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Identifying Business Incubators Based on Their Real Activities: Evidence from China

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***Abstract*—**Past literature on business incubators distinguished incubators based on their mission statements. However, more and more mission statements become a slogan rather than a reality. It is therefore more appropriate to identify business incubators based on their real activities, rather than the missions they declared. With a sample of technology business incubators (TBIs) in China, we try to investigate business incubators' real activities by examining the incubation efficiency along the following five dimensions, i.e., survival of new ventures, technology transfer, local economic growth, job creation, and profit generation. Furthermore, we identified six types of business incubators. The results indicate that generally Chinese TBIs have a greater preference for acquiring profits over other dimensions.

***Keywords*—**Business incubators, mission statements, real activities, incubation efficiency, technology business incubators, China.

I. Introduction

FROM 1980s onward, the numbers of business incubators are growing rapidly all over the world [1]-[3], especially in the developing countries such as China, Brazil, Turkey and so on [4]. By the end of 2011, there are 1034 technology business incubators (TBIs) in China. According to the Chinese Ministry of Science and Technology (MST) [5], China was ranked second to the United States in the world in terms of the number of TBIs (Fig. 1). Nevertheless, as the term business incubator has become an "umbrella word" utilized to cover a heterogeneous group of institutions [6]-[9], some authors identify business incubators based on their mission statements, and argue that incubators declaring the same missions belong to the same type [6], [7]. However, as each business incubator is unique and different [7] and 'no two incubators are alike' in the world [10], [11], the mission statements vary from one incubator to another. Also, business incubators will have different missions depending on different generations [2], countries, and geographies, etc. [6], [7]. Moreover, in most cases, a business incubator has multiple sponsors with different interests [12], and an incubator may advertise several missions depending on the interests of its sponsors, or at least make 'different priorities' within these missions [13]. Therefore, it is difficult to distinguish between business incubators with different mission statements. On the other hand, in reality, some business incubators failed to provide their promised support services or value proposition [14]. In other words, business incubators may not do the right activities related to the missions they stated [6], or they even do not know their mission statements clearly. As a result, business incubators' mission statements have become a slogan rather than a reality. It is, therefore, more appropriate to identify business incubators based on their real activities, rather than the missions they stated. With a sample of the technology business incubators (TBIs) in China, this study aims to identify business incubators' real activities by examining the incubation efficiency along the following five dimensions, i.e., the survival and growth of new ventures, technology transfer, local economic development, local job creation, and profit generation. Based on the efficiency scores of each incubator in each dimension, we categorize Chinese TBIs into different typologies.

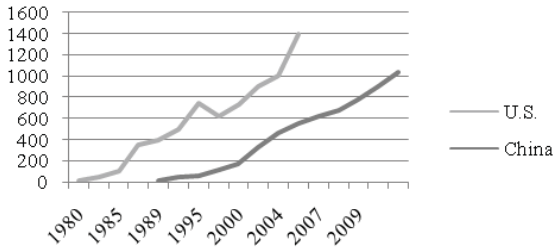

Fig. 1 The number of incubators in U.S. and China

The remainder of the article is organized in the following manner. In the next section we start by reviewing literature on the objectives of incubator activities. The methodology applied in our empirical test is briefly explained in Section III. Section IV describes the background information about Chinese TBIs, and the results are given in Section V. Finally, the study ends with conclusions, implications, and limitations.

II. Literature Review

Due to the heterogeneity of business incubators, the incubator activities are implemented along multiple dimensions depending on their objectives. While some business incubators have a greater preference for facilitating the survival and growth of new ventures, some other business incubators focus more on promoting local economic development and employment [15]. To identify the appropriate dimensions of incubator activities, we begin with a simple description of the

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objectives of business incubators. A table summarizing such literature has been included in Table I.

Regardless of the diversity and complexity of incubator objectives, the universal purpose of incubator activities is to increase the formation, survival and growth of new ventures [10]. There is no doubt about the important role that new ventures play in the development of economies - they are a major source of sales, new jobs, and innovations in most economies [3], [16]-[18]. Paradoxically, these young firms are often fragile and many unfortunately do not make it through their first critical years [13], [15]-[19]. Business incubators are thus adopted in many countries as a popular tool to respond to this general concern. Reference [6] studies business incubator by going back to the roots of the concept, and argues that the principle of business incubator is that premature infants require temporary care in controlled environments. Besides many scholars [2], [6], [8], [10], [11], [15], [16], [20]-[24], some famous organizations in the world, i.e., National Business Incubation Association [25], United Kingdom Business Incubation [26], and European Commission [27] defined business incubators as a tool to nurture and develop the fledgling ventures by providing them with an array of services and supports. It is notable that business incubators not only stimulate the survival and growth of new ventures, but also help promoting entrepreneurs to create their business [8], [11], [15], [17], [28]. Reference [8] argues that the aims of business incubators are seeking an effective means to improve entrepreneurial talents. Similarly, [6] proposes that one of the important goals of business incubators in Europe is bridging the entrepreneurial gap and exploring how the region can become more enterprise friendly. Thus, training entrepreneurs is also an important objective for business incubators in some regions.

Unlike the stand-alone enterprises, most business incubators are deeply embedded in political system [3]. Indeed, business incubators are often publicly funded [1], [6], [15], [17], [22], and therefore the main objectives of establishing business incubators in most countries is to promote or revitalize local economic development and stimulate employment opportunities which are the aspects of particular interest to the national and/or local governments [11], [20], [23], [29]. In addition, the similar objectives such as diversification of the local economy [11], enhancement of the image of location [30], bridging the social gap by increasing employment possibilities for people with low employment capacities [6] are considered to be affiliated to the two dimensions: local economic development and job creation.

Stimulating technology transfer and research commercialization are generally considered as an important component in goal portfolio of incubator activities, especially in the case of technology business incubators (TBIs) and science parks (SPs). TBIs are institutions providing services and assistance to new technology-based firms (NTBFs) [8]. The UK Science Park Association defines a Science Park as follows: (a) has formal and operational links with a university or other higher education institution or major centre of research; (b) is designed to encourage the formation and growth of knowledge-based businesses and other organizations normally resident on site; (c) has a management function which is actively engaged in the transfer of technology and business skills to the organizations on site. TBIs and SPs are similar to traditional business incubators but they place more emphasis on technology transfer and research commercialization [8], [31], [32]. For example, [12] argues that TBIs are enterprise development tools employed by some entrepreneurial universities to effectively link talent, technology, capital and know-how to speed the commercialization of research. According to [29], there are three most important objectives for TBIs: (a) economic development and local employment opportunities; (b) commercialization of research, and (c) transfer of technology.

Despite the fact that many business incubators are linked to a not-for-profit culture [6], [11], there are also many business incubators with a for-profit nature [7], [8], [10]. A typical example is the private incubators which invest their own money in affiliated tenants. Private business incubators are always set up by large companies or single individuals, and the main purpose of their activities is to generate profits to develop sustainably [7], [8]. In reality, they can make money in several ways, including charging service fees, taking a percentage of revenues from tenants, and so on [8].

TABLE I
DESCRIPTION OF OBJECTIVES OF INCUBATOR ACTIVITIES IN PREVIOUS RESEARCH

Objectives	Authors
Formation/survival/growth of new ventures	[6], [8], [10], [11], [15], [16], [19]-[24]
Training entrepreneurs or entrepreneurship	[6], [8], [10], [20]
Local economic development/ wealth creation/ diversification of the local economy	[6], [7], [10], [11], [15], [20], [22], [23], [29]
Employment opportunities/job creation	[6], [10], [11], [15], [20], [22], [23], [29]
Technology transfer and/or research commercialization	[7], [8], [10], [11], [15], [20], [22], [29], [40], [41]
Profit generation	[7], [8], [10]

Of course, there is also some research by authors who have studied specific incubator objectives, e.g., basic research development [6], real estate appreciation [10], and so on. However, most popular incubator activities are implemented along the following five dimensions, i.e., the survival of new ventures, local economic development, job creation, technology transfer, research commercialization, training entrepreneurs, and profit generation.

III. CONTEXT OF THE STUDY

China implemented a series of science and technology policy initiatives at the beginning of the reform era to address the China's lower levels of science and technology capabilities, such as Tackle (Gong Guan) program, the High Technology Research and Development Plan, and so on [33]. As one of the most important policy initiatives, the Torch Program was put in place in 1988 with the purpose of 'developing new- and high-technology products, establishing NTBFs, and paving the way for the commercialization of research that will come out of major national science and technology programs' [34]. A major

component of the Torch Program in China was the establishment of the technology business incubators (TBIs) in the whole country.

In China, the majority of TBIs are established as publicly funded vehicles for supporting the development of new technology-based firms. Fig. 2 shows that the evolution over time of the number of TBIs. In comparison with developed countries, China has been a laggard in the development of such initiatives. The first Chinese TBI, the Wuhan Eastlake Hi-tech Innovation Center, was established in 1987. According to Fig. 2, the TBIs movement did not take off until the early 2000s: between 1999 and 2011 the number of TBIs rose from 110 to 1034.

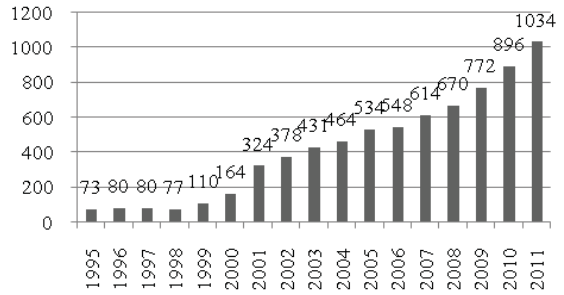

Fig. 2 The number TBIs in China from 1995 to 2011

Fig. 3 presents the number of tenants/incubatees and their employees in TBIs. It suggests that the number of incubatees increases quickly from 1,854 in 1995 to 60,936 in 2011. However, in the year 2008, the number dropped a little, presumably because of the financial crisis in the world. The number of employees is increasing in line with the incubatee growth (from 25,700 in 1995 to 1,256,000 in 2011). In general, the size of TBIs in China is large compared with US and European business incubators. In 2011 alone, Chinese TBIs provided rental space of 34 million m^2 which supported 60,936 new ventures with 21 employees each, creating 1.2 million jobs, and generating annual revenue of more than 380 billion yuan. By the end of 2011, the accumulated number of graduates incubated by TBIs had reached 39562.

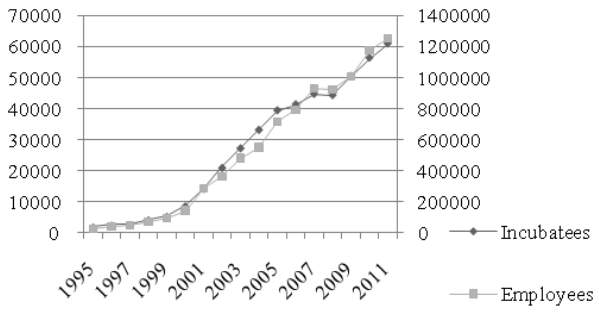

Fig. 3 The number of incubatees and employees in TBIs

In China, most TBIs are initiated by national and/or local government agencies, and the purchasing of land and the initial investment in infrastructure for TBIs is partially financed by these official institutions. To specifically define and manage the development of TBIs, the Chinese Ministry of Science and Technology (MST) [5], a government institution in charge of business incubators, has enacted a decree listing a range of standards, and the TBIs having met these standards are given the title of "National Technology Business Incubators" (NTBIs) and enjoy favorable public images, financial support and other governmental resources. For example, the decree stipulates that the number of incubatees located in the NTBIs must surpass 80, and the proportion of incubatees with intellectual property must beyond 30%. With respect to selection criteria, the tenant firm's age at entry must be less than 24 months. Also, the incubation period must be less than 42 months. To become a graduate, a incubatee must meet at least two of the following three criteria: (a) the incubatee must have acquired intellectual property; (b) the annual revenue generated by incubatee must have been over 10 million yuan for 2 consecutive years; (c) the incubatee is merged or acquired, or goes public and becomes a listed company at home or abroad. Such national status test is to be repeated every year, and if the NTBIs fail to meet the standards for 2 continuous years, the qualification of 'NTBIs' will be revoked. According to the decree, the objectives of NTBIs' activities contain many aspects, including facilitating the survival and growth of NTBFs, enhancing local economic development, promoting local employment opportunities, stimulating technology transfer, training entrepreneurs, and so forth. It is therefore necessary to examine the extent to which each dimension of objectives is being achieved by these Chinese TBIs.

As the general TBIs do not usually employ the same relatively stringent criteria that the NTBIs use, our empirical study focuses on the NTBIs in 2010. The data were collected from several sources. One is 2011 'China Torch Statistical Yearbooks' provided by the Chinese MST, which provides data on each NTBI's annual sales revenue, employment size, number of graduates, incubator size, etc. These data are collected by incubator management from the resident tenants; then, they are aggregated to the incubator level and reported annually to the MST, which publishes the data. We collected additional information from the Web site of the national and local business incubation association and from the individual NTBI's Web sites and brochures. We also telephoned some incubator top managers and entrepreneurs of incubatees to verify the data. There were 343 NTBIs in 2010 in China. Because of the missing data, we have to remove 61 NTBIs, and finally our sample includes 282 NTBIs in 2010.

Based on the objectives of incubator activities described above, the indicators of outputs in different dimensions can be created as follows. First, as the most common type of incubator objectives, the output in the dimension of facilitating the survival and growth of new ventures (SUR) is measured by the number of graduates generated by NTBIs in 2010 [1], [10], [11], [17]. Second, since our samples are all TBIs, stimulating technology transfer (TRAN) is of particular importance, and we use the number of intellectual property acquired by all the incubatees in each NTBI as the indicator [16]. Third, because most NTBIs in China are publicly funded, the output in terms of

promoting local economic development (ECO) and job creation (JOB) are therefore incorporated. The revenue generated by the graduates in 2010, and the number of employees in both incubator and incubatees [10], [17] are used as the indicators, respectively. Finally, as some NTBIs are private incubators and for-profit, the output in the dimension of profit generation (PRO) is measured, and we use the income acquired by incubators in 2010 as the proxy. The inputs of the business incubators mainly contain three aspects which are widely used in the estimation of firm performance [35]. The first input is the labor used, which is calculated in terms of the number of incubator staff (STAFF) [36], [37]. The second is the capital expressed as the volume of the incubation funds (FUND) which stem from various sponsors, i.e., national and local government agencies, universities, corporations, individual, and so on [36], [37]. The third input is material resources or infrastructures represented by the rental space of NTBIs (INFRA) [36], [37]. Descriptive statistics for the outputs and inputs are presented in Table II.

TABLE II
DESCRIPTIVE STATISTICS FOR OUTPUTS AND INPUTS

Variables	Description	Mean	S.D.
SUR	Number of graduates generated by NTBIs in 2010	10.97	8.76
TRAN	Number of intellectual property acquired by incubatees in 2010	64.02	76.29
ECO	Revenue generated by the graduates in 2010 (million yuan)	100.62	136.70
JOB	Number of employees in both incubator and incubatees in 2010 (persons)	2477.53	2916.07
PRO	Income acquired by the incubators in 2010 (million yuan)	10.12	14.86
STAFF	Number of incubator staff (persons)	21.07	12.02
FUND	Incubation fund (million yuan)	30.07	298.17
INFRA	Rental space of NTBIs (m^2)	47747.05	43413.44

IV. ECONOMETRICS MODELS

To assess the extent to which each dimension of incubator activities is being achieved by the TBIs in China, we use the stochastic frontier estimation (SFE) technique to evaluate the incubation efficiency. We say that a business incubator is inefficient if, when compared to incubators with similar amounts of inputs, it could produce more outputs without increasing its inputs usage, or, equivalently, it is one which, when compared to incubators with similar levels of outputs, could produce the current levels of outputs with fewer inputs [38]-[41]. As the SFE technique has been described elaborately in other literature [42], [43], we briefly outline the framework. SFE generates a production frontier with a stochastic error term consisting of two components: a conventional random error ('white noise') and a term representing deviation from the frontier. In SFE, a production function of the following form is estimated:

$$Y = X_i b + e_i \quad (1)$$

where the subscript *i* denotes the *i*th business incubator, Y the output, X the vector of inputs, β the unknown parameter vector, and $\varepsilon_i=V_i-U_i$, where U_i represents a non-negative error term to account for the inefficiency, or failure to produce maximal output, given the set of inputs used, and V_i is a symmetric error term that accounts for random effects. The inefficiency term (U_i) is assumed to have a half-normal distribution, i.e., incubators are either "on the frontier" or below it. An important parameter in this model is $g = s_u^2 / (s_v^2 + s_u^2)$, the ratio of the standard error of technical inefficiency to the standard error of statistical noise, which is bounded between 0 and 1. Note that γ=0 under the null hypothesis of an absence of inefficiency, signifying that all of the variance can be attributed to statistical noise.

$$U_i \sim i.i.d.N^{+}(0,\sigma_u^2), U_i \geq 0$$
$$V_i \sim i.i.d.N(0,\sigma_v^2)$$

More specifically, our specification of (1) is based on the Cobb-Douglas production function:

$$\ln(OUTPUT_i) = b_0 + b_1 \ln(STAFF) + b_2 \ln(FUND) + b_3 \ln(INFRA) + V_i - U_i \quad (2)$$

where OUTPUTi denotes the *i*th dimension of incubator activities, i.e., SUR, TRAN, ECO, JOB, PRO, respectively. According to the SFE approach, if the efficiency score is equal to 1, the TBI is considered to be efficient, and if it is less than 1, there is some degree of inefficiency. Using the FRONTIER 4.1 statistical package, the empirical results are presented in the next section.

V. EMPIRICAL EVIDENCE

A. Incubation Efficiency in Each Dimension

According to Table III, the correlation coefficients between inputs and outputs all have the expected signs, although some results are not significant. It suggests that hiring additional incubator staff (STAFF) results in more local jobs and profits (see JOB model and PRO model), but not additional survival of new ventures, technology transfer, and local economic development (see SUR model, TRAN model, and ECO model). Like [42], [43], we can assume that incubator sponsors or managers in NTBIs have established incubator staff incentives to promote employment and generate profits. For the variable of FUND, it suggests that receiving additional incubation funds results in more survival of new ventures, local economic development, and profits (see SUR model, ECO model, and PRO model), but not additional technology transfer and jobs (see TRAN model and JOB model). The results reveal that most of the incubation funds are used to facilitate the survival and growth of new ventures, enhance economic development, and acquire profit. For the input of INFRA, we find that it has significantly positive association with all the five dimensions of incubator activities. Thus, the infrastructure of NTBIs is the most widely used resource. Altogether, it appears that the Chinese NTBIs have a greater preference for acquiring profit over other dimensions, although NTBIs are often publicly funded.

TABLE III
MAXIMUM LIKELIHOOD ESTIMATES OF THE STOCHASTIC FRONTIER

	SUR model	TRAN model	ECO model	JOB model	PRO model
Intercept	-0.838(0.675)	0.358(0.853)	6.412(0.972)***	1.558(0.464)***	2.834(0.930)***
STAFF	0.072(0.094)	0.127(0.124)	0.076(0.138)	0.216(0.069)***	0.901(0.132) ***
FUND	0.068(0.042) *	0.051(0.054)	0.148(0.062) ***	0.018(0.031)	0.175(0.062) ***
INFRA	0.115(0.083)* **	0.328(0.079)***	0.374(0.090) ***	0.534(0.045) ***	0.238(0.087)***
Log likehihood	-309.642	-387.740	-419.472	-226.423	-416.397
γ	0.493(0.289) **	0.749(0.084) ***	0.666(0.121) ***	0.575(0.107) ***	0.714(0.085) ***
Mean efficiency	0.650	0.485	0.483	0.685	0.471

Notes: standard errors in parentheses; N=282 NTBIs; * Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level.

The last row of Table III presents the average efficiency in each of the five dimensions. It appears that the mean incubation efficiency in terms of job creation (JOB-efficiency) is the highest compared with other dimensions (0.685), and the incubation efficiency in terms of facilitating the survival of new ventures (SUR-efficiency) ranks second (0.650 on average). The incubation efficiency score of stimulating technology transfer (TRAN-efficiency) and promoting local economic development (ECO-efficiency) are both under 0.50 (0.485 and 0.483, respectively). Finally, the incubation efficiency in the dimension of profit generation (PRO-efficiency) is the lowest (0.471 on average). In general, the incubation efficiency of NTBIs in China is low.

B. Six Typologies of TBIs

Based on the efficiency scores of individual NTBIs in each dimension, we use the SPSS 16.0 as a tool to do the K-mean cluster analysis (K=6)[1]. Table IV is the final cluster centers operated by the SPSS, and we can identify six typologies of NTBIs in China. The first type is termed as the 'PRO-oriented incubator'. The most important characteristic of this type is the incubation efficiency in the dimension of profit generation is disproportionately high (i.e., PRO-efficiency is 0.74 on average), while the efficiencies in other dimensions are low (i.e., the average TRAN-efficiency, ECO-efficiency, JOB-efficiency, SUR-efficiency is 0.21, 0.24, 0.30, 0.24, respectively). In other words, the PRO-oriented business incubators are more effective at acquiring profits. The second typology is called the 'SUR-oriented incubator' whose SUR-efficiency is markedly higher (0.72 on average) than those of other dimensions. By definition, NTBIs of this type are more effective at facilitating the survival of NTBFs. The third type is characterized by the high efficiency scores in all the four dimensions, i.e., SUR, TRAN, ECO, JOB, while the efficiency in the dimension of PRO which is always an objective of private incubators [7], [8] is low (about 0.07 on average). To name this type of incubator, we use the term 'public-excellent incubator'. The two national technology business incubators belonging to this type are Xuzhou Hi-tech Innovation Service Center and Huzhou Technology Incubation Service Center which are both publicly funded and non-profit incubators[2]. The fourth type is labelled as the 'TRAN-oriented incubator' which is efficient in technology transfer, i.e., the TRAN-efficiency score is higher than the scores in other dimensions on average. The fifth type is called the 'multi-inferior incubator' characterized by low efficiency scores for all the five dimensions. The final type is called 'ECO-oriented incubator' with good incubation performance in promoting the local economic development (i.e., the mean ECO-efficiency is higher than those of other dimensions).

TABLE IV
THE FINAL CLUSTER CENTERS

Typology	Cluster					
	1	2	3	4	5	6
SUR-efficiency	0.2494	0.7288	0.8010	0.2810	0.2011	0.1735
TRAN-efficiency	0.2106	0.1490	0.9890	0.6043	0.0977	0.1378
ECO-efficiency	0.2417	0.1509	0.9530	0.1296	0.0873	0.7873
JOB-efficiency	0.3024	0.3321	0.8055	0.2637	0.1831	0.2483
PRO-efficiency	0.7461	0.1145	0.0720	0.1280	0.0885	0.0877

Furthermore, we created a spider chart to visually present the characteristics of the six typologies in terms of the average incubation efficiency along the five dimensions (Fig. 4). According to the results, there are 10 NTBIs belonging to the first type. And the numbers of NTBIs belonging to other typologies are 27, 2, 24, 213, 6, respectively. Thus most NTBIs are belonging to the 'multi-inferior' type, and once again, this confirms the result that the incubation efficiency of Chinese NTBIs is low generally.

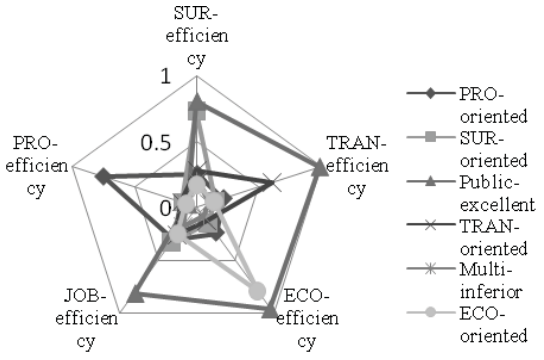

Fig. 4 The characteristics of the six typologies

[1] The result is statistically significant. It is notable that we also did the hierarchical cluster analysis and confirmed that the number of typology can be clustered as 6.

[2] Xuzhou Hi-tech Innovation Service Center is located in Jiangsu Province, and Huzhou Technology Incubation Service Center is located in Zhejiang Province. The host cities are both located in the eastern region which is the developed area in China.

C. Differences among Six Incubator Typologies

In order to identify the differences among the six incubator typologies to find out why some NTBIs are more effective in a certain dimension, we adopted the one-way ANOVA test. The results are shown in Table V. It suggests that there are significant differences in the four dimensions of outputs among the six archetypes, i.e., SUR (F=13.901, p=0.000), TRAN (F=29.033, p=0.000), ECO (F=31.916, p=0.000), PRO (F=45.732, p=0.000). More specifically, the PRO-oriented NTBIs generated the most amount of income compared to the other types (62.15 on average), and the SUR-oriented incubators created the highest number of graduates in 2010 (213.67 on average). Similarly, the incubatees of the TRAN-oriented type acquired the highest number of intellectual property (209.25 on average), and the graduates within the ECO-oriented NTBIs generated the highest amount of revenue for the local economy (39.29 on average). However, we do not find significant differences in JOB among the six types (F=2.061, p=0.070). Generally, the NTBIs which are efficient in a dimension always have high level of outputs or performance in this dimension.

As the newly established incubators are doing better than the older ones [2], we therefore include a metric variable that measures incubators' age (AGE) in years at the time of 2012 [44]. According to Table V, the mean ages of NTBIs of the six types are 11.00, 15.85, 9.50, 11.58, 12.58 and11.00, respectively, and the result is significant at the 1% level (F=3.101, p=0.010). Thus, the SUR-oriented NTBIs are relatively older than other types, i.e., the early NTBIs in China are mostly established to stimulate the new business creation and survival. Also, the public-excellent incubators are the youngest (9 years on average). In other words, the NTBIs established recently perform better than the old ones. Furthermore, the influence of incubator size (SIZE) measured as the number of incubatees within the incubator is examined. Despite the fact there are no significant differences in the incubator size across the six categories (F=0.689, p=0.615), the SUR-oriented NTBIs have the highest number of incubatees on average (125.11). The results may explain why the SUR-oriented NTBIs create the highest number of graduates on average. TRAN-oriented, multi-inferior and ECO-oriented NTBIs also rank high in the number of incubatees with the mean values of 100.88, 113.83 and 104.67 respectively. And the PRO-oriented NTBIs have the least (87.50 on average) mainly because of the cost consideration.

In China, the mentors are of particular importance for the NTBIs, and by the end of 2010, the number of mentors had been over 3500. The mentors are always recruited by the incubators, consisting of such elites from different fields as successful entrepreneurs, financial experts, management consultants and college professors. It is therefore desirable to investigate whether there are discernible differences in terms of the number of mentors (MENTOR) among the six types. The average numbers of mentors across the six types are 10.76, 8.59, 9.00, 9.98, 9.38, 17.67, respectively. However, no significant differences are founded in the table (F=1.523, p=0.183).

The importance of the venture capital for successful incubation has been widely discussed in incubator literature [2], [6], [8], [12], [21], [23], [29], [31], [32]. According to Table V, significant differences can be appreciated in the accumulated amount of venture capital provided by the NTBIs (VEN) among the six categories (F=7.413, p=0.000). On average, the SUR-oriented incubators provide more venture capital funds (443845) for their incubatees than other types. The result confirms the traditional wisdom that one important milestone in the development of a nascent firm is obtaining venture capital funding [31], [32], which can be another reason to explain why the SUR-oriented NTBIs have the most graduates compared to other types.

TABLE V
RESULTS OF ANOVA TEST

	PRO-oriented NTBIs	SUR-oriented NTBIs	Public-excellent NTBIs	TRAN-oriented NTBIs	Multi-inferior NTBIs	ECO-oriented NTBIs	Sig. (F test)
SUR (unit)	55.70	213.67	91.00	65.38	76.23	56.17	0.00(13.90)
TRAN (unit)	65.50	51.00	112.50	209.25	48.98	51.83	0.00(29.03)
ECO (million yuan)	11.88	6.71	18.59	10.17	8.24	39.29	0.00(31.91)
PRO (million yuan)	62.15	9.40	2.09	8.07	8.04	8.82	0.00(45.73)
JOB (unit)	2754.80	3918.71	2118.00	1497.54	2318.14	1881.17	0.07(2.06)
AGE (year)	11.00	15.85	9.50	11.58	12.81	11.00	0.01(3.10)
SIZE (unit)	87.50	125.11	92.50	100.88	113.83	104.67	0.68(0.61)
MENTOR (person)	10.76	8.59	9.00	9.98	9.38	17.67	0.18(1.52)
VEN (million yuan)	59.41	443.85	---	51.31	51.36	36.09	0.00(7.41)
QUAL1 (%)	96%	92%	90%	90%	92%	91%	0.65(0.66)
QUAL2 (%)	25%	43%	---	33%	48%	37%	0.03(2.49)

Notes: standard errors in parentheses.

There is no doubt about the important role that incubator managers play in the incubation process [9], [12], [14], [24], [28]. The services and supports that incubators provide to the incubatees depend mainly on the incubator managers, on their own knowledge and competencies, and on the external networks of relationships that they bring to the incubatees [8].

We therefore try to find the difference in the quality of incubator managers which is measured by the proportion of employees who have tertiary education in incubator management (QUAL1) and proportion of employees who are technical experts in incubator management (QUAL2) among the six incubator types. According to Table V, we find no significant differences in the QUAL1 among the different types (F=0.653, p=0.661). The average proportions of employees with tertiary education in incubator managers in the six types are all above 90%, which is one of the qualification requirements for NTBIs according to the decree. With respect to the variable of QUAL2, significant differences are observed (F=2.499, p=0.031). It is surprising that the multi-inferior incubators employ the highest number of technical experts compared with total employees in incubator management (48%). One plausible explanation is that incubator managers often lack the detailed technological expertise directly related to the core technology of the affiliated NTBFs , so the technical expertise within the incubator management are not sufficient to offer technology broke support [9].

VI. Conclusions

As it is difficult to distinguish between business incubators with different mission statements, and sometimes the mission statement is a slogan rather than a reality, it is therefore more appropriate to identify business incubators based on their real activities, rather than the missions they declared. Based on the data of the technology business incubators (TBIs) in China, the paper aims to identify the incubators' real activities by examining the incubation efficiency along the five dimensions, i.e., SUR, TRAN, ECO, JOB, and PRO. The study reveals that most of the NTBIs in China have a greater preference for acquiring profit over other dimensions. Moreover, based on the efficiency scores of individual NTBIs in each dimension, we identify six NTBIs typologies in China, i.e., PRO-oriented, SUR-oriented, publicly excellent, TRAN-oriented, multi-inferior and ECO-oriented incubators. Then, by one-way ANOVA analysis, we attempt to find some differences among the six types to find out why some NTBIs are more effective in a certain dimension. It appears that the NTBIs which are efficient in a dimension always have high level of outputs in this dimension. In addition, the success of SUR-oriented NTBIs is primarily due to the larger number of incubatees and more venture capital.

The study displays specific implications for incubator managers, incubatees, and policy makers. According to the results of the study, incubator managers should understand the strengths and weaknesses of their business incubator more clearly. Also, the incubator managers should know whether the missions stated or the interests of sponsors are achieved or not. Meanwhile, we strongly recommend that incubator managers realistically and explicitly state their incubation missions and marketing strategies. For incubatees, based on the incubation efficiency along multiple dimensions noted above, rather than the missions they declared, the new ventures should seek affiliation with the most suitable business incubators whose strengths are consistent with the firms' strategies and objectives. Finally, policy makers should make more careful assessments of business incubators before allocating financial and other supports to these organizations. The incubation performance should be related to the different dimensions of incubator activities. Moreover, because there are some PRO-oriented incubators in the NTBIs, the MOST in China should incorporate the profit generation into the objectives of the 'NTBIs' in the decree.

This study is not without limitations, which may provide avenues for further research. The incubation efficiency of incubator activities in other dimensions like training entrepreneurs, research commercialization is not examined, although these aspects are also important. Second, the sample for this study is cross-sectional in nature across incubators and is not longitudinal in nature, allowing only for analysis at one point in time rather than over the course of time. Finally, the paper only focuses on TBIs and China context. It is therefore desirable to extend our study to examine other types of incubators (i.e., UTBIs, bottom-up incubators, etc.) and economies.

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