a successful facility. He tried to assess the value-added contributions of TBIs to new ventures (Mian, 1996b), and provided insights into elements that are key to making a TBI successful in developing new research/technology based firms (Mian, 1996a). Similarly, O'Neal (2005) highlighted the success factors that facilitate TBI to develop new ventures: integrating clients in the wider technology development system; fostering interactions among clients; providing management services; providing access to staff, outside experts, and an incubator advisory panel; and providing access to external funding sources, university resources, community/local government economic development agencies, and other entrepreneurial support organisations.

Although the critical success factors approach provides a way to assess the efficiency of TBIs, some success factors may be critical in some cases, but may not be decisive in other cases. For example, entrepreneur training and

virtual networking play critical roles in operating European TBIs, whereas company financing and management functions are considered important for the performance of TBIs in the USA (CSES, 2002). Therefore, there is a need for an integrative and systematic approach to assessing the efficiency of TBIs at a general level.

The model developed by Mian (1997) that is based on three sets of variables: (i) management and operational policies; (ii) services; and (iii) performance outcomes of TBIs provides such integrative and systematic analytical framework to examine the performance of TBIs.

Comparative Studies of STI

The third stream of business incubator literature consists of comparative studies of TBIs, which mainly show how the nature of ownership of incubators (public or private) influences the efficiency of the incubator system. Philips (2002) compared private and hybrid types of incubators in the US and found that the first type did not significantly influence the declared objective of technology transfer. Becker and Gasmann (2006) compared TBIs with corporate incubators and suggested that TBIs should learn from corporate incubators in relation to a clear mission orientation, industry and public representatives on advisory boards, value-added services to start ups and efficient management of resources. Von Zedtwitz and Grimaldi (2006) characterized five incubator archetypes in Italy and concluded that differences in competitive scope and strategic objectives influenced the quality of incubator services and the way incubators were managed.

With the exception of Lee and Osteryoung (2004)[1], both the critical success factors approach and comparative studies were based mainly on specific cases within national boundaries and many used US examples. Few studies have involved cross-country analysis of TBIs, particularly focusing on emerging and developing economies. Our paper aims to contribute to this gap in the literature by presenting a comparative case study of TBIs in two major emerging economies in Asia – China and India.

3. Integrative Analytical Framework

Our research focus is on comparing the two different national TBI systems. For this, we employed an integrative analytical framework that combines three broad categories of indicators which were derived from the original model developed by Mian (1997) with the national system of innovation (NSI) concept. This is another original contribution of our paper.

The three categories of indicators that we have adapted from Mian (1997) are:

- Management policies and practices: program goals, structure and governance, financing and capitalisation, target markets, entry/exit policies, tenant performance review policy, equity/royalty policy, and intellectual property;
- Services and their impacts: shared incubator services and university-related services;
- Performance outcomes: programme growth and sustainability; tenant firm survival and growth; contribution to sponsoring university mission, and community-related impacts.

These indicators are used to analyse the core aspect of this study at the micro (TBI) level - the development, governance, management, services and performance of TBIs, while the NSI concept is used to understand the contextual factors that influences the TBIs. That is, whether distinct national contexts have shaped the nature and growth of TBIs in distinct ways in the respective case countries, and what are the major factors that contributed to this.

NSI provides the conceptual approach or framework for studying both developed and developing economies at various stages of development. It has evolved over the years and has been used widely as a major policy framework across both developed and developing countries (see Freeman, 1987, 1995; Lundvall, 1988, 1992, 2007; Nelson, 1993; and Edquist, 1997; Cimoli, 2000; Intarakumnerd and Chaaminade, 2007; Muchie et al., 2003). Therefore, we adopt NSI conceptual framework for the comparative analysis of TBIs in China and India. This is done by first identifying those elements of NSI which could have significant impact on the way TBIs developed and their environment in these countries.

Lundvall (2007, p. 102) argued that NSI concept can be employed at two levels: (i) the 'core' - "firms in interaction with other firms and with the knowledge infrastructure" including universities; and (ii) 'wider setting' that includes "national education systems, labour markets, financial markets, intellectual property rights, competition in product markets and welfare regimes". In the 'wider setting' the government plays a major role in a number of ways. We would argue that in the narrow sense NSI involves a system of interaction of a wide variety of public and/ or private firms with other institutions such as universities, and government agencies -- all working together towards attaining the production and diffusion of knowledge and science, technology, and innovation within the boundaries of legally recognised states. In other words, 'firm' (whether public or private) is the core of the NSI in the narrow sense. Since TBI's function is to foster and develop firms (core of NSI in narrow sense) to maturity providing or facilitating various supporting resources such as finance, technical advice, market

intelligence and so on (which are part of wider setting of NSI), there is a clear link between TBIs and NSI. Therefore, it will be interesting to see how the NSI influences the shape and performance of TBIs and conversely, how the TBIs contribute to the NSI. However, our main focus is only on the former, that is, NSI's impact on TBIs. So for this study, we adapted the NSI concept in its wider setting (Lundvall, 2007) and modified it further for analysing the TBIS in China and India. This helps to trace the links between differences in the national contexts which could lead to different impacts on the way TBIs are developed and their environment in these countries.

Figure 1 (Baskaran and Muchie, 2011) presents our modified NSI concept in its wider setting which has 4 key sets of elements. Set 1 - Conceptual Framing: the ideas, visions and policies that frame the overall scope or possible set of interactions of politics, economics and knowledge. The behaviour and interactions are often shaped by sets of common habits, norms, routines, established practices, rules, or laws. Set 2 - Institutions, Technologies, and Knowledge and their co-evolution: These enable the implementation of the conceptual framing and policies (Set 1) and to build an efficient innovation system. Set 3- the means provided to the institutions (Set 2) for realising the goals identified (by Set 1), that is, various incentives such as financial and social rewards. This is vital to foster appropriate incentive system. If the incentive system is inappropriate or fails to command wider acceptance, the opportunity to organise robust NSI and achieve measureable results will be put in jeopardy. Set 4 - Overall efficiency of the environment for learning: in terms of implementation, monitoring, review, and feedback involving the above three sets. The learning outcomes can be different such as transformative, adaptive, corrective, modifying, evolutionary, and so on. This can also be negative.

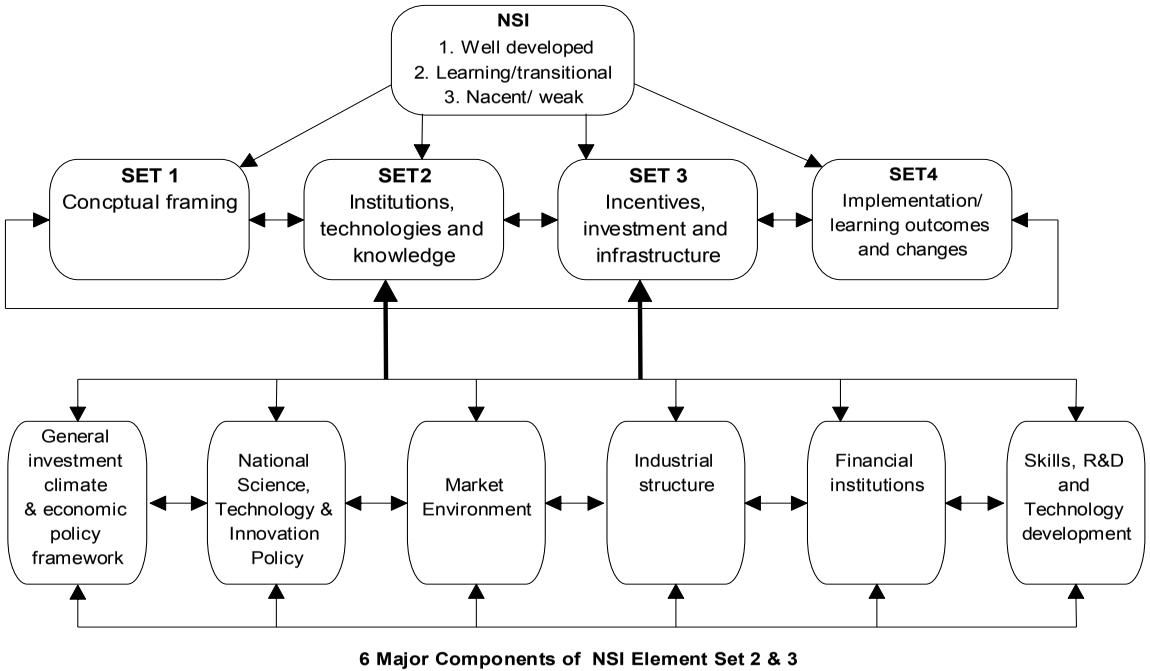
In Figure 1, we elaborate Set 2 (Institutions, Industry, Technologies and Knowledge), and Set 3 (Incentives, Investment and Infrastructure) further into individual components or sub-elements, as these are relevant to making linkages and relations between NSI and TBIs development/ environment. The strong presence and interaction and linkages between various institutions, industrial sectors, technologies, knowledge, incentives, investment, and infrastructure determine the higher or relatively stronger or weaker level of functioning of a particular NSI. We can categorise them in to three types: 1. Well Developed; 2. Learning or Transitional; and 3. Nascent or Weak. We identified 6 sets of components (sub-elements) of NSI that could have significant impact on the development of TBIs in a national economy. These are shown in Table 1. These are part of 4 sets of major NSI elements that are illustrated in Figure 1. It is expected that these elements and sub-elements are likely to have varying degrees of impact on the TBIs in each case, due to differences in the national context.

These NSI elements and components of these elements are largely derived from the Word Investment Reports published by the UNCTAD (e.g. 2002, 2003, 2004, 2005) and the NSI literature.

Table 1: Some Major Components of NSI that could Shape and Impact on the Development of TBIs and their Environment

Components (Sub-elements) of NSI	**Related to the Elements of NSI (As shown in Figure 1)**
1. The general investment climate and economic policy framework: (a)Macroeconomic conditions and stability (b) National fiscal policy regime (c) Regulatory regime such as trade and tax policies	NSI Elements Set 1 and Set 3 and their components: Investment & Infrastructure, and Incentives
2. National Science, Technology & Innovation Policy Framework: (a) National strategic priority sectors (b) National S&T projects (c) National effort towards innovation	NSI Elements Set 1 and Set 2 and their components: Institutions, Industry Sectors, Technologies and Knowledge
3. Nature of Market Environment: (a) Domestic market size / structure (b) Links to regional and global markets	NSI Elements Set 2 and its components: Institutions and their environment
4. Industrial structure: (a) Presence of diverse industrial structure (b) Strength of domestic firms (c) Presence and role of foreign firms, and links to foreign companies	NSI Elements Sets 2 and Set 3 and their components: Institutions, Investment & Infrastructure, and Incentives
5. Financial Institutions: (a) Banking sector (b) Venture Capital (c) Other sources of financing for start-ups and new enterprises	NSI Elements Set 2 and its components: Institutions, Industry Sectors, Technologies and Knowledge
6. Skills, R&D, and Technology development (a) Investment in education and skills (human resources) development (b) Investment in R&D	NSI Elements Set 2 and Set 3 and their components: Industry, Technologies and Knowledge; and Incentives

Figure 1: National System of Innovation (Wider Setting): A Conceptual Framework



Source: Baskaran and Muchie (2011)

4. Methodology

This study employs phenomenology research approach and comparative case study. The fundamental aspects of a case study are the choice of the individual unit of study and the setting of its boundaries. That is, a case study is an intensive analysis of an individual unit, stressing developmental factors in relation to context (Flyvbjerg, 2011). When the boundaries between phenomenon and context are not clearly evident, case study research method is employed as an empirical inquiry and multiple sources of evidence are used (Yin, 1984, 2009). The value of case studies is increased when they are employed comparatively. The comparative approach can be more effective in well-matched cases, where the circumstantial similarities help highlight the differences in terms of paths taken as well as paths not taken. Furthermore, they are valuable for the study of complex socio-economic systems, particularly in unravelling causal links and underlying mechanisms (Markusen, 1999).

In this study we are comparing the cases of TBIs in China and India, which are well-matched cases, as both China and India are emerging economies with comparable characteristics with different national contexts. Also, our approach was to conduct a comparative case analysis using multiple sources of data, mostly secondary sources. It should be stressed that the main thrust of comparison in this study, however, is not so much aimed at generalization of findings, but to enhance the qualitative understanding of each of the cases, particularly by drawing contrasts between them.

5. Background of TBIs in China and India

Growth of TBIs in China's NSI

Since 1980s China's NSI has gone through paradigm shifts in the quest to transform its command-self reliant economy into a globally competitive economy. Some of the major policy thrusts to achieve this included development of high tech industries, rapid expansion of higher education and science and technology infrastructure, and the development of private enterprises. A number of initiatives such as state support for non-governmental enterprises, development of high technology zones, national standards, and regulation of specific sectors were implemented, which led to the remarkable economic growth rate of China (e.g. 9.6% in 2008 to 10.3% in 2010, when the large part of the world is still under recession). With increasing consensus on the centrality of scientific and technological advances in driving economic growth and progress, China is one of the countries which started giving greater focus and increasing investment in innovation. The

investment in R&D has increased from 1% in 2000 to 1.42% of GDP in 2006 (about 70% by Business enterprises and about 25% by the government). This further increased to 1.75% of GDP in 2010, and will increase to 2.5% in 2020.

Since the 1990s there has been a broad shift from technology policy to innovation strategy, representing a transition from a more top-down, industrial policy approach to development towards a more indirect effort to foster and support technological entrepreneurship. China witnessed rapid expansion of private enterprise over the last decade and their increasing prominence in the economy. This is not surprising as there is a long history of Chinese culture and entrepreneurship. Kirby and Ying (1995), for example, found overlap in some of the requirements of entrepreneurial activity and Chinese culture -- perseverance, diligence, emotional stability, integrity, intelligence, and harmony -- but conflict with others, such as a positive response to change, initiative, profit-orientation, creativity, innovation, and flexibility. Although, a number of measures have been taken to support private enterprise particularly in access to finance and financial incentives, newly-developed private firms still face serious disadvantages such as access to bank loans and enjoying the same preferential tax treatment as state owned enterprise (SOEs) and foreign-invested enterprises. Other problems they face include: government procurement and bidding is in general only open to government departments and SOEs; local governments are slow to give approval for new enterprises; approval procedures, including registration and rectification are complex and burdensome that impose high transaction costs; and there are high barriers to entry in many fields such as high minimum capital requirements (OECD, 2005; Kanamori and Zhao, 2004). To meet the financing of new ventures, different types of venture capital firms -- government, corporate, university and foreign-backed -- have emerged over the years. However, venture capital as an effective mechanism for financing appears to have significant constraints due to institutional, political, and legal characteristics of China's business system, and also due to the direct involvement of the central government in the VC industry (White et al., 2002; Li, 2002).

China has been consistently investing in education and skills over the years and it has reached about 5% of GDP in 2008. One of the major developments in China's NSI was the rapid expansion of higher education since 1990s and the numbers of students studying sciences, engineering, and mathematics (e.g. 600,000 engineers in China compared to 60,000 in the United States) (Newcomb, 2005). Although there are problems with the level of high skills among these vast pool of scientific and technical talents (Farrell and Grant, 2005), the availability of such large population of skilled people is likely to make an impact on innovation and entrepreneurship development in the Chinese NSI.

Over the last two decades, China has been shaping its NSI by embedding two complementary building blocks: a foreign direct investment (FDI)-based innovation system and an indigenous innovation system (Tang and Hussler, 2011). The government has taken a series of measures to attract new actors of innovation (motivating foreign innovators to invest in China, hiring domestic and foreign talents, supporting R&D exchanges between foreign and local actors); to build institutions to catalyze knowledge generation (launching major S&T programmes, developing universities and public research institutes, and protecting innovative ideas); and to promote interactions between indigenous actors of innovation (creating technology market and regional technology transfer alliance, building TBIs, science & technology industrial parks, creating productivity promotion centres and innovation networks, as well as establishing national technology transfer centres and demonstration institutes). Both systems are perceived to impact on China's innovation capability positively. While the former system is expected to compensate the weakness of domestic innovation in high-tech industries, the latter is expected to push domestic firms as the main innovators and strengthen the industry-science linkage. However, the coexistence of these two complementary systems needs to be sustained for a long period, as domestic firms needs time to learn and acquire strong innovation capability. The challenge for the NSI in China is how to strengthen indigenous innovation to guarantee more systematic spillovers between (foreign and Chinese) knowledge creators and Chinese knowledge users. The development of technology business incubators (TBI) is expected to play a key role in meeting this. TBIs create a favourable environment for nurturing small high-tech start-ups to commercially exploit R&D achievements resulting from universities, public research institutes and enterprises. Distinguished from the economic zones, TBIs accommodate and give priority to start-ups with originally China-rooted technology. The technology may not be new to the world but new to China. TBIs are widely used as a policy tool to groom original Chinese-brand technology. In other words, they play an important role at the core of NSI in creating and developing high tech firms which employ high skilled work force.

Since the 6th Five-year plan (1981-1985) in China, all successive national plans made specific emphasis on commercialising technological activities and collaboration between research and production. To achieve this, the Chinese Ministry of Science &Technology sponsored high-tech business incubators in 1988 through the 'Torch Programme'. The first TBI was established independently, that is, outside then existing public policy framework. In 1987, Wuhan province created a TBI in Eastlake, a new technology development zone to encourage academic researchers to create technology ventures. At the beginning, it provided very limited services in terms of

incubation infrastructure and administration support. After seven months, it got the approval from the local government and then went under the umbrella of 'Torch Programme'. Pushed by the bottom-up spontaneity and the objective of developing high-tech industries, in 1996, the State Council announced regulations for accelerating the commercialization of R&D findings. In 1999 it took further policy initiatives to accelerate the development of TBIs. By 2008, 670 TBIs have been set up across the country. These TBIs occupied 231.6 million square metres and hosted 44,346 ventures which generated €18.662 billion[2], and employed 928,000 persons. In all, 31,764 ventures in total have graduated out from these TBIs.

Growth of TBIs in India's NSI

Since 1991, the NSI in India has been going through a transition from an inward-looking (with main focus on self reliance) to an outward-looking NSI (to become globally competitive), driven by economic liberalization policies at home and globalisation from outside (Baskaran and Muchie, 2003; Cooper, 1988). This shift is mainly triggered by the severe economic problems faced by India in the late 1980s and early 1990s. Although the economic growth over the last two decades was significant in India, it was inconsistent compared to China due to specific internal and external factors (e.g. structure of its economy, industry sectors, and export markets).

Over the years, the NSI has developed a higher education system with a strong emphasis on science, engineering and technical disciplines, and also created extensive S&T infrastructure (Mashelkar, 2001). India has been investing about 3 to 4% of GDP in education and skills. Its investment in R&D has been between 0.7% to 0.8% of GDP (about 20% by business enterprises and 75% by the government). In this background, India has been putting a strong emphasis on developing its high tech industries by fostering innovation and entrepreneurship.

At the central government level, the Department of Science and Technology (DST) and Department of Scientific and Industrial Research (DSIR) are the main agencies responsible for promoting science and technology (S&T) activities as well as fostering inventors/ entrepreneurs. In addition, the National Innovation Foundation (NIF) has also been established to enhance institutional support for innovative ventures and activities. A number of 'National Flagship Programmes' such as Technology Promotion, Development and Utilization (TDPU) Programme; Technology Development and Innovation Programme (TDIP); Technology Development and Demonstration Programme (TDDP), and Technopreneur Promotion Programme (TePP) were launched to promote innovation and entrepreneurship. Other policy initiatives include: Science and Technology (S&T) Policy;

National Innovation Act, 2008; and 'Special Innovation Zones'. A wide variety of financial institutions have been set up at the national level to meet diverse financial requirements of the entrepreneurs. These include all India development banks like IDBI, SIDBI, IFCI Ltd, IIBI; specialised financial institutions like IVCF, ICICI Venture Funds Ltd, TFCI; and investment institutions like LIC, GIC, UTI; and the venture capital funds (VCFs) governed by the Securities and Exchange Board of India (SEBI).[3]

India's exposure to technology incubators began with the three pilot projects namely Birla Institute of Technology & Sciences (BIT), Pilani; Shriram Institute, New Delhi; and MITCON, Pune; which were set up with the support of the United Nations Fund for Science and Technology (UNFS&T) during 1987-1990. Of these, only MITCON survived beyond pilot stage after UNFS&T funding came to an end. As the country was going through serious economic problems until mid 1990s, it was not until 2000 that India again started its TBI programme with clear policy strategy. By then, China has established nearly 200 TBIs. What is interesting is that UNFS&T also supported similar initiative in China in 1988 and China subsequently became more successful in creating TBIs than India[4] (Somasekhar, 2001).

TBI programme in India was launched in 2000 by the National Science & Technology Entrepreneurship Development Board (NSTEDB) which was established in 1982 under the Department of Science and Technology (DST) to promote knowledge and technology driven enterprises. Until then, 18 Software Technology Parks (STPs) which were established by the Department of Electronics, and 15 Science and Technology Entrepreneurs Parks (STEPs) which were established by the DST in the early 1980s have been playing the role of technology incubators in India. By 2004, only 15 TBIs were established by NSTEDB, mostly in Institutions of Excellence such as Indian Institute of Technology, Bombay; Indian Institute of Management, Ahmadabad; Birla Institute of Technology, Pilani; Vellore Institute of Technology, Vellore; and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad (Ministry of Science and Technology, 2004).

By the end of 2009, there were approximately 120 TBIs in India. Of these, 40 were established in the Software Technology Parks (STPs), promoted by the Ministry of Information and Communications Technology. About 30 TBIs were promoted by other government departments, banks and financial institutions, and private companies. These included Indiaco (one of the oldest privately established TBIs), Society for Innovation and Development (set up by Indian Institute of Science, Bangalore), and Foundation for Innovation and Technology Transfer (set up by IIT, Delhi). NSTEDB promoted 53 TBIs in collaboration with premier academic and research institutions with

an investment of Rs 10b (about US$21m). Of these, 14 are in Science and Technology Entrepreneur's Parks (STEPs) (NSTEDB, 2009). The incubated enterprises in these TBIs have generated cumulative revenue of Rs 59.5b (about US$125m) by 2009 (NSTEDB, 2009, p.6). TBIs under NSTEDB focus on technology areas such as information and communication technology (ICT), biotechnology, new materials including nano materials, instrumentation and maintenance, manufacturing and engineering, design and communication (media & infotainment), health and pharma, agriculture and allied fields, and energy and environment. Tenant companies in a TBI may number 10 to 20 and they generally graduate out after 2-3 years of incubation.

Although there was no comprehensive study about all the 120 TBIs, it is estimated about 500 enterprises graduate from them every year and 60% of them are technology based start-ups (NSTEDB, 2009, p.11). In recent years there has been increasing involvement of various government departments in setting up TBIs. Various State (provincial) Governments are also making strong efforts towards setting up infrastructure and allocating funds to develop entrepreneurship. These government agencies are increasing their effort with the aim of setting up 1000 TBIs (Gupta, 2010).

6. Comparison of Chinese and Indian TBIs

Both in China and India TBIs are mainly supported by public funding (they are non-profit organisations in China). The aim is to reduce the cost of creating businesses by providing services, with the ultimate goal of creating jobs and sustaining regional economic development. Although there are private sector TBIs in India, over two thirds of TBIs are promoted by the central government and also state (provincial) governments are setting up their own TBIs. In this section, we compare the TBIs in China and India by using the three indicators adapted from Mian (1997) which are set out in the analytical framework: Management and Operational Policies of Incubators, Services Provided by TBIs, and Performance outcomes.

6.1. Management and Operational Policies of Incubators

In this part we analyse TBIs in China and India using the sub-indicators: objectives and governance structure, TBI funding system and new venture creation, selection, graduation procedures and duration.

(a) Objectives and Governance structure

In China, the main objectives behind TBIs are: creation of technology based new enterprises, facilitating technology transfer, creating jobs and regional economic development.

TBIs, at the macro-level, are under the direction of central government, namely the Ministry of Science & Technology (MOST). But at the micro-level, they are governed by the local government, sometimes with participation from universities, state-owned enterprises and other sponsors. These founders and funding institutions have representatives on the Board of Directors of TBI, which is responsible for making policies and monitoring. Below the board level is one or more management committee(s), responsible for guiding the creation of TBI at the very early stage, auditing the finances, implementing human resources management, and setting entry and exit criteria for tenants (Ma et al., 2008). Besides, an administrative office is created to manage daily operations, network building, interact with clients, access to external funding and to maintain the physical facilities. The selection of tenant firms is organised within the TBI by involving outside experts to assess the business plans.

In India, the main objectives behind TBIs are: (i) creating technology based new enterprises; (ii) creating value added jobs and services; (iii) facilitating transfer of technology; (iv) fostering the entrepreneurial spirit; (v) speedy commercialization of R&D output; (vi) and providing specialized services to existing SMEs. Over two thirds of TBIs are government promoted and the rest are under financial institutions and private companies. The government promoted TBIs are based in what is known as Host Institutions (HI) which is expected to play a major role during and after the establishment of the TBI to ensure its efficient functioning. The HI which may be from the public or private sector has to provide the requisite land and building for the TBI which mainly draws upon the existing facilities of HI. That is, HI should provide a building area of about 5,000-10,000 sq. ft. and also utilities such as electricity and water. TBI would create certain essential facilities such as modern work space, communication facilities, computing facilities and vital equipment needed, library and information centre, and training and conference facilities. The HI can decide the legal status of the TBI, which may be one of following: (i) not-for-profit registered society; (ii) registered trust; and (iii) registered company, known as section 25 company. In the case of a NSTEDB promoted TBI, a memorandum of understanding (MOU) has to be signed by the TBI, HI and DST, clearly defining the role of each agency. In some cases the State (provincial) Government and other government agencies may also be involved in setting up TBIs to promote specific industry such as food processing, and bio-technology. Financial

institutions like Small Industry Development Bank of India (SIDBI) have also set up TBIs (e.g. TBIs at Indian Institute of Technology, Kanpur and BITs, Ranchi).

Table 2: Typical Profile of a TBI in India

	Electronics & ICT Domain	**Biotech & Agriculture Domain**	**Mechanical & Manufacturing Domain**
Total Floor Area	8500 -10000 sq ft	10000 to 20000 sq ft	15000 to 25000 sq ft
Number of Companies	15-20	8-12	10-15
Floor area for Each Company	100-300 sq ft	225-750 sq ft	350-500 sq ft
Number of Employees at Start-up	1 to 5	3 to 10	3 to 10
Incubation Period	1 to 2 years	2 to 3 years	3 to 5 years

Source: NSTEDB (2009a), Chapter 2.

An Indian TBI is generally governed by an Advisory/ Governing Board, which formulates a strategic plan that proposes quantifiable objectives and an efficient management system. The Board membership consists of representatives from promoting department/ agencies and outside experts. That is, they may be representatives of DST, SIDBI, HI, industry, VC companies, entrepreneurs, student bodies and tenants of the TBI. The Board will set up a separate expert committee for the selection of tenant firms. The day-to-day operations of TBI are managed by the Chief Executive Officer/Managing Director and a management team which may include one or two experts with technical/managerial qualification and relevant industry experience. These experts manage areas such as business planning, technology transfer, training and consultancy. The management team also includes accounts/administrative officer and a secretarial assistant. TBI also hires outside experts/ consultants (selected from a panel of experts) to provide specialist skills and expertise when needed on case by case basis (e.g. technical, legal, intellectual property, fund management) (NSTEDB, 2010). A survey of 36 TBIs by DST revealed that majority of the governing boards consisted of 11 to 20 members. Table 2 illustrates the profile of a typical TBI in each selected technology domain.

(b) TBI Funding System

As about 90% Chinese TBIs are non-profit organisations, local governments provide subsidies to TBIs. At the very early stage, government often offers free land and initial construction funds. At the operation stage, government provides finance in three different ways: (i) bears all operation cost of TBI but TBI should submit all income to the government; (ii) compensates the cost-income spread of TBI; (iii) subsidises TBI based on its performance (Ma et al., 2008). For private TBI, the funding mainly depends on sponsors themselves. Bank loans are often easily accessible in the early incubator construction stages.

In India, each TBI prepares a detailed project proposal including the cost and submits to NSTEDB. The project cost may range from Rs 40m to 70m. NSTEDB provides support for capital expenditure such as procuring specialised equipment, software and support facilities, and also provides partial support for recurring operational expenditure for five years. The building and basic infrastructure cost is borne by the HI. In case of private sector HI, nearly 50% of the project cost is borne by the HI. Each TBI is expected to become self sufficient within a period of five years and become free from depending on government funding. The TBI project is implemented by an expert Project Manager. After the disbursement of first instalment of funds by the NSTEDB, the subsequent funding requires financial reporting from the TBI which includes funds utilisation certificate, statement of audited expenditure, audit report, activity progress report, action plan for next year, periodic review of performance and recommendations by National Advisory Committee (NAC) (NSTEDB, 2009).

(c) Funding of New Ventures

In China, over 49% of the available funds for tenant firms are raised by the companies themselves, and government support accounts for only 2.9%. Tenant firms in a TBI can obtain financial support from three different sources:

- **Ministry of Science & Technology (MOST):** With the assistance of TBI, tenant firms apply to the Innovation Funds for Technology-based SMEs (Innofund) provided by MOST, through a project competition. Innofund attracts other investments for incubated firms. In 2005, the average support from Innofund per project reached RMB 769,612.[2] Most of the government's financial support is allocated through various national S&T programme competitions and through Innofund

(51% of the programme), which distributes non-refundable and refundable grants and also provides loans on favourable terms.

- **Local Government Agencies:** The local Departments of Finance, S&T Bureau and the Bureau of Industry, Commerce and Taxation are directly involved in pooling funds, identifying investments and channelling funds into new ventures. For instance, government-backed guarantee companies have been set up to guarantee bank loans to local ventures (White et al., 2005). Tenant firms benefit from 'tax holidays', rents at lower than market prices, 'one shop' administrative services and other preferential conditions provided by local governments. Tenant firms can continue to benefit from favourable tax policies after the period of incubation if they are recognized as high-tech firms.
- **Investors:** In the early stages, venture entrepreneurs mainly depend on self-funding and only few ventures can get seed capital from TBI-based venture capital. During the incubation process, financial support can come from domestic and foreign venture capital, and regional and national Innofunds. But the funding mainly depends on individual applications and bank loans. Regional and national Innofunds are limited, and venture capital funds are difficult to obtain due to the strict selection criteria.

In India, tenant firms can obtain funds from different sources: (i) Seed funding (Rs 2m to 5m, i.e. up US$100,000) from NSTEDB which is disbursed through TBIs and seed funding by Technology Development Board/DST (Rs 100,000 to Rs 2.5m, average is Rs 1m); (ii) Angels network/ Venture capital (VC); (iii) Lending from commercial banks/ Financial Institutions; (iv) Grants-in-aid such as the Technopreneur Promotion Programme, administered by the DSIR to support individuals with innovative ideas. The Angels network includes Indian Angels Network and Mumbai Angels Network which were formed in 2006. The members of angel networks invest in early stage businesses, mostly in sectors such as IT, intellectual property, internet, mobile, education and hospitality. Many members of Mumbai Angels Network have prior Silicon Valley experience. The network also provides mentoring, links to vast networks in India and abroad, and inputs on strategy. The network looks at investing from US$100,000 to $1m and exiting over 3 to 5 year period through IPO, M&A, or strategic sale. The VC firms are part of Indian Venture Capital and Private Equity Association (IVCA) which provides funds for seed ventures and early stage companies.

There are different categories of venture capital funds (VCFs) which are governed by the Securities and Exchange Board of India (SEBI). These includes VCFs promoted by the Central Government controlled development finance institutions such as ICICI Venture Funds Ltd., IFCI Venture

Capital Funds Limited (IVCF), SIDBI Venture Capital Limited (SVCL); those promoted by State Government controlled development finance institutions such as Gujarat Venture Finance Limited (GVFL), Punjab Infotech Venture Fund, Hyderabad Information Technology Venture Enterprises Limited (HITVEL); those promoted by public banks such as Canbank Venture Capital Fund, SBI Capital Markets Limited; those promoted by private sector companies such as IL&FS Trust Company Limited, Infinity Venture India Fund; and those established as an overseas venture capital fund such as Walden International Investment Group, SEAF India Investment & Growth Fund, BTS India Private Equity Fund Limited.[5]

A study by Sunil Mani (2001) found that the operation of venture capital in India conformed to the ideal model of providing equity support to technology-based ventures in their early stages. However, according to the First Status Report on Technology Business Incubation in India (NSTEDB, 2009a), when 28 tenants were surveyed their responses to the question of 'Funding pattern of start-ups' were as following: Own investment – 35%; Friends/ Family – 27%; Loan – 17%; Seed – 10%; Angel – 7%; and Grants – 4%. This suggest that in practice, the early businesses are predominantly funded by own finance, by friends/ family, and loans, rather than VC and Angels, which reflects largely the experience of tenant firms in China.

In practice, the early stage businesses have been facing serious difficulties in getting funds from organised investors such as banks. There was a big increase in early stage funding by VCs in 2000, but it came to an end after their portfolio companies went out of business during dot.com market crisis. Until 2004, the nature of venture capital in India was "more of a glorified loan rather than a true risk", as the VCs were more concerned in protecting their capital than taking real risk. This was mainly due to the problems faced by the VCs as technology adoption within Indian companies was slow (Hariharan, 2004). Also, the VCs faced uncertainties about exit route, as the starts-up were taking longer time for maturity (Varma, 2004).

However, the situation appears to have improved in recent years, as investors are more willing to accept risk and there are more funding programmes for early stage/start-up businesses. For example, iAccelerator programme started by Centre for Innovation, Incubation, and Entrepreneurship (CIIE) at IIM, Ahmadabad, provides start-up funding of $10,000 for entrepreneurs who have good business ideas in the internet and mobile areas. Indian Angels Network and Mumbai Angels Network are also funding more early stage ventures than in the past (Gupta, 2010). The VC schemes of SIDBI have also improved it funding mechanisms to support early stage companies. As a result, VC investment increased by 3% to Rs 388.8b with 80 deals completed compared to Rs 378.9b invested in 85 deals in 2007 (NSTEDB, 2009a, p.82).

(d) Tenants Identification and Selection Procedure Leading to Graduation

In China, selection of tenants is often organised within TBI, and the selection team comprises of incubator staff and external experts. The selection criteria related to the incubated project include: belonging to a high-tech field, ownership of intellectual property rights, mature technology with commercial potential, and environmental-friendly products. Other selection criteria include: legal status (clear ownership and independent economic entity) - less than 2 years, registration and work place within incubator, registered capital less than €0.2 million, firm's incubation surface less than 1000m^2 and the qualifications of venture entrepreneurs (e.g. R&D professionals).

The average incubation period is three to five years depending on the industrial sector and the incubation agreement. The MOST gives an outline of graduation criteria, such as recognition of high-tech firms, sales income over €0.5m, physical assets and self-funding more than €0.1m. Each incubator can set specific graduation criteria based on the MOST criteria. For example, when the incubation period expires, some TBIs require firms to submit graduation documentation, such as balance sheets, resources declaration sheets, management reports and so on. On the basis of these documents and an on-site inspection, the incubator decides whether the firm should graduate, semi-graduate (if certain graduation criteria are unfulfilled), have the incubation period extended or have the incubation discontinued without graduation. In sum, to graduate from the incubator, firms are required to meet certain exit criteria with respect to sales income, R&D expenditure and highly qualified team members.

In India, the identification of potential entrepreneurs/tenants are done through business meets, referrals, and business plan competition. They are provided pre-incubation support such as one-to-one counselling, help for developing of business plan and network support. The TBI usually sets up a Selection Committee which is composed of representatives from the faculty of the Host Institute, Financial institutes, and Technical domain experts. However, the selection policy/criteria may differ among TBIs depending upon their mission and overall objectives. Generally, the following criteria are applied for selection: (i) sound idea and business plan which are pertinent to the core areas of the TBI; (ii) commitment and integrity of promoters; (iii) potential for growth; (iv) willingness to accept and follow mentoring/ advice; (iv) capacity to meet targets; and (vi) willingness to pay for the facilities and services. The TBI enters into a legal framework with tenants such as commercial agreements, facilities agreement, and exit/ graduation terms. Exit criteria is incorporated in incubation agreements which includes maximum time limits (e.g. 2 to 3 years), stepped up rent (gradually increas-

ing each year), incentives to exit, gradual reduction of subsidies, and non-performance (NSTEDB, 2009a, pp. 23-24).

6.2. Services Provided by TBIs to Tenants

In this part, we use the second indicator - Services Provided by TBIs to Tenants (from our analytical framework) to compare TBIs in China and India.

Chinese TBIs provide various services (see Figure 2): assessment and selection of business plans at the pre-incubation period; access to physical resources such as office space, common meeting rooms, and IT infrastructure; business support services such as secretarial and mail services, security systems, and firm registration; access to capital, including seed money, and venture capital; business development support such as mentoring, coaching, consulting, but also legal advice and book-keeping; networking services, and contacts with customers, collaborators and potential investors at the incubation period; and track service in post-incubation period. In many Chinese TBIs, the emphasis is on buildings and administrative management (Zhang et al., 2004; Sun et al., 2005; Ma et al., 2008).

Value-added services such as business/marketing consulting and funding services for tenant firms appear to be less satisfactory, except in the case of top ranking ones, such as Caohejing TBI and Zhangjiang TBI. This is due to a number of reasons such as financial constraints hindering TBIs from providing professional services, less experienced incubator management staff resulting in low level of interactions between incubators and market actors, and reluctance of tenant firms towards paying for professional services. As a result, in many cases, tenant firms have to find and exploit niche markets without outside help.

In India, the TBIs provide a number of services to the tenant companies (see Figure 3): (a) mentoring or access to mentors from within TBI management or outside (but this does not appear to be working well in TBIs located outside first tier cities); (b) networking for business development, that is, providing access to tenants different professional services such as legal, accounting, taxation and intellectual property, business support, skills, markets and customers, and finance. The network includes banks, business angels, VCs, business links, customer networks, local authorities, and high education/research institutions; (c) providing basic/ infrastructure facilities such as work space, meeting room, reception area, computing and communications, office equipment, networking areas, lab space, and utilities.

TBIs also provide safety and security to protect the physical and intellectual properties of the tenants such as expensive equipment and intellectual property assets. The developed/mature TBIs also provide addition-

al/specialist (value added) services and facilities such as seed funding and patenting facility.

A survey by DST has shown that typically the following support services are provided by the TBIs to their tenants: infrastructure support (seminar hall, power back up), laboratory and testing equipment facility, mentoring support, and facilitation of funding support (NSTEDB, 2009a). TBIs also provide some post-incubation period support by creating links between the graduated firms and the new start-ups, and facilitate networking for future mentoring.

6.3. Performance and Outcomes in TBIs

In this part, we use the third indicator from the analytical framework - Performance and Outcomes to analyse the TBIs in China and India.

Table 3 provides the growth and performance of TBIs in China between 2005 and 2008 in different measures. The number of TBIs increased from 534 to 670 and the number of tenants increased from 39,491 to 44, 346. Total income of tenants has risen from €162m to €186m. Very significantly, the number of tenants graduated doubled from 15,815 to 31,746, and also the number of employees of tenants increased by 21,000. These figures show that the TBIs' growth and performance in China is very significant overt this period.

Unlike the case of China there is a lack of availability of comprehensive performance related data for TBIs in India. For example, the First Status Report on TBIs in India was released only in 2009 by the NSTEDB/DST. Even this report is based on a sample of 28 tenant firms and 36 respondents (NSTEDB, 2009a). Only summary information for performance TBIs in India is available. According to NSTEDB, there are about 120 TBIs in India. Of these, 53 are under NSTEDB/DST, 40 are STPs promoted by Ministry of Information and Communication Technology, and 30 are under other government departments, banks, financial institutions and private companies. It is estimated that about 500 enterprises graduate from the TBIs every year and 60% of them are technology based start-ups (NSTEDB, 2009, pp. 10-11); and "over 1150 entrepreneurs have been nurtured and incubated in the NSTEDB supported incubators up to 2008" (NSTEDB, 2009, p. 39).

Figure 2: Services Provided by the Chinese TBI to Tenant Companies

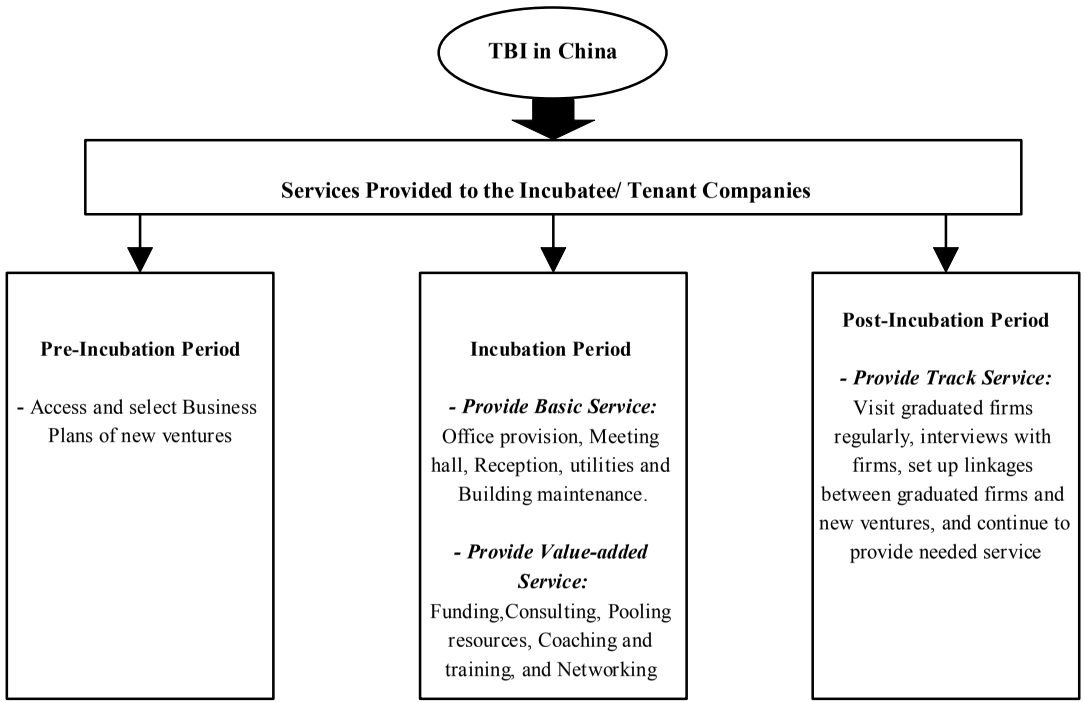


Figure 3: Service Provided by the Indian TBI to Tenant Companies

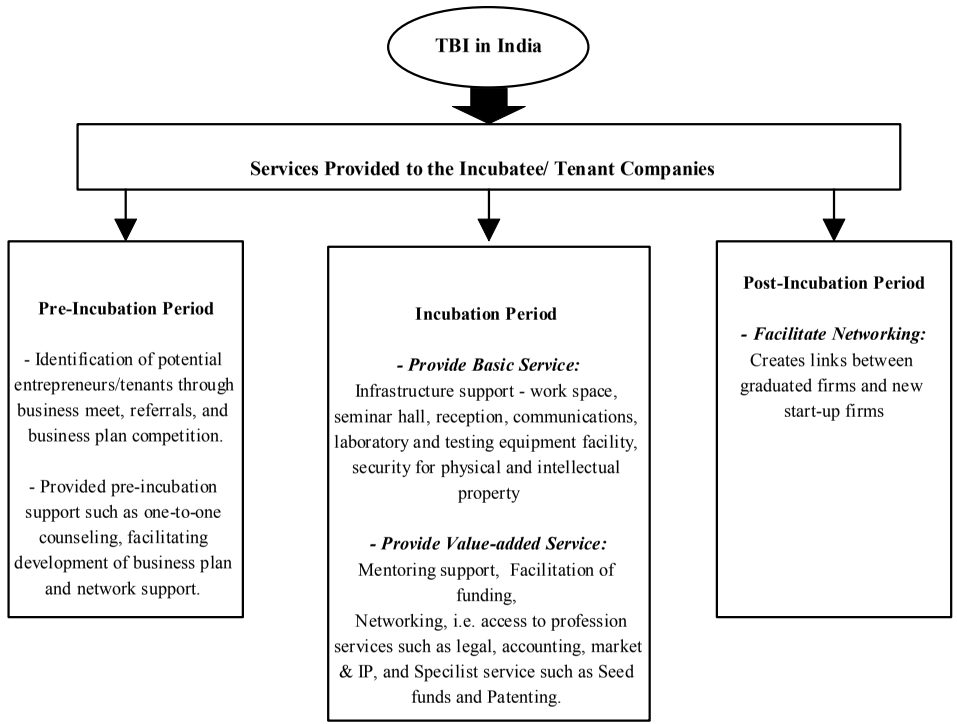


Table 3: The Development and Performance of TBIs in China (2005-2008)

Indicators	2005	2006	2007	2008
Number of TBI	534	548	614	670
Incubation surface 1000sq.m	1 969.9	2 008	2 270	2 316
Number of tenants	39491	41 434	44 750	44 346
Total income of tenants (€million)	162.54	192.6	262.1	186.62
Number of graduated tenants	15 815	19 896	23 394	31 764
Number of tenant employee (1000person)	71.7	79.3	93.3	92.8

Source: Government of China, China Torch Statistical Yearbook (2009).

Monitoring of performance of TBIs in India is done at two levels – local and national levels. At the local level, the Governing/ Advisory Board monitors and reviews the performance on quarterly basis and takes feedback on satisfaction of the stakeholders and incubate companies. At national level, the National Expert Advisory Committee (NAC) which is composed of representatives from the government, industry, VCs, and other stakeholder organisations reviews the TBI performance twice a year against a set targets and parameters. In addition, visit to the incubators are also undertaken by the DST officials (NSTEDB, 2009). However, a survey indicated that only in about 70% of the TBIs surveyed there are monitoring committees (NSTEDB, 2009a). Therefore, it is not clear how effective is the monitoring system at both local and national levels.

Table 4a: Comparison of TBIs in China and India: Management and Operational Policies

<table>
<tr><td>Objective</td><td colspan="2">Mostly TBI objectives are similar in China and India. These are: Creation of technology based new enterprises, facilitating technology transfer, creating jobs and regional economic development.</td></tr>
<tr><td>Nature of Ownership</td><td colspan="2">China: Non-profit organizations and mostly government-sponsored
India: Both profit and Non-profit organisations – More than two third TBIs are government promoted and about one third by others such as banks and private companies. Host institutions where the TBIs are located play an instrumental role in management and performance of the TBI.</td></tr>
<tr><td rowspan="2">Governance/ Structure</td><td colspan="2">China: Central government directly involved in implementation and monitoring; Governed by local government and other investors; Board of Directors.
India: Central government plays a promoting role and has loose control over TBIs. The main bodies that govern the TBIs are the Governing/ Advisory Board and the Executive Management Team at the local level. Unlike China, the Local or Regional governments do not have major control over TBIs, except where they are involved as one of the stake-holders.</td></tr>
<tr><td>China:
(a) Number of Management personnel varies between 5 and 97. The majority of management size is above 10 personnel and average is 19.9.
(b) Management Committee: interface between government, universities, enterprises, other investors and community.</td><td>India:
(a) Governing Board members varies from 0-5 to 16 to 20. Average seems to be 11 to 15.
(b) The management team includes Chief executive and, professional/ technical experts which interface with outside agencies including universities and industry.</td></tr>
</table>

Table 4b: Comparison of TBIs in China and India: Sources of Funding of TBI

	TBIs in China	TBIs in India
Sources of Funding of TBI	(a) Local government (free land and initial fund). (b) Other sponsors such as universities, state-owned enterprises and other investors.	(a) Central government (b) Host institutions (c) Financial institutions (d) Private sector companies
Funding of New Ventures	In both countries: Very complex system with many potential funding institutions at different levels. High proportion of venture capital comes from entrepreneur themselves. Weak venture capital system especially at early stages. Public funding used (as seed) to attract other funds from other sources.	
	China: (a) Critical role played by incubator at early stages of firm creation. (b) Innovation fund is available for new ventures through a project competition. (c) Local government agencies pool funds, identify investment and channel funds into new ventures.	India: (a) TBI plays a critical facilitating role to obtain funding for start-ups and provide seed capital in some cases. (b) Weak support from Angels and VC, but improved in recent years.
Selection	China: Required to hold intellectual property with market potential and have a qualified entrepreneurial team. India: Selection policy may differ among TBIs depending upon their mission and overall objectives.	
	Meet the requirement of MOST such as: (a) maximum registration capital; (b) foundation year; (c) registration place; (d) incubation surface; (e) property of high-tech and environment friendly products; and (f) professional entrepreneurs.	Generally, meeting the following criteria: (a) sound idea and business plan; (b) commitment and integrity of promoters; (c) potential for growth; (d) willingness to follow mentoring/ advice; (e) capacity to meet targets; and (f) willingness to pay for facilities and services.
Duration	3-5 years depending on the sector	2-3 years depending on the sector (duration can be reviewed)
Graduation	A series of formal criteria determined by MOST and TBI	A series of formal criteria determined by TBI (Bench marks suggested by NSTEDB/DST)

Table 4c: Comparison of TBIs in China and India: Services Provided to Tenant Companies

Services Provided	TBIs in China	TBIs in India
Similarities in services	Physical resources, business operation support, access to capital and investments, mentoring, coaching, consulting, legal advice, book-keeping, networking services (links with customers, universities, investors etc.)	
Differences in Services	China: (a) Emphasis on building and administrative services. (b) Networking not well developed. (c) Focus on few services on competitive advantages.	India: (a) Emphasis on basic – infrastructure service. (b) Significant value-added services: Mentoring and Networking. (c) Matured TBI provide specialist services such as Seed and Patenting.

Table 4d: Comparison of TBIs in China and India: Performance and Outcomes

Outcomes	TBIs in China	TBIs in India
During the period 2005-2008 (on average)	China: (a) 72 tenant firms per incubator (b) 19.75 employees per tenant firms (c) 37.85 graduated firms per incubator	India: (a) It is estimated that about 500 tenants graduate every year from total TBIs in India (b) 60% of them are considered to be technology based start ups. (c) In terms of number of TBIs, number of tenants, employees of tenants and income, India is far behind China.

Tables 4a, 4b, 4c and 4d provide comparison of Chinese and Indian TBIs. They show both countries have similar features in terms of objectives, selection criteria for tenants, funding of new venture, and various basic services provided to the tenants. But they also show some important differences: nature of structure and governance of TBIs, funding of TBIs, value-added services and specialists services provided by TBIs to the tenants, duration of incubation for tenants, and in terms of number of TBIs, tenant firms, employees of tenants, and revenues generated by the tenants.

6.4. The impact of NSI on Development of TBIs and their Environment

Table 5 attempts to link our integrative analytical framework to the experiences of the cases and identify the major components of NSI (sub-elements) in each case that shaped and had some impact on the development of TBIs and helps compare them. It clearly shows that although all components identified in the analytical framework have contributed to the way the TBIs' development took shape in China and India, some specific components of NSI in each case have played more significant role in influencing the TBIs development and their environment.

First, the macroeconomic conditions clearly played a crucial role in the way the TBIs developed in each case country. In China, due to sustained stable economic conditions, there has been consistent effort to develop TBIs since the 1980s. Although there were shifts in policy focus over the years, the main thrust on developing TBIs could be consistently maintained due to sustained economic growth and stability. In India, the macroeconomic conditions were unstable and the national economy was growing unevenly until 2003. The economy was in serious crisis by 1991, when the liberalization of the economy was initiated. This affected policies of almost all industrial sectors including the development of TBIs.

Second, clearly the national science, technology and innovation policy framework in each has played a major role in the way the TBIs development took shape. In China, under different national S&T programmes, there has been consistent effort to develop TBIs through central funding mechanisms. These programmes were implemented across the country involving all major industrial sectors. In case of India there has been selective development of TBIs under the targeted programmes and initiatives such as Software Technology Parks (STPs) and Science and Technology Entrepreneurs Parks (STEPs), but there was no thrust to develop TBIs on a national scale across all sectors of the economy and across all regions of the country.

Third, the industrial structure, mainly in terms of private and public ownership, also influenced the way TBIs were developed in China and India. Even though there has been significant growth of private enterprises in China, the role of central government, local governments and state institutions is still very strong and decisive. TBIs, at the macro-level, are under the direction of the central Ministry of Science & Technology (MOST) and, at micro-level, they are governed by the local government. Almost all of the TBIs are state funded. In India, historically there has been a very strong and thriving private sector. Although the central government through the Department of Science and Technology (DST) guides and supports the development of TBIs, most of them are autonomous (societies or companies) and some of them are privately owned. They are not controlled by the state. This

appears to be making a big difference particularly in recent years towards achieving a rapid growth of TBIs in India.

Fourth, in the area of financing of TBIs, in China, there have been strong and sustained efforts to provide access to finance both at national and local levels through targeted banks and other financial institutions. This is further strengthened by the emergence of different types of venture capital firms -- government, corporate, university and foreign-backed, although private enterprises still face some disadvantages in accessing finance compared to state owned enterprises. In India, although banks have been set up both at national and provincial levels, the results of their effectiveness appear to be mixed due to bureaucratic constraints, and political and economic policy shifts. A strong venture capital sector (government, corporate and foreign owned) and business angels network have emerged over the last decade, but they are still taking shape and yet to make a decisive difference in the TBIs development and their environment. For example, there are still problems to access VC for very small ventures.

Fifth, both China and India have large domestic markets and are well linked to global and regional markets. Also, both countries are very attractive FDI destinations, although China is far ahead in some areas of FDI. However, there are no clearly identifiable market related factors that led to differences in the TBIs development in between China and India (which requires further investigation).

Sixth, both countries have been investing significantly in the education and R&D sectors, although China has been investing significantly more in both areas than India. Again, some of the differences in TBIs development in both countries can be traced to different strategies followed by them in using universities and higher education institutions. In China, the university incubators are well established, but they are a small part of the whole TBI environment. In India, predominantly the TBIs are mainly based in national and provincial level higher education institutions (known as host institutions - HIs), while other types of TBIs are in small number. This is because of the national initiative by the DST to develop TBIs rapidly to catch up with countries like China, as India lost over 10 years without major effort to develop TBIs in the 1990s.

Table 5: Some Major Components of NSI that Shaped and Impacted on the Development of TBIs: Comparison of China and India

Components of NSI	China	India
1. The general investment climate and economic policy framework: (a)Macroeconomic conditions and stability (b) Regulatory regime such as trade and tax policies	(a) Major shift in macroeconomic policy since 1980s, consistent liberalisation of policy regime. Steady growth of GDP (from 7% to over 10% in last 10 years). (b) Comprehensive regulatory regime aimed at supporting enterprises through tax, R&D, and trade incentives. However, there are problems for private enterprises to access these incentives and due to bureaucratic procedures at local level.	(a) Severe macroeconomic problems faced in late 1980sand 1990s; Economic liberalisation policy since early 1990s. Inconsistent GDP growth (4.4% to 9.5%), but more consistent from 2003 to 2007. (b) Comprehensive regulatory regime aimed at supporting enterprises through tax, R&D, and trade incentives. But there are problems due to excessive bureaucracy.
2. National Science, Technology & Innovation Policy Framework: (a) National S&T projects/ policy initiatives (b) National effort towards innovation and enterprise development	(a) Central government identified high tech sectors for growth and initiated policies to achieve that in all 5-year plan since 1980s. Example: Recent focus on 'sunrise' industries such as biotechnology, nanotechnology, and electro-optics. (b) Key Technologies R&D Program (initiated in 1982); National High-tech R&D Program (863 Program – initiated in 1986);National Science and Technology Infrastructure Program; Environment Building for S&T Industries; and A number of S&T programs, such as the Spark Program, Torch Program were initiated over the years.	(a)Central government identified specific high tech sectors for growth particularly since 1980s (Computer policy, Electronics policy) such as software, and bio technology and initiated measures to achieve them such as setting up Software Technology Parks (STPs); Science and Technology Entrepreneurs Parks (STEPs); Science and Technology (S&T) Policy; National Innovation Act, 2008; and setting up 'Special Innovation Zones' (b) A number of programmes such as Technology Promotion, Development and Utilization programme; Technology Development and Innovation Programme; Technology Development and

		Demonstration Programme, Technopreneur Promotion Programme were launched to promote innovation and entrepreneurship
3. Nature of Market Environment: (a) Domestic market size / structure (b) Links to regional and global markets	(a) Large domestic market than other cases and strong domestic demand (b) Strong links to Asian markets as well as global markets such as EU and the US	(a) Large domestic market and strong domestic demand (b) Strong links to Asian markets, EU and the US
4. Industrial structure: (a) Presence of diverse industrial structure (b) Strength of domestic firms (c) Presence and role of foreign firms, and links to foreign companies	(a) Diversified sectors with manufacturing sector leading. (b) Strong domestic firms led by state owned firms and emergence of diverse private sector firms over the last 2 decades, but they mostly look for support from the state. (c) Strong presence of foreign firms, as China is the leading destination for FDI inflow. (d) Inward FDI -13.5% of GDP (2001-2005) and 9.6% in 2007.	(a) Diversified sectors with services sector playing leading role. (b) Strong domestic firms, both Public and private sector firms. (c) Significant presence of foreign firms in selected sectors such as technology and services, as India emerged as a leading destination for FDI inflow in these sectors. (d) Inward FDI -5.2% of GDP (2001-2005) and 6.7% in 2007.
5. Financial Institutions: (a) Banking sector (b) Venture Capital (c) Other sources of financing for start-ups and new enterprises	(a) A number of measures taken consistently to support new enterprises/ventures particularly in access to finance and financial incentives (both national and provincial levels). (b) Variety of banks providing loans to new enterprises, both at national and provincial levels. However, there are disadvantages for private enterprises in receiving bank loans and enjoying the same preferential tax treatment as state owned enterprise (SOEs) and foreign-invested enterprises. (c) Emergence of different types of venture capital firms -- government, corporate, university and foreign-backed. However, venture	(a) A number of initiatives to support new enterprises particularly in access to finance and financial incentives (both national and provincial levels), but these appears to be less effective due to too much bureaucratic requirements. (b) Banks at national and State (provincial) levels have been set up to support new enterprises/ventures by the government. But the results appear to be mixed due to political and economic policy

	capital as an effective mechanism for financing appears to have significant constraints. (d) Presence of a large informal financial sector catering to private enterprises	shifts/ changes. (c) Emergence of a strong venture capital sector (government, corporate and foreign owned) over the last decade. However, there are problems to access VC for very small ventures. (d) Emergence of Business Angels network; Presence of Informal financial sector catering to private enterprises.
6. Skills, R&D, and Technology development (a) Investment in education and skills (human resources) development (b) Investment in R&D	(a) Investment in education and skills has been significant over the years and has reached about 5% of GDP in 2008. (b) Investment in R&D has been between 0.86 in 2000 to 0.92% of GDP in 2006 (about 70% by Business enterprises and about 25% by the government). This increased to 1.5% of GDP in 2008, and will increase to 2.5% in 2020.	(a) Investment in education and skills has been between 3 to 4% of GDP (b) Investment in R&D has been between 0.7 to 0.8% of GDP (about 20% by Business enterprises and 75% by the government)

Source: ESCAP (2009), Tables 1 to 9, pp. 174-182; Ministry of Finance, Government of India (2008), from Table 7.4B, pp. A95-99; National Bureau of Statistics of China (2009).

To sum up, it is clear that major components of NSI such as macroeconomic conditions, national S&T policy framework, industrial structure (role of state and private enterprises), and the nature of financial institutions significantly shaped the nature and rate of TBIs development in China and India.

7. Conclusions

We have compared the TBIs in China and India by employing an integrative analytical framework that combines the model developed by Mian (1997) and the national system of innovation concept. Our comparative analysis of TBIs in China and India brings out the following major findings: (i) The crucial role played by the government agencies in fostering TBIs (in China nearly all TBIs are government sponsored, while about two thirds of TBIs in India are government supported); (ii) TBIs in both countries are increasingly trying to provide varieties of value-added services in addition to basic infrastructure related services, but there appears to be significant differences among TBIs within each country in terms of range and complexity of value added services provided; (iii) China's achievements and India's poor performance in the growth of TBIs (although both started at the same time in the 1980s, India is far behind China in terms of number of TBIs, tenant firms, employees of tenants, and revenues generated by the tenants.) show that developing TBIs is resource and time intensive and needs consistent and sustained effort; (iv) Although objectives and motivations behind TBIs are similar in both countries, the governance and ownership structure of TBIs show significance difference (e.g. the increasing role of private sector TBIs and different types of ownership of TBIs in India); and (iv) While universities play a major role in TBIs in China, selected higher education and specialist academic institutions play pivotal role as 'host institutions' in TBIs in India.

Our study shows that the differences and contrasts between the TBIs in China and India are mainly due the differences between the NSIs of China and India. Major components of NSI such as macroeconomic conditions, national S&T policy framework, industrial structure (role of state and private enterprises), and the nature of financial institutions have played significant role in shaping the nature and rate of TBIs development in both countries. Therefore, building and strengthening the NSI is imperative to achieve high outcomes in the growth and performance of TBIs. Specific and strong measures to develop TBIs alone may not be enough to produce desired outcomes, if the NSI is weak. That means, the context in which TBIs are developed and operate matters and therefore effort to strengthen the NSI

in a national economy is imperative to achieve successful performance outcomes from TBIs.

Notes

1 Lee and Osteryoung (2004) evaluate the performance of UIs in US and Korea and found no major differences other than their goals and operational strategies.

2 RMB100 = €9.532 (based on April 2007 values).

3 See: http://business.gov.in/business_financing/index.php

4 Ironically, five Indian experts from the Entrepreneurship Development Institute, Ahmadabad who were employed by UNFS&T played a major role in preparing the Chinese program of TBIs and one of them, Dr. Rustam Lalkaka continued to be a leading consultant to the Chinese incubator programme.

5 http://business.gov.in/business_financing/index.php

References

Allen, D. (1985), 'An entrepreneurial marriage: business incubators and start-ups', in *Proceedings of the Fifth Annual Babson College Entrepreneurship Research Conference*, Center for Entrepreneurial Studies, Babson College, Wellesley, Massachusetts.

Allen, D. and Levine, V. (1986), *Nurturing advanced technology enterprises: emerging issues in state and local economic development policy*, New York: Prager Publishers.

Baskaran, A. and Muchie, M. (2003), 'Towards African National System of Innovation: Sharing with the Experiences of Indian National System of Innovation', in Muchie, M.., Gammeltoft, P. and Lundvall, B.-Å. (eds.), *Putting Africa First: The Making of African Innovation Systems,* Aalborg, Denmark: Aalborg University Press.

Baskaran, A. and Muchie, M. (2011), 'Can the Relative Strength of the National Systems of Innovation Mitigate the Severity of the Global Recession on National Economies? – The Case of Selected Developed Economies,' *Paper presented at the DIME Final Conference*, 6-8 April, Maastricht, Netherlands.

Becker, B. and Gassmann, O. (2006), 'Corporate incubators: industrial R&D and what universities can learn from them', in *Journal of Technology Transfer*, 31(4): 469-483.

Campbell, C., Berge, D., Janus, J., and Olson, K. (1988), *Change Agents in the New Economy: Business Incubators and Economic Development.* Minneapolis, MN: Hubert Humphrey Institute of Public Affairs.

Chan, K.F. and Lau, T. (2005), 'Assessing technology incubator programmes in the science park: the good, the bad and the ugly', in *Technovation*, 25(10): 1215-1228.

CSES (2002), 'Benchmarking of business incubators. Available at: http://ec.europa.eu/enterprise/entrepreneurship/support_meaures/incubators/benchmarking_bi_part_one_2002.pdf'.

Cimoli, M. (2000), *Developing Innovation Systems: Mexico in a Global Context,* London: Continuum.

Cooper, C. (1988), 'Supply and Demand Factors in Technology Imports,' in Desai, A. V. (ed.), *Technology Absorption in Indian Industry*, New Delhi: Wiley Easter Limited.

ESCAP (2009), *Economic and Social Survey of Asia and the Pacific 2009*, New York: United Nations.

Edquist, C. (ed.) (1997), *Systems of Innovation: Technologies, Institutions and Organisations,* London: Pinter.

Farrell, D. and Grant, A. J. (2005), 'China's Looming Talent Shortage,' *McKinsey Quarterly*, No. 4. Available at: http://www.sdpc.gov.cn/zjgx/t20051028_47339.htm

Flyvbjerg, B. (2011), 'Case Study', in Denzin, N.K. and Lincoln, Y. S. (eds.), *The Sage Handbook of Qualitative Research*, 4th Edition, Thousand Oaks, CA: Sage.

Freeman C. (1987), *Technology Policy and Economic Performance: Lessons from Japan,* London: Pinter.

Freeman C. (1995), 'The National Innovation Systems in historical perspective,' in *Cambridge Journal of Economics*, 19(1): 5-24.

Gupta, P. (2010), 'The Rise of Incubation in India – India Chief Mentor', *Wall Street Journal*, 07 April. Available at: http://blogs.wsj.com/india-chief-mentor/2010/04/07/the-rise-of-incubatio...

Hariharan, V. (2004), 'Can India Plug Its Brain Drain?', in *Technology Review*, 24 March. Available at: http:www.technologyreview.com

Intarakumnerd, P. and Chaminade, C. (2007), 'Strategy versus Practice in Innovation System Policy: the Case of Thailand,' in *Asian Journal of Technology Innovation*, 15(2): 197-213.

Kanamori, T. and Zhao, Z. (2004), Private Sector Development in the People's Republic of China, Tokyo: ADB Institute. Available at: http://www.adbi.org/book/2004/10/07/602.private.sector.prc/

Kirby, D. and Ying, F. (1995), 'Chinese Cultural Values and Entrepreneurship: A Preliminary Consideration', in *Journal of Enterprising Culture*, 3(3): 245-260.

Knudsen, M.P. (2007), 'The relative importance of inter-firm relationships and knowledge transfer for new product development success', in *Journal of Product Innovation Management*, 24(2): 117-138.

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', in *Journal of Small Business Management*, 42(2): 418-426.

Li, J.Y. (2002), *Investing in China: The Emerging Venture Capital Industry*, London: GMB Publishing.

Lundvall, B.-Å. (1988), 'Innovations as in Interactive Process: From User-Producer Interaction to the National System of Innovation', in Dosi, G. (ed.), *Technical Change and Economic Theory,* London: Printer.

Lundvall, B.-Å. (ed.) (1992), *National Systems of Innovation: towards a theory* of *innovation and interactive learning,* London: Pinter.

Lundvall, B.-Å. (2007), 'National Innovation Systems-Analytical Concept and Development Tool,' in *Industry and Innovation*, 14(1): 95-119.

Ma, F. L., Xia, W. D. and Zhang, F. H. (2008), *Theory and practice of technology business incubators*, Chinese version, Beijing: Science and Technology Documents Publishers.

Mani, S. (2001), 'Role of Government in Promoting Innovation in the Enterprise Sector: An Analysis of the Indian Experience,' *Discussion Paper, No. 3*, United Nations University, Institute for New Technologies, Maastricht, Netherlands. Available at: http://www.intech.unu.edu/publications/discussion-papers/2001-3.pdf

Markusen, A. (1999), 'Fuzzy concepts, scanty evidence, policy distance: the case for rigour and policy relevance in critical regional studies', in *Regional Studies*, 33(9): 869-884.

Mashelkar, R. (2001), 'The Indian Innovation System,' *Development Outreach*, World Bank Institute, Washington D.C. Available at: http://www1.worldbank.org/devoutreach/fall01/article.asp?id=128

Mian, S. (1991), 'An assessment of university-sponsored business incubators in supporting the development of new technology-based firms', *Unpublished Doctoral Dissertation*, School of Business and Public Management, The George Washington University, Washington, DC.

Mian, S. (1994), 'A framework for assessing the performance of university-sponsored business incubators', *Working* paper, State University of New York, Oswego, New York.

Mian, S. (1996a), 'Assessing value-added contributions of university technology business incubators to tenant firms', in *Research Policy*, 25(3): 325-335.

Mian, S. (1996b), 'The university business Incubator: a strategy for developing new research/technology-based firms', in *Journal of High Technology Management Research*, 7(2): 191-208.

Mian, S. (1997), 'Assessing and managing the university technology business incubator: an integrative framework,' in *Journal of Business Venturing*, 12(4): 251-285.

Ministry of Finance (Government of India) (2008), *Economic Survey 2007-2008*, New Delhi: Government of India.

Ministry of Science and Technology, Government of India (2004), 'Global Forum on Business Incubation – A Backgrounder', Available at: http://pib.nic.in/release/release.asp?relid=4357

Matt, M. and Tang, M.F. (2010), 'Management of university incubators in China and in France: A comparative

analysis', *International Journal of Entrepreneurship and Innovation Management*, Vol. 11, No. 3, pp. 282-301.

Muchie, M.., Gammeltoft, P. and Lundvall, B.-Å. (2003), *Putting Africa First: The Making of African Innovation Systems,* Aalborg, Denmark: Aalborg University Press.

NSTEDB, Department of Science and Technology, Government of India (2009), *Developing Ecosystem for Knowledge to wealth creation: Technology Business Incubator*, New Delhi: NSTEDB.

NSTEDB, Department of Science and Technology, Government of India (2009a), *First Status Report on Technology Business Incubation in India*, New Delhi: NSTEDB.

NSTEDB, Department of Science and Technology, Government of India (2010), 'Institutional Mechanism: Technology Business Incubators (TBI)', Available at: http://www.nstedb.com/institutional/tbi.htm

National Bureau of Statistics of China (2009), *China Statistics Year Book 2009*, Available at: http://www.sei.gov.cn/try/hgjj/yearbook/2009/indexce.htm.

Nelson, R. (ed.) (1993), *National Systems of Innovation: A Comparative Study*, Oxford: Oxford University Press.

Newcomb, A. (2005), 'China goes to college - in a big way', in *Christian Science Monitor*, July 29.

OECD (2005), *Economic Survey of China 2005*: Improving the Productivity of the Business Sector, Paris: OECD.

O'Neal, T. (2005), 'Evolving a successful university-based incubator: lessons learned from a UCF technology incubator', in *Engineering Management Journal*, 17(3):11-25.

Phillips, R.G. (2002), 'Technology business incubators: how effective as technology transfer mechanisms? ', in *Technology in Society*, 24(3): 299-316.

Rein, G.L. (2004), 'From experience: creating synergy between marketing and research and development', in *Journal of Product Innovation Management*, 21(1):33-43.

Riel, A.C.R.V., Lemmink, J. and Ouwersloot, H. (2004), 'High-technology service innovation success: a decision-marking perspective', in *Journal of Product Innovation Management*, 21: 348-359.

Scillitoe, J. L. and Chakrabarti A. K. (2010), 'The role of incubator interactions in assisting new ventures', in *Technovation*, 30(3): 155-167.

Smilor, R. and Gill, M. (1986), *The new business incubator: linking talent, technology and know-how*, Lexington, MA: Lexington Books.

Somasekhar, M. (2001), 'Technology business incubators', in *The Business Line*, 03 October. Available at: http://www.blonnet.com/2001/10/03/stories/040367so.htm

Sun, D.H., Lin, L., Shi, L.H., Zhang, Z.H., Tang, F.Q. and Li, N.L. (2005), 'A report on 100 Chinese incubators', Chinese version, *Journal of Science & Technology Industry of China,* pp. 14-18.

Tang, M. F. and Hussler, C. (2011), 'Betting on indigenous innovation or relying on FDI: The Chinese strategy for catching-up,' in *Technology in Society*, 33(1-2): 23-35.

UNCTAD (2002), *World Investment Report: Transnational Corporations and Export Competitiveness,* New York and Geneva: UN.

UNCTAD (2003), *World Investment Report: FDI Policies for Development: National and International Perspectives,* New York and Geneva: UN.

UNCTAD (2004), *World Investment Report: The Shift towards Services,* New York and Geneva: United Nations.

UNCTAD (2005), *World Investment Report: Transnational Corporations and the Internationalization of R&D,* New York and Geneva: United Nations.

Verma, Y. (2004), 'FIIT: Seeding for the Future?', *IT Magz.com,* 22 June. Available at: http://www.itmagz.com

Von Zedtwitz, M. and Grimaldi, R. (2006), 'Are service profiles incubator-specific? Results from an empirical investigation in Italy', in *Journal of Technology Transfer*, 31(4): 459-468.

White, S., Gao, J. and Zhang, W. (2002), 'China's Venture Capital Industry: Institutional trajectories and system structure,' Available at: http://www.insme.info/documenti/white.pdf.

White, S., Gao, J. and Zhang, W. (2005), 'Financing new ventures in China: system antecedents and institution', in *Research Policy*, 34(6): 894-913.

Yin, R. K. (1984), *Case study research: Design and methods*, Newbury Park, CA: Sage Publications.

Yin, R.K. (2009), *Case Study Research: Design and Methods*, Fourth Edition, Newbury Park, CA: Sage Publications. California.

Zhang, D. D., Fan, W. J., Wu, S. R., Zhang, W., Chen, Y., Xing, X. and Wu, X. Y. (2004), 'A Report on Problems of Business Incubators in China', *Chinese version*, pp.50-58.

Acknowledgment

We thank the Southwestern University of Finance and Economics (SUFE), Chengdu, China, for their financial support for this research through the 211 Research Programme.