
Assessing government-supported technology-based business incubators: evidence from China

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Abstract: This study examines the effectiveness of government-supported incubator programmes in China. Findings highlight the importance of private-sector involvement in the incubators' governing body. Previous literature acknowledges the importance of government intervention in the entrepreneurial incubation process to overcome innovation market failure. However, factors that potentially influence the effectiveness of government-supported incubators have not been explored. Using surveys and follow-up interviews with managers of tenant venture firms, as well as administrators of four sampled incubators in Shanghai and Chongqing, we find that government-supported business incubators effectively provide physical infrastructure, general resources such as administrative support, and access to university resources. Except for the incubator that has been managed by business professionals, government-supported incubators are found to be rather ineffective in offering counselling, external private financing, and networking services to incubated tenant firms, which suggests that government agencies and officials lack business and technological expertise. The implications of the effectiveness of government-driven incubator programmes and avenues for future research are discussed.

Keywords: business incubators; entrepreneurship; technology-park; government-supported incubators; incubator assessment; university-sponsored incubators; entrepreneurship in China; technology management; China.

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1 Introduction

The success of Silicon Valley's model for regional economic development has inspired and fostered entrepreneurship in many regions of the world, including the USA, Europe, Asia, and South America (Leslie and Kargon, 1996; Miner et al., 2012; Ritvala and Kelymann, 2012; Thomas and Mueller, 2000; Wonglimplyarat, 2010). The establishment of science parks and technology business incubators (TBIs) has been widely recognised as an effective policy instrument to spur entrepreneurship, innovation, and economic growth (Leslie and Kargon, 1996; OECD, 1997, 1999; Sa and Lee, 2012; Thomas and Mueller, 2000; Salvador and Rolfo, 2011; von Zedtwitz and Grimaldi, 2006; Yang et al., 2009; Zhao et al., 2009). In particular, studies on the establishment of TBIs have demonstrated the significance of government intervention (Etzkowitz et al., 2005; Hsu

and Chiang, 2001; Koh et al., 2005; Patton et al., 2009). Given the high uncertainty associated with firm creation and market failures in supporting entrepreneurs to overcome obstacles in their early development stages, government intervention has been deemed necessary (Avnimelech et al., 2007; Kihlgren, 2003; Palmai, 2004; Patton et al., 2009).

China is no exception. The Chinese Government has established science parks and TBIs since the 1980s. The first TBI was built in Wuhan Province in 1987. One year later, the Ministry of Science and Technology (MOST) launched the ‘Torch Program’ (1988), a key policy tool devoted to the creation of science and technical industrial parks (STIPs) and TBIs. By 2010, 83 state-level STIPs and 896 TBIs had been created, 86 of which were state-level, university-sponsored technology business incubators (UTBIs) and 344 of which were state-level TBIs. China has the second largest number of operating TBIs in the world, behind only the USA. This trend demonstrates the Chinese government’s recognition of the role of TBIs in the development of high-technology industries, particularly in the context of China’s transformation toward an innovation powerhouse. The release of China’s Five-Year Outline (2011–2015) and the opening of the 18th National Congress of the Communist Party of China signify the new economic growth model, shifting from an assembling-export economy to an innovation-driven development economy.

This study evaluates government-supported TBI programmes. Specifically, we endeavour to understand the critical factors leading to the success of such programmes.¹ Literature on TBIs is mainly concerned with elucidating the TBI concept (Allen, 1985; Hansen and Sebra, 2003; NCUED, 1985; Smilor and Gill, 1986; von Zedtwitz and Grimaldi, 2006); the role of university linkage in TBI performance (Colombo and Delmastro, 2002; Ferguson and Olofsson, 2004; Mian, 1997; McAdam and McAdam, 2008; Rothaermel and Thursby, 2005); specific case studies of regional-level TBIs (Kim and Jung, 2010; Koh et al., 2005; Palmai, 2004; Ratinho and Henriques, 2010; Sofouli and Vonortas, 2007); and the evaluation frameworks for TBIs (Chan and Lau, 2005; Mian, 1996, 1997; O’Neal, 2005; Ratinho and Henriques, 2010). However, previous studies are rather silent on the factors that explain the success of government-supported TBI programmes (Barbero et al., 2012; Markman et al., 2008). Thus, we aim to contribute to the literature by exploring critical factors that influence the success of government-supported TBI programmes.

We examine the characteristics and performance of four government-supported TBIs in China and analyse the key factors that influence their performance. Of the sample, two are university-sponsored TBIs (UTBIs) and two are non-university sponsored TBIs. UTBIs are mainly established in or near university campuses, and they focus on fostering academic entrepreneurship and commercialising university research findings. Non-UTBIs are located in STIPs and aim to foster high-technology venture firms and establish high-technology industries. These two types of TBIs are both covered under the umbrella of the ‘Torch Program’, which is supervised and monitored by MOST.

We begin with a review of relevant literature. The research methods used to collect the dataset are described, followed by analytical approaches used to evaluate the four TBIs’ performance. The next section presents the results of the analyses, and the paper concludes with a discussion of the key factors for the success of government-supported TBIs. In addition, our findings’ implications are discussed and future work is described.

2 Review of literature

2.1 Rise of business incubators

In the 1980s, business incubators were mostly believed to be physical spaces that provided low market rents, shared services, logistical support, and business consulting services (Allen, 1985; Merrifield, 1987; Smilor and Gill, 1986). Since the 1990s, however, the concept of a business incubator has expanded from a physical space with basic facilities to value-added services that provide not only physical but also intangible resources, such as professional business support or advice and network provision for early-stage ventures and entrepreneurs (Bergek and Norrman, 2008). At present, incubators provide new ventures with both physical and intangible resources to hatch new ideas (Allen and Bazan, 1990), speed up the creation of new ventures and increase their chances of success (Hansen and Sebora, 2003), and help entrepreneurs develop business and marketing plans, build management teams, obtain venture capital, and provide access to professional and administrative services (Cooper et al., 2012; Cumming and Fischer, 2012; von Zedtwitz and Grimaldi, 2006).

Parallel to literature on business incubators, studies on UTBIs likewise began emerging in the 1980s (Becker and Gassmann, 2006; NBIA, 1992). Both UTBIs and non-UTBIs provide shared office services such as reception areas, rental space, electricity, and water, as well as building maintenance and security. Business-assistance services include planning and administrative services such as business and tax registration, counselling, financing, and other value-added services (Mian, 1996, 1997; Peters et al., 2004; Scillitoe and Chakrabarti, 2010). UTBI services tend to focus, however, on providing tenant ventures with access to university-related resources such as libraries, information technology, venture capital, laboratories, workshops, student employees, faculty consultants, and institutional reputation (Cooper et al., 2012; Mian, 1996, 1997). UTBIs also facilitate professors' and students' full- or part-time business-creation activities, and thus offer a favourable environment for academic entrepreneurship to transfer and commercialise university-invented technologies (Markman et al., 2005; Patton and Marlow, 2011; Rothaermel and Thursby, 2005). Non-UTBIs overcome the lack of linkage to university resources by developing a wide network of external factors that can include public research institutions, industry laboratories, and industry experts (Bollingtoft and Ulhoi, 2005; McAdam et al., 2006).

The emergence of UTBIs is closely related to the belief that linkages to university knowledge stock and research outputs would enhance the survival and competitiveness of tenant ventures (George et al., 2002; Mian, 1994, 1996; Patton et al., 2009). While studies of UTBIs are still limited (Rothaermel et al., 2007), previous studies of UTBIs illustrate the positive effects of university linkage on technology-based tenant firms. UTBIs have increased the survival rate of new ventures, promoted higher growth than off-incubator firms, accelerated time-to-market, and enhanced the likelihood of success (Colombo and Delmastro, 2002; Ferguson and Olofsson, 2004; Mian, 1997; Ratinho and Henriques, 2010; Rothaermel and Thursby, 2005). Other UTBI studies report management and operational policies (Mian, 1997; Scillitoe and Charkrabarti, 2010;

Tornatzky et al., 1996), ownership (Becker and Grassmann, 2006; Phillips, 2002; von Zedtwitz and Grimaldi, 2006), strategy (Lee and Osteryoung, 2004; Schwartz and Hornyk, 2008), and service (Bergek and Norrman, 2008; Chan and Lau, 2005; Mian, 1997; O'Neal, 2005) as factors that influence UTBIs' effectiveness.

2.2 Innovation market failure and government-supported business incubators

Previous studies on technological change and innovation report the high probability of innovation market failure when the innovation's appropriability condition is difficult. This results in a lack of private incentives to invest in such technologies (Dosi, 1988; Nelson and Rosenberg, 1993). Technologies based on the advanced basic research of academic entrepreneurs often possess a generic characteristic that may be applicable and useful to intermediary-goods industries. However, this characteristic makes it difficult for small innovating venture firms to appropriate economic returns (Dosi, 1988; Mowery and Rosenberg, 1993). Moreover, high transaction costs due to the idiosyncratic and cumulative nature of firm-specific R&D capabilities further increase the difficulties small innovating ventures encounter in securing the capital necessary to develop and commercialise their technologies. Thus, government policy interventions that bridge intermediary institutions in the form of incubators or technology research parks is critical to overcome innovation market failure (Martin and Scott, 2000). Such intermediary institutions can organise and provide resources more efficiently than market exchange or a unitary hierarchy mechanism, especially to early-stage entrepreneurs (Phan et al., 2005).

Given the importance of incubators in enhancing economic competitiveness through regional economic development and overcoming innovation market failure, government policy makers have actively sought to create both UTBIs and TBIs (Avnimelech et al., 2007; Etzkowitz et al., 2005; Hsu and Chiang, 2001; Kihlgren, 2003; Koh et al., 2005; Kroll and Liefner, 2008; Mian, 1994, 1996; Palmai, 2004; Patton et al., 2009; Sofouli and Vonortas, 2007; Souder et al., 1996). However, studies on government-supported incubators are mostly descriptive (e.g., Avnimelech et al., 2007; Etzkowitz et al., 2005). A detailed analysis of the factors related to the performance of government-supported incubators is yet to be conducted. The following section discusses the research approaches adopted in this study to evaluate and identify the key factors that influence the effectiveness of government-supported TBI programmes.

3 Methodology

3.1 Analytical approach: multiple case studies

We used the case study method described by Yin (2003). Several researchers advocate this method for incubator research (Allen and Bazan, 1990; Campbell et al., 1988; Mian, 1997). To avoid potential limitations and problems of selective recollection, revisionism, and possible bias, we used multiple data sources, as suggested by Yin. We conducted multiple case studies using mail surveys combined with semi-open, face-to-face and phone interviews (Dillman et al., 2008). We then supplemented the study by collecting and analysing secondary data from various sources.

First, we identified four business incubators (two UTBIs and two TBIs) in Chongqing and Shanghai and contacted their head offices to seek support for the surveys and interviews. With assistance from the head offices, we selected two tenant ventures from each incubator and sent out the questionnaires, which were based on Chan and Lau's (2005) nine incubator assessment variables: pooling resources, sharing resources, consulting, public image, networking, clustering, geographic proximity, costing, and funding. We deemed these assessment variables, which were originally used to evaluate technology incubator programmes on and off science parks in Hong Kong (Chan and Lau, 2005), appropriate for our analysis because of the similar cultural and managerial characteristics between Chinese and Hong Kong firms, as well as their close economic links.

After receiving the completed surveys from the tenant ventures, we also interviewed managers² from the tenant ventures to avoid a potentially biased evaluation of each sampled incubator. These managers were asked to provide their perceptions regarding the quality of the services they received from respective incubators. We also asked them about any progress they achieved after entering the incubators. Finally, we interviewed the incubators' administrators to ensure an appropriate understanding of the performance of the sampled business incubators and to collect additional performance-related data, such as the survival rate of tenant firms and the specific services available.

To improve the study's robustness and validity, we also collected secondary data from the China Torch Statistical Yearbook, MOST, and the sampled incubators' internal archives. This data yielded rich information about the organisations within the incubators, the funding systems, and incubator performance such as number of tenant firms and employees, total amount of incubation funds, total income of tenants, and cumulative total of graduated tenants. We used the assessment typology of the European Commission (2002) as a performance indicator for the sampled incubators. These indicators are compatible with those used by MOST.

3.2 Incubators and tenant ventures studied

We focused on four government-supported business incubators: two UTBIs, Chongqing National University Science Park Business Incubators Ltd. (Chongqing UTBI) and Shanghai Huigu High-Tech Innovation Service Ltd. (Shanghai UTBI); and two TBIs, Chongqing High-Tech Innovation Center (Chongqing TBI) and Shanghai Caohejing New-Tech Industrial Development Zone Technology Innovation Center (Caohejing TBI). According to the MOST classification, Chinese TBIs include high-technology innovation centres, national innovation parks for overseas Chinese scholars, international business incubators, and university science parks. The first three place a high priority on domestic and overseas technology-based ventures with commercial prospects. The last type is equivalent to a UTBI, with an emphasis on fostering a favourable environment for technology-based university ventures and training academic entrepreneurs. Nevertheless, both UTBIs and TBIs ultimately aim to foster high-technology ventures and help tenant firms commercialise their research findings. Table 1 lists the focused markets for the eight incubated tenant ventures in the study.

The rationale for sampling UTBIs and TBIs in Chongqing and Shanghai are as follows. First, detailed information on these four business incubators is readily accessible. Second, all four TBIs are located along the Yangtze River, where the economy is

dynamic. Finally, Chongqing and Shanghai both serve as barometers for the Chinese economy and are prominent for fostering ventures in information technology, biotechnology, and electronics. Table 2 provides the basic economic indicators for Chongqing and Shanghai. As shown in Table 2, although Chongqing and Shanghai are barometers for the Chinese economy, there are differences between these two key regions. For example, a substantially larger R&D workforce resides in Shanghai (198,700) than in Chongqing (65,287), even though the surface area of Chongqing is significantly larger than that of Shanghai. The larger R&D workforce in Shanghai seems to explain the greater number of granted patents and higher R&D expenditures in Shanghai than those of Chongqing.

Table 1 Focused market of incubated tenant ventures in the study

<i>Incubators</i>	<i>Focused market</i>	
	<i>Tenant venture no. 1</i>	<i>Tenant venture no. 2</i>
Chongqing UBTI	Household innovative product	Multimedia technology design
Shanghai UBTI	Network technology	Insurance
Chongqing TBI	LED lightening technology	Information technology
Caohejing TBI	New energy technology	Souvenir product design and manufacturing

Table 2 Basic economic indicators of Chongqing and Shanghai

	<i>Chongqing</i>	<i>Shanghai</i>
Year-end resident population (millions)	29.19	23.47
Surface (km ²)	82,400	6,300
Population density (population/km ²)	354	3726
Average GDP growth rate (%) (1978–2011)	15.6	10.2
Share (%) of national GDP	2.12	4.07
GDP per capita (US\$)	5,493	13,017
Unemployment rate (%)	3.5	4.2
Pillar industry	Automobile and motorcycles, equipment manufacturing, material, electronics and IT	Electronics, motor vehicles, petrochemicals, refined steel products, equipment manufacturing, biological medicine
Number of higher education institutions	67	66
Number of R&D workforce	65,287	198,700
Number of patents granted	6,443	31,117
R&D expenditure (100 million US\$)	20.7	90.4

Notes: Original data collected from Chongqing Statistical Year Book 2012, Shanghai Statistical Year Book 2012, calculated by the author; Currency exchange rate of US\$1 = RMB 2819 is used (<http://www.boc.cn/sourcedb/whpj/>, February 2013)

Table 3 The characteristics of four TBIs

	Chongqing UTBI		Shanghai UTBI	Chongqing TBI	Caohejing TBI
Status	National-level technology business incubators				
Ultimate objective	Promote the commercialisation of research findings, foster high-tech firms and develop high-tech industry				
Objective focus	Commercialise university R&D results (indigenous innovation) and foster academic entrepreneurship			Foster high-tech (both domestic and foreign) ventures with industrialisation potential	
Founding year	2001		1999	1999	1997
Main executors	<ul style="list-style-type: none"> Chongqing University Shapinba District Government 		<ul style="list-style-type: none"> Shanghai Jiaotong University Xuhui District Government and Shanghai S&T Committee 	<ul style="list-style-type: none"> Chongqing High-Tech Zone Management Committee (a branch of local government) 	<ul style="list-style-type: none"> Caohejing New High-tech Development Zone Corporation (a government-owned company)
Location	Near Chongqing University campus; Proximity to 7 universities and 125 research institutes		Near Shanghai Jiaotong University; Proximity to 18 universities and 113 research institutes	In Science and Technical Industrial Park	In Science and Technical Industrial Park
Service provision	Offer access to financial resources, university resources and information; administration support, consulting and training; public service platform (test platform, large general-purpose instrumentation, etc.) and tutor assistance available		Offer access to financial resources and university resources; administration support, consulting, training, marketing, domestic and international network building; public service platform (test platform, large general-purpose instrumentation, etc.) and tutor assistance available	Offer access to financial resources, outsource bank resources; consulting, training, management, marketing; public service platform (test platform, large general-purpose instrumentation, etc.) and tutor assistance available	Offer access to financial resources, outsource bank resources, unsecured loans available for ventures; administration support, marketing, technology management, training; public service platform (test platform, large general-purpose instrumentation, etc.) and tutor assistance available
Main sectors of activity	IT 46%, optical, mechanical and electronic integration 10%, biotechnology 8%, environment protection, energy saving and new materials 21% and others 15%		IT 81%, optical, mechanical and electronic integration 5%, service 8% and others 6%	IT 41%, advanced manufacturing 26%, biotechnology 17%, environment protection, energy saving and new materials 4 % and others 12%	IT 60%, biotechnology 12%, optical, mechanical and electronic integration 12%, S&T consulting 8%, and others 8%

4 Results

4.1 General characteristics of the four sampled TBIs

All four sampled incubators are government-supported TBIs under the ‘Torch Program’ umbrella. Approximately one third of all venture entrepreneurs in UTBIs are academic. However, since there are not as many academic entrepreneurs and UTBIs face economic pressures in their day-to-day operations, UTBIs also host non-academic tenant venture firms with commercial potential. Venture entrepreneurs in non-UTBIs are mainly engineers coming out of companies, scientists moving from research institutions, and Chinese individuals returning from abroad. Together they account for more than 80% of TBI-housed entrepreneurs, who often have experience in both business and technology. Interestingly, TBIs likewise host academic entrepreneurs. The proportions of academic entrepreneurs in TBIs and UTBIs are close to equal. This cross hosting of venture entrepreneurs in UTBIs and non-UTBIs has challenged the perception that UTBIs host more academic ventures than TBIs, due to their close linkages with universities.

UTBIs are co-managed by their sponsoring universities and the local government. For example, representatives from both Chongqing University and the Shapingba district government oversee the Chongqing UTBI. Shanghai Jiaotong University, the Shanghai Science and Technology Committee (a Chinese government agency), the Xuhui district government, and the Chinese Academy of Sciences-Shanghai Institute comprise the board of management of the Shanghai UTBI.

The Chongqing TBI is managed by the Chongqing High-Tech Zone Management Committee, a branch of the local government, whereas the Caohejing TBI is managed by the Caohejing New High-Tech Development Zone Corporation, a government-owned company.

The two UTBIs are located in academic clusters and are geographically proximate to higher education institutions and research organisations. The TBIs are located in a STIP.

Table 3 provides brief descriptive characteristics of the four sampled TBIs.

4.2 Assessment of incubator programmes

We employed the nine-criteria assessment framework proposed by Chan and Lau (2005) as an analytical tool to evaluate the quality of services in these four incubators. The factors that influence the quality of their services are likewise analysed.

4.2.1 Pooling resources

Chongqing University and Shanghai Jiaotong University are two of the top 100 Chinese universities, with a strong emphasis on engineering. Maximising the rich educational resources of their respective universities, both UTBIs organise and offer tenant entrepreneurs free training in intellectual-property management, general management, and marketing. They likewise provide their tenant ventures access to the Higher Education Science and Technology Achievement Exhibition, as well as assistance in presenting new products to the media.

The Chongqing and Caohejing TBIs invite technological and business professionals to give lectures or seminars in their training centres. Training courses are free or paid for with tokens for the in-house staff and venture entrepreneurs. Moreover, both TBIs have

an exhibition hall and organise exhibits to help tenant venture firms and entrepreneurs introduce new products and services to the public. In addition to organising domestic exhibits, the two TBIs provide opportunities for tenant ventures to attend exhibitions overseas.

4.2.2 Sharing resources

With their proximity to universities, ventures in UTBIs have easy access to university resources and facilities. Academic entrepreneurs, such as faculty members and students who hope to commercialise their research findings, can retain their academic positions while involved in the venture process.

Non-academic entrepreneurs in TBIs also gain access to university facilities and benefit from exchanging ideas with professors and students involved in active research. In addition, they obtain leverage to establish their own research laboratories within the university setting. By contrast, TBIs do not enjoy proximity and easy access to university resources and public laboratories. To overcome this weakness, the Chongqing and Caohejing TBIs have developed networks with universities and public research institutes. These TBIs have also made significant investments to establish public service platforms that provide tenant ventures with the opportunity to test equipment, access database expertise, and build linkages to universities. By 2010, the Chongqing and Caohejing TBIs had invested \$1.14 million and \$4.57 million, respectively, in their efforts to satisfy their tenant ventures' resource requirements. Thus, through a broad network of expertise, resources, and investment, TBIs can offset the relative advantage of UTBIs' proximity to universities.

4.2.3 Consulting

Both UTBIs and TBIs offer tenant venture firms consulting services in government tax policy and public funding, but outsource other consulting services. They also assist tenant firms to obtain tax holidays, as long as the firm meets the requirements for high-technology ventures. For financial counselling, UTBIs and TBIs establish connections with government R&D funds, banks, and venture capital investment corporations. However, complex funding sources and asymmetrical information between new ventures and incubators may delay the availability of financial support. Other consulting services in such areas as business management and technology are available through outsourcing.

Tenant firms are usually charged for value-added consulting services, but at less than the market price because the incubators organise group purchases. However, we found that UTBI-based tenant firms seldom request such paid services, mainly due to limited funds and the stagnated mentality³ of tenant venture firms. In addition, university entrepreneurs tend to rely on personal and informal networks of colleagues with expertise in the relevant field. Another reason for tenant firms' reluctance could be related to the lack of trust in external consultants. The possibility that sensitive technology and proprietary information could be leaked by consultants hampers UTBI-based tenant firms' willingness to pay for consulting services.

In contrast, we found that most ventures in the Caohejing TBI use external consulting services facilitated by the incubator. This implies that for the same price, consulting services facilitated by the Caohejing TBI are perceived to be of higher quality. Our

results show that, compared to other incubator programmes in the study, Caohejing TBI tenant firms have easier access to consulting services.

4.2.4 Public image

All four incubators are well regarded as a creditable *danwei*, a symbol of ‘trust’ or ‘social capital’ in China (Eun et al., 2006). In particular, UTBIs and their tenant firms benefit from the positive public image of their sponsoring universities. For example, the public may believe that venture firms incubated in UTBIs emphasise innovation and produce high-quality products. With strong government support, universities in China are generally held in positive regard and are perceived to be creditable organisations.

Government-supported TBIs, such as the Chongqing and Caohejing TBIs, also enjoy public trust. The Chongqing TBI is one of three international business incubators in China recognised by the Chinese Ministry of Science and Technology, and has repeatedly received regional and national awards as an ‘Excellent Incubator’. Among Chinese incubators, the Caohejing TBI has also been lauded for its ‘best practices’, which is particularly true because of its management by the Caohejing New High-Tech Development Zone Corporation, a government-owned enterprise. With financial support from the government, such state-owned enterprises (SOEs) perform a dual function by creating wealth and providing social services such as the construction of houses, public hospitals, and schools (Ding et al., 2000). Eun et al. (2006) contend that government-owned enterprises are a microcosm of Chinese urban society.

4.2.5 Networking

Networking is considered to be one of the key success factors for UTBIs (Becker and Gassmann, 2006; CSES, 2002; Mian, 1997; O’Neal, 2005). Potential network connections include universities, public research institutes, central and local governments, municipalities, industrial and commercial chambers of commerce, industries, banks, venture capitalists, and angel funds. These network contacts can transfer their expertise and skills to incubated tenant firms through collaboration (Saxenian, 1990). When in-house services are insufficient, incubators use their broad networks to outsource the provision of services to meet tenant ventures’ specific needs. Access to networks is significant, especially in supporting the growth of small start-ups (Macpherson and Holt, 2007).

In China, incubator networks have been set up at different levels: municipal, regional, national, and international (Wang, 2003). However, many incubator networks lack relevant actors, such as industrial customers, suppliers, creditors, and entrepreneurial firms, which significantly impairs their operational efficiency. The risk of leaked commercial or technological information due to involvement with external actors may also prevent tenant venture firms from interacting with external experts in the network. In fact, many Chinese incubators offer only basic services such as office space, internet access, building management and extremely limited external network connections.

Even so, compared to UTBIs, TBIs perform better in providing network services to tenant venture firms. The network services of UTBIs are limited to the creation of university-based networks, whereas TBI network services focus more on attracting external experts. In addition, TBIs place high priority on building beneficial relationships with institutions such as governments, banks, universities, and public research centres.

Through extensive network contacts, tenant venture firms incubated at TBIs can learn and absorb best practices from external experts. Therefore, the disadvantage of a lack of linkages to university resources can be offset.

4.2.6 Clustering

Both UTBIs and TBIs incubate ventures that are less than three years old with registered capital of no more than \$750,000 as well as innovative student-led projects. Compared with TBIs, however, UTBIs are more interested in developing a pool of innovative academic talent. Ventures, especially by academic entrepreneurs, regularly participate in university apprenticeships. In both UTBIs and TBIs, incubated ventures in information technology (IT) comprise the largest percentage of total incubated tenant ventures, accounting for more than 40% of all tenant ventures (see Table 2). Among the four sampled business incubators, the Shanghai UTBI demonstrates the highest proportion (81%) of tenant venture firms in IT. This is not surprising, given that compared to the business incubators in other sampled regions, Shanghai hosts more entrepreneurial IT firms. In addition, our study demonstrates that TBIs host more biotechnology venture firms than UTBIs.

Interestingly, this finding contradicts the results of past empirical studies that show that biotechnology industries have relatively closer linkages with the academic research community (Bekkers et al., 2006; Feldman et al., 2002; Geuna and Nesta, 2006; Smith, 2003). This contradiction may be due to the fact that a higher proportion of top universities in China focus on IT rather than biotechnology.

4.2.7 Geographic proximity

In general, UTBIs are near university resources, whereas TBIs are near STIPs (e.g., Bergek and Norrman, 2008; Rothaermel and Thursby, 2005). In our sampled business incubator cases, the Chongqing and Caohejing TBIs are located in STIPs, whereas the Chongqing and Shanghai UTBIs are located near their sponsoring universities. When tenant venture firms graduate from an incubating TBI, they can easily move to the STIP where they were located during the incubation period to further develop and commercialise their technologies. The Chongqing and Shanghai UTBIs are surrounded by nearly 10 universities and more than 100 research institutes. The Chongqing and Shanghai TBIs, in contrast, do not enjoy as many academic resources due to their distance from universities. To overcome this disadvantage, these TBIs made significant investments to establish broad networks of external experts and public service platforms. In terms of market access, rapid urbanisation and universities' movement out of downtown areas have reduced the distance between incubators and their potential clients.

4.2.8 Costing

Costing is a key factor that influences the growth of new technological ventures. At the initial stage, costs for new ventures mainly include office rent and equipment, telephone and Internet fees, and consulting services. Considering the fact that new ventures tend to be small in size and have limited cash flow, UTBIs and government-supported TBIs usually offer free or affordable office space, equipment, training, and consulting services in tax policies and government funding. Corporate-supported incubators often charge

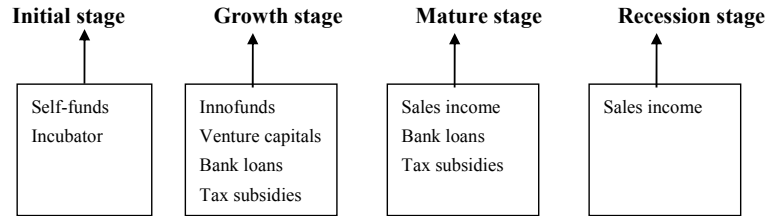
tenant ventures for such services, but at prices lower than market rates. Outsourced consulting services charge tenant venture firms the market price.

The Chongqing and Shanghai UTBIs are the exceptions to this general rule. The Chongqing UTBI does not benefit from access to free land from the local government, so it rented three unused buildings near Chongqing University and invited the Chongqing Jialing Motor Company (a government-owned enterprise), as a funding partner, to manage the buildings. The Jialing Motor Company built the physical infrastructure for the tenant firms. Because of this unfavourable financial situation, the Chongqing UTBI is unable to offer free space to tenant venture firms, which must pay rent close to the market price. Similarly, for the Shanghai UTBI, proximity to the downtown area and the higher demand for incubation services raises the cost of office rent for tenant firms.

4.2.9 Funding

The funding system is related to the different developmental stages of a venture firm (Figure 1). At the initial stage, when entrepreneurs with new ideas are preparing to launch a business, they rely principally on funds they have collected, such as personal savings and gifts or loans from family members or friends. Promising start-ups can also acquire seed capital from venture capital firms founded by UTBIs or TBIs. Once venture entrepreneurs establish their companies and begin to market their products or services, they will need access to additional institutional financial support beyond that of the UTBI or TBI. Such support includes venture capital, governmental innovation funds for technology-based small firms (Innofund)⁴, and bank loans. Government funds can be a significant financial resource during this developmental stage of a venture firm. In China, the local government sets up high-technology-venture investment corporations with funds from its own budget, tax income from successfully graduated start-ups, and a loan-guarantee agency. Innofunds at the local and national levels are available to tenant venture firms through project selections. Similarly, bank loans are available to venture firms and guaranteed by a government agency. When venture firms achieve the scale economy in manufacturing products or offering services, their sales income and tax subsidies become their main sources of funding. Bank loans are still available at this stage (Figure 1). Bank loans will no longer be available, however, when substitute products or services by other firms become available. At this stage, venture firms depend on sales income as their major source of funding. Both UTBIs and TBIs assist tenant ventures in obtaining access to the aforementioned financial support through funding networks. However, UTBIs generally experience greater difficulties in attracting funding, especially from foreign venture capitalists. This difficulty may be due to the UTBI management, which lacks linkages to external venture capital funding (Kroll and Liefner, 2008).

The venture-capital industry in China has rapidly developed since the early 1990s, and venture capital has enjoyed a more prominent role in the development of technology-based start-ups. However, more than 90% of domestic venture-capital funds come from various levels of the government (Fung et al., 2005). Venture capital has been a dominant funding source for high-technology ventures. Perhaps the heavy involvement of public funding support in China offsets the incentive of private sources to finance such ventures. The complexity of and asymmetrical information about the funding system also prevent incubators and tenants from gaining easy access to appropriate external financial resources.

Figure 1 Funding system of new ventures in China**Table 4** Assessment of sampled incubator programmes

Assessment criteria	Examples of specific indicators	Chongqing UTBI	Shanghai UTBI	Chongqing TBI	Caohejing TBI
Pooling resources	Organising staff training and development activities, marketing events, exhibitions, press conference	Medium	Medium	High	High
Sharing resources	Sharing laboratory facilities, office equipment, testing equipment, administrative support (e.g. meeting room, library, reception area...)	Medium	Medium	Medium	High
Consulting	Provision of legal, accounting, business, technical advices at low cost (or free-of-charge)	Low	Low	Low	High
Public image	Image of the science park/university/government	High	High	High	High
Networking	Access to clients/suppliers/subcontractors partnership opportunity with other technology firms within the incubator, knowledge sharing/dissemination	Medium	Medium	High	High
Clustering	Development of a pool of skill labour, externalities from logistics arrangement, externalities for supporting network (e.g., emergence of complementary industry)	Low	High	Low	High
Geographic proximity	Access to market, research centre, universities	High	High	High	High
Costing	Rental subsidies, subsidies on telecom/computer network access, other subsidies related to cost reduction	Medium	High	High	High
Funding	Access to venture capital (VC) funding, bank loans, other funding sources	Low	Low	Low	High

Note: The assessment results were based on semi-structured survey, interviews, published documents and our own judgement.

Source: The nine assessment criteria come from Chan and Lau (2005)

Caohejing TBI has a different major funding source from the three other business incubators in this study. The government-supported Caohejing New High-Tech Development Zone Corporation invests not only in incubators but also in ventures. The corporation provides direct seed capital at a maximum of \$79,450 to a start-up venture in its initial stage, and another \$79,450 to a growing start-up, if necessary. Its international reputation and networks attract foreign venture capitalists to finance tenant firms. Similar to the three other incubators, Caohejing TBI helps ventures gain access to bank loans and Innofunds. Caohejing TBI's broader network brought in roughly \$5.56 million in incubation funds at the end of 2010, an amount significantly higher than those obtained by the others.

Table 4 summarises results from our assessment of the four sampled incubator programmes.

4.3 Performance outcomes of four sampled incubators

Table 5 shows the comparative performance outcomes of the four sampled incubators. To evaluate performance, we used the assessment indicators of the European Commission as the criteria: incubation funds, incubation surface, number of incubator employees, number of tenant firms, total income of incubators, survival rate of tenant firms, and number of graduated tenants. In addition, we adopted other incubator performance indicators, such as the number of tenant employees, approved patents, and the number of national science and technology projects undertaken.

Table 5 The performance outcomes of four sampled TBIs

<i>Measure indicators</i>	<i>Chongqing UTBI</i>	<i>Shanghai UTBI</i>	<i>Chongqing TBI</i>	<i>Caohejing TBI</i>
Total incubator funds (million \$)	1.69	0.64	0.79	5.56
Incubation surface (m ²)	12,993	26,195	46,659	30,414
Total number of incubator staffs	6	15	56	39
Number of tenants	85	110	93	118
Number of tenant employees	1,600	1,564	2,148	2,103
Total income of incubators (million \$)	0.12	0.82	1.91	3.06
Survival rate of tenants	80%	85%	86%	91.6%
Number of granted patents	8	6	27	29
Number of undertaken national science and technology project	4	N/A	10	5
Accumulated number of graduated tenants	37	84	362	108

Source: Survival rate of tenant firms was collected from our interviews with four sampled incubators, the other data were collected from China Torch Statistical Yearbook 2011

The amount of incubation funds represents the capability of incubators to pool funding resources. The incubation surface and number of employees represent the incubator's capacity to accommodate new technological ventures. The number of tenant firms, total incubator income, survival rate of tenant firms, number of graduated tenants, and other indicators demonstrate the quality of the incubator's service in terms of creating new technology firms.

The statistics in Table 5 show that in most of the indicators, TBIs generally achieve performance outcomes that are higher than those of UTBIs.

4.3.1 Incubation funds

In terms of incubation funding, the Caohejing TBI is far ahead of the other incubators: \$5.56 million versus \$0.79 million for the Chongqing TBI, \$1.69 million for the Chongqing UTBI, and \$0.64 million for the Shanghai UTBI. This confirms our previous qualitative finding that, compared to other incubators, Caohejing TBI possesses the strongest capability to pool resources and funds due to its wider financial network.

4.3.2 Incubation surface

TBIs occupy larger incubation surface areas than UTBIs (Table 5). These differences in incubation surface can be explained by the incubator's mission orientation and location. UTBIs mainly focus on nurturing academic technology-based ventures. Academic ventures incubated in UTBIs do not tend to require large spaces, especially during the initial stage of technology development. Inventions arising from university laboratories are mostly embryonic and lack a scale economy of production. In addition, the Chongqing and Shanghai UTBIs are near university campuses in the city centre, where the price of land is high. In contrast, the Chongqing and Caohejing TBIs' mission differs from those of UTBIs in the sense that the TBIs we studied focus more on industrialising high technology in China. They emphasise the incubation of comparatively mature technology, which is closer to achieving commercialisation and economies of scale. Consequently, tenant ventures in TBIs tend to be larger than academic ventures in UTBIs, and the local government endows the Chongqing and Caohejing TBIs with free land in STIPs at the outskirts of the city. Thus, TBIs possess a relatively larger incubation surface than UTBIs. Numerous venture entrepreneurs in the Chongqing and Caohejing TBIs are engineers and researchers who left their previous positions to establish their own businesses. As such, they can afford the additional rental costs when a large incubation space becomes necessary.

4.3.3 Number of incubator staff, tenant firms, and total income

TBIs employ more staff and host more tenant firms than UTBIs. On close examination of the workload per incubator staff, we found that UTBI employees have a heavier workload than those in TBIs. The statistics for tenant firms per staff member are as follows: 14.2 for the Chongqing UTBI; 7.3 for the Shanghai UTBI; 1.7 for the Chongqing TBI; and 3 for the Caohejing TBI. In terms of total income, TBIs generate higher income than UTBIs. In 2010, the Caohejing TBI generated the highest income at \$3.06 million, followed by the Chongqing TBI at \$1.91 million, the Shanghai UTBI at \$0.82 million, and the Chongqing UTBI at \$0.12 million.

4.3.4 Survival rate and accumulated number of graduated tenant firms

Tenant firms in TBIs have a higher survival rate than those in UTBIs. The higher quality of services in the former could explain this difference. For the cumulative total of graduated tenant ventures, TBIs are found to be more successful in creating new ventures, compared to UTBIs. Based on our interviews, tenant firms enjoy university resources and are reluctant to leave UTBIs, an attitude that may retard the rate tenant firms' graduation rate. This result is consistent with Rothaermel and Thursby's (2005) finding that knowledge flow from universities enhances the performance of incubated firms.

4.3.5 Number of approved patents and national science and technology projects undertaken

TBIs perform better than UTBIs in these areas, not only in terms of the absolute number of granted patents and research projects under taken, but also in the average number of granted patents and research projects per tenant venture. This finding indirectly implies that TBIs are comparatively more successful than UTBIs in incubating more innovative ventures.

4.4 Analysis of the performance of incubated tenant firms

As mentioned in the Method section, managers of the eight tenant ventures (discussed in Section 3.2) were interviewed regarding their ventures' progress. All of the managers, with the exception of the manager of one of the two tenant ventures at the Chongqing UTBI, stated that their ventures had made progress. These seven reported that sales volume, number of patent applications, and number of employees increased after they began receiving support from an incubator. For example, one tenant at the Caohejing TBI said, "After incubating in the Caohejing TBI, our sales volume has been quadrupled. The current sales volume has passed over RMB 5 million. The number of staff has increased from 6 to 11."

Reported business progress was especially notable for those tenant ventures incubated at two TBIs (Caohejing and Chongqing TBIs). Managers of two tenant ventures at the Caohejing TBI reported current yearly sales volume of more than 4 million RMB (approximately \$0.65 million), which is more than double their sales volume prior to being incubated. Similarly, one manager of a tenant venture at the Chongqing TBI reported that sales volume had tripled, and the other that annual sales volume had risen more than 35%. These TBI tenant ventures also reported an increase in the number of employees. The average number of employees at these ventures had grown from about 4 to 12 since incubation. In terms of patent application, tenant ventures at Caohejing and Chongqing TBIs have, on average, about 13 patent applications per firm. Some tenants have learned about the importance of intellectual property rights since joining the incubator; one manager at the Caohejing TBI was quoted as saying, "Our company has been a resident in the TBI since October 2011. After residency, we are more aware of intellectual property rights. Now we are applying for 5–6 patents."

Another manager at the Chongqing TBI made the same point: "We have been a resident of the incubator since 2009. After receiving incubation service, we are more

aware of intellectual property rights protection. We are applying for four software patents and national scientific research projects.”

Incubators in our study have clearly reached out to tenant firms, not only to provide landlord services, but also to serve as educators or centres for the dissemination of critical management information.

5 Discussion and Implications

5.1 *Evaluating the performance of government-supported business incubators: UTBIs versus TBIs*

Overall, TBIs perform at a higher level than UTBIs. Under the incubator assessment framework of Chan and Lau (2005), TBIs outperform UTBIs in four out of nine assessment criteria: pooling resources, sharing resources, consulting, and networking. In the remaining five assessment criteria, TBIs and UTBIs had comparable assessment results. Both the Chongqing and Caohejing TBIs organise exhibition events for their tenant firms and provide opportunities to attend international exhibitions. They likewise make significant investments in public service platforms, such as an expert database and research equipment, to better meet the resource requirements of tenant firms. The Caohejing TBI offers higher-quality consulting services with easier accessibility compared to those offered by other incubator programmes. Moreover, the network services of TBIs are more focused on attracting external experts to the networks and building beneficial relationships with other institutional players such as banks, universities, and public research centres. Establishing an extensive network of external experts and institutional actors could be helpful because it provides tenant venture firms with easier access to financial resources such as bank loans and Innofund, as evidenced by the Caohejing TBI.

Our quantitative investigation of the performance outcomes of these two types of incubators using the incubator assessment indicators of the European Commission (2002) likewise demonstrates that TBIs are superior to UTBIs in terms of job creation, income generation, survival rate of tenant firms, number of graduated tenant firms, and innovation. This is consistent with the results obtained from a previous qualitative comparative analysis using the assessment framework of Lau and Chan (2005). Factors such as better services in consulting, pooling and sharing of resources, and networking seem to explain the higher performance of TBIs than UTBIs in the cited indicators.

Our study shows that university sponsorship of business incubators may not be compatible with maximising the profitability of tenant firms. First, TBIs and UTBIs have different foci in their missions. Although the ultimate objectives of TBIs and UTBIs converge toward fostering high-technology ventures, UTBIs are established mainly to transfer university technology, foster entrepreneurial academic innovation, and conduct indigenous innovation activities. Meanwhile, TBIs are built to industrialise high technologies and achieve both firm- and regional-level innovative capabilities. UTBIs are designed to function as experimental bases for academic entrepreneurs to accumulate experience in innovation and promote their capabilities for innovation. Academic entrepreneurs prefer to reside in UTBIs to gain easy access to university technology, laboratory facilities, and other university-related resources. Unfortunately, academic tenant firms prefer informal personal contacts and are reluctant to pay for value-added

services. Although such behaviour helps academic entrepreneurs reduce operational costs, it also impedes UTBIs' incentive to improve consulting services and develop a wider network for tenant firms. Furthermore, university policies allows professors to keep their positions in the university when they engage in the creation of high-tech start-ups, thus preventing them from fully committing to the development of new ventures.

The majority of entrepreneurs in TBIs possess many years' worth of technical background and experience in commercial organisations. Moreover, they are usually not affiliated with other positions, unlike many academic entrepreneurs. This independence strengthens TBI entrepreneurs' commitment to develop successful businesses. Furthermore, TBIs are located in STIPs, where many multinational companies conduct large-scale manufacturing production and R&D. As a result, TBIs tend to enjoy spillover from multinational firms, unlike UTBIs.

The Caohejing TBI directly invests in its tenant venture firms, implying that it is more committed to their successes. To achieve this objective, Caohejing TBI strives to further improve its incubation services by such measures as developing broader networks with external institutions such as universities, public research institutions, specific experts, and foreign venture capitalists.

5.2 Implications of the effectiveness of government-driven incubator programmes

Our findings strongly suggest that, as expected, the government's role is limited to supporting the functions required to nurture high-technology venture development through business incubator programmes. Survey and interview results from tenant venture firms, as well as archival evidence, indicate that government-supported incubators are generally effective in providing infrastructure, a perception of credibility, and resources such as staff training and laboratory facilities. Tenant firms in all four incubators have satisfactory perceptions of the services they receive, such as laboratory facilities, office equipment, training, and exhibition opportunities. In addition, they have relatively easy access to resources of universities and public research institutes, and enjoy a positive public image for their association with government-supported UTBIs and TBIs. However, except for those incubated at the Caohejing TBI, the quality of consulting services for tenant venture firms is inferior. This is particularly true for advice related to business and technology, as well as for access to an external network of key actors, such as potential industry clients, creditors, or other established entrepreneurial firms.

The Caohejing TBI is the only incubator whose tenant venture firms report satisfaction in all nine assessment categories, including consulting and networking services. Moreover, unlike the other incubators, Caohejing TBI has successfully attracted foreign investment capital for its tenant venture firms.⁵ What differentiates the Caohejing TBI from the other three incubators is its management board, which is led by business professionals of the Caohejing New High-Tech Development Corporation.⁶ Meanwhile, the management boards of the three other incubators consist of local government officials and representatives from their sponsoring universities. These officials and representatives lack the necessary business expertise to transfer competencies and knowledge to incubated venture firms (Autio and Klofsten, 1998; von Zedtwitz and Grimaldi, 2006). Thus, they are relatively incapable of satisfying their clients in value-added consulting and networking services compared to the professionally managed Caohejing TBI, which provides a higher level of professional management and financial services to tenant

venture firms due to their governance structure and corporate sponsorship. A successful incubation process requires critical external resources such as knowledge, financial and human capital, and market-related resources (e.g., Bergek and Norrman, 2008; Bollingtoft and Ulhoi, 2005; Cooper et al., 2012; Mian, 1996; Sa and Lee, 2012). Thus, the incubator plays a critical role as an intermediary that bridges the incubated venture firms and the established entrepreneurial network (Lin et al., 2012; Scillitoe and Chakrabarti, 2010; Schwartz and Hornyh, 2010). Moreover, the fast rate of technological and market changes requires incubators to assume a more intense and proactive stance in providing counselling services to improve effectiveness of their services. Consequently, our findings support the idea that greater involvement by the private sector in the management of government-supported incubators promotes successful incubation and entrepreneurship.

Regarding the effectiveness of government-driven incubator programmes, feedback from managers of tenant firms is consistent with the key findings of this study. These managers expressed their general satisfaction with the overall services provided by the hosting incubators. One of the tenant firms from the Shanghai UTBI stated, “We were satisfied with the services and appreciated the geographic advantage of the hosting incubator.” A tenant firm from the Chongqing TBI stated, “We were satisfied with the services provided by the hosting incubator, and we especially appreciate the service and the assistance in the early stage of venture development.” Furthermore, both tenant firms at the Shanghai UTBI commented on their advantage in terms of proximity to the market and university resources. A manager of a tenant firm at the Caohejing TBI remarked on his satisfaction with the consulting services provided by the incubator, saying, “We appreciate the efficient communication and information transfer provided by the hosting incubator”, as described in Subsection 4.2.3. This comment indirectly supports our claim that the differentiated management structure at the Caohejing TBI, which involves business professionals, is superior to that of the other government-supported business incubators in terms of offering value-added services, such as consulting and networking, to its tenant venture firms.

6 Conclusions

This study examines the characteristics and performance of government-supported TBIs in China and analyses the key factors related to their performance. Based on the framework of Chan and Lau (2005) and the incubator assessment criteria of the European Commission (2002), we examined four TBIs, two university-sponsored (Chongqing UTBI and Shanghai UTBI) and two non-university-sponsored (Chongqing TBI and Shanghai TBI). Our study revealed that government-supported business incubators are generally effective in providing physical infrastructure, office support, and access to resources of university and public research institutes. However, except for the professionally managed Caohejing TBI, government-supported incubators are relatively ineffective in providing access to external capital or business-related consulting and networking services. These findings, therefore, demonstrate the importance of private-sector involvement in managing government-supported incubators through continuous and proactive counselling, as well as by providing more effective networking services to tenant venture firms.

A limitation of this research is that we used eight ventures to assess the performance of four incubators. Although our sample is small, participants' responses generally reflect the overall service quality of incubators, given their likely interactions with similar ventures. Our findings are also consistent with additional research, which involved the interviews with managers at incubators and tenant firms as well as archival data analysis. Nevertheless, future research that examines the organisational and institutional arrangements involving the private sector in government-supported incubators is advised. Moreover, a firm-level longitudinal study that closely monitors and investigates the factors that influence the survival and profitability of graduated incubated venture firms would enhance our understanding of the effectiveness of government-supported incubators.

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Notes

- 1 The success of the government-supported TBIs program refers to fostering new ventures and helping them grow by providing a broad range of services. Further details on how we measured their success are given in Section 4.2.
- 2 Interviewed managers were mainly the ventures' executive directors, including the CEO, and the incubators' administrative managers.
- 3 A belief system influenced by the socialist philosophy that government services or donor-sponsored agencies must be free of charge (Lalkaka, 2001).
- 4 A special government fund established in China in 1999 on the approval of the State Council. The Innofund aims to facilitate and encourage the innovation activities of small technology-based firms and to commercialize academic research output. Funding can be provided in the form of appropriation, loan-interest subsidy, or equity investment on the basis of project selection (Kroll and Liefner, 2008).
- 5 Connecting tenant ventures to external investors is essential, especially when tenant ventures create their own companies and begin to market their products or services, as shown in the growth stage of the funding system in Figure 1.
- 6 A government-owned corporation.