The role of science park in innovation performance of start-up firms: An empirical analysis of Tsinghua Science Park in Beijing

Kazuyuki Motohashi
Department of Technology Management for Innovation, University of Tokyo
7-3-1 Hongo Bunkyo-ku Tokyo, 113-8656, Japan
e-mail: motohashi@tmi.t.u-tokyo.ac.jp; tel: +81-3-5841-1828

Abstract

This study empirically analyzes determinants of start-up firms in the Tsinghua Science Park in Beijing by survey data. More than 50% of firms are software and internet related ones with strongly technological background CEOs. It is found that firms have their internal innovations grounded in their own competitive advantage show better innovation performance, while formal R&D collaboration with Tsinghua University plays only marginal role. However, they are benefited from informal connection with faculty members and access to students. Human resource management services by the Science Park management company are most appreciated by tenant businesses. Finally, networking activities among tenants are found to be weak.

Key words: science park, start-up firms, innovation, China

1. INRODUCTION

China's innovation system was modeled on the former Soviet Union, characterized as a separation of firms, universities and public research institutes. Since the mid-1980s, the Chinese government has embarked on reforming its innovation system in order to solve this problem of inefficiency associated with separation of science and economic activities. However due to the legacy of centrally planned innovation system in China, human resources and know-how in relation to science and technology was naturally concentrated in the science sector, comprising universities and public institutions [3]. At present, there are few companies capable of conducting their own research and development and of withstanding international competition.

With this large discrepancy between the technical capabilities of the science and industry sectors, most technology transfers between these sectors have been a result of businesses that have been spun out from universities as opposed to industry-university cooperation. Lenovo, for example, well known for acquiring IBM's PC division, was a business founded by members of the Computer Research Institute of the Chinese Academy of Sciences. In addition, Founder was spun out from Beijing University, and companies such as Tongfang and UNIS emerged from Tsinghua University, all of which have grown into major companies producing high-tech products. The policy that promoted university lead innovation system in China is known as the Torch Program, a program aimed at building science parks around China's major universities to promote ventures being spun out from them. Here, we consider the Tsinghua Science Park, one of China's leading university science parks, and analyze the innovative performance of businesses within the park, in order to understand effectiveness of the policy.

In this study, we conduct a survey of the businesses within the Tsinghua Science Park, and performed a detailed analysis by using only within science park samples. Our survey is consistent with the framework of [2], covering items of innovation performance of inhabitant firms, their relationship with Tsinghua University and the value added provided by the park service company. We have collected the responses from 68 start-up firms in Tsinghua Science Park, out of about 200 inhabitants in 2008 for analyzing the role of science park in their innovation performance.

2. SURVEY RESULTS

In order to understand the role of the Science Park on innovative performance of tenant businesses at Tsinghua Science Park, we have developed a survey instrument containing the following items.

- Basic company information such as year of founding, size, and type of business. (including information about the founder)
- Status of innovation performance such as new products/processes innovation
- Status of cooperation with the Tsinghua University
- Reasons for entering the Science Park, along with any merits/demerits

The targets of the survey were 80 venture companies that were tenants of the "Innovation Square" within the Tsinghua Science Park, which has a relatively concentrated number of high-tech venture companies. Valid responses were obtained from 68 of these companies. The survey was conducted in December 2008. The Tsinghua Science Park management company, Beijing Innovation Incubator Co., Ltd., was commissioned to distribute and collect the questionnaires.

In terms of the types of businesses surveyed, internet/software-related businesses made up 46%. Following this were environment- and energy-related businesses (10%), bio-related businesses (9%), and computer/communications equipment (8%). Combining both the hardware and software elements, information technology made up more than 50% of the companies, providing a structure which is virtually the same as that of the overall tenants of the Science Park. In addition, with regard to the year of founding of these companies, most were founded after 2000, with 2007 being the most common year. With more than 50% of the target companies founded five or less years ago, this study is focused on extremely young companies.

When we look at the ownership status of the high-tech venture companies within the Science Park, the overwhelming majority (65%) are private enterprises. After private enterprises are foreign companies and stock companies, both at 10%, followed by Chinese-foreign joint ventures. Recently, in China, many state and co-operative businesses (in many

cases these are businesses related to local governments) have been privatized (limited liability companies, stock companies, etc.), and as such, the activities of private companies are relatively small. However, in the Tsinghua Science Park, private companies are the focus, and while their scale may be small, their potential for growth is tremendous.

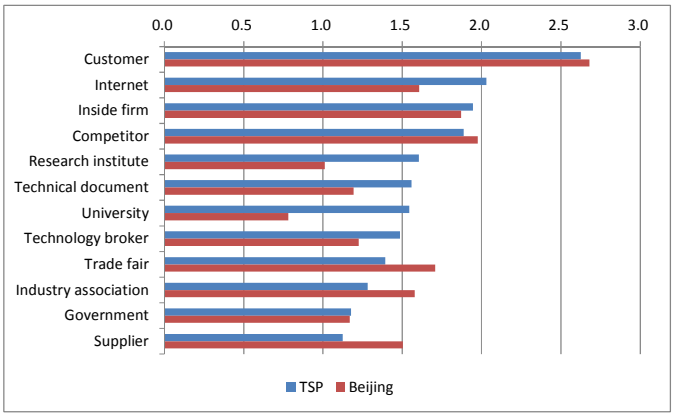
For venture companies, how to acquire funding at start-up and for operations is an important issue. Personal savings make up more than 50%, at 60%, followed by corporate investors and angel investors, with shares of 14% and 9%, respectively. The shares of loans from parents or friends, overseas venture capital, domestic venture capital, pledges, bank loans, and government funding all make up 5% or less each. Thus, it can be observed that in China, the support mechanisms to provide venture capital for venture financing are insufficient, and companies are reliant on self-funding when starting businesses. Tenants at the Tsinghua Science Park are assumed to be relatively successful venture businesses, but the capital environment for starting businesses is extremely difficult.

Since most of the businesses are young tech-based venture companies, many do not have established sales. The average growth rate for 2006–2008 was a very high 63.6%, however, meaning that these companies are growing at an extremely fast pace. But there is a great degree of variation, with a standard deviation of 170%, which means that it should be noted that many companies have been experiencing a negative growth rate in sales. We also examine the amount spent on R&D annually from 2006 to 2008. The average expenses show a rising trend from 491,000 yuan in 2006 to 757,000 yuan in 2007, and 853,000 yuan in 2008. This is believed to be so because a large proportion of the companies are still at the stage of building their business through R&D for the development of new products.

Based on the definitions in the OECD Oslo Manual, the survey asked (for the period of 2006–2008) whether there are R&D results in the form of new product development (product innovation), or the evolution of major production processes (process innovation). Of 54 companies providing valid responses, 81.5% of companies responded that they had conducted product innovation, and 74.6% also responded that they had conducted process innovation. It is thus possible to see that a majority of companies have developed their own products as fruits of their R&D processes, and are at the stage of selling these products.

Next, the results of the question of where the ideas for further innovation were obtained are described. Figure 1 shows the responses from businesses in the Science Park as compared with small businesses in Beijing, "Chinese Industrial Enterprise Innovation Survey" by National Statistical Bureau. For this item, to determine who is most influential in putting together innovative ideas, businesses were asked to select from a scale of "high," "medium," "low," and "none" in terms of the degree of importance for in-house sources, customers, etc. The scale of "high" to "none" is then given points from 3 to 0, and the scores are then averaged.

Figure 1: Information source for innovation



What can be said about the general trends of in-house versus customer sources of ideas is that the effect of customer requirements that represented the needs of consumers is the greatest. The major difference between the two sides is the importance of research institutions and the science sector, including universities. With regard to universities, these results naturally reflect companies in the Science Park of Tsinghua University, and with the Science Park being situated in Beijing's Zhongguancun area, where a number of public research institutions are focused, including universities and the Chinese Academy of Sciences, the position of research institutions in this response is likely higher.

In addition, for Tsinghua Science Park businesses, the importance of public information such as technical literature and the internet is increasing. This is because the technical information that high-tech ventures need to refer to is constantly advancing, and many academic studies are published in the form of academic papers, all of which are useful sources of information to assist in innovation.

In terms of the importance by type of cooperation with Tsinghua University, the item receiving the highest number of points was "Access to Faculty Staff," which is believed to be the result of the advantage of having many opportunities to mix with faculty members on an informal basis because of the geographical proximity with the university. Next is "Recruiting Students," but due to the fact that the targets of this survey are mostly young companies, as high-tech ventures throughout China grow in the future, there will be great incentives to pick graduates from leading universities such as Tsinghua University. At the same time, the rank of the kind of formal joint research or contracted research with universities is generally low. It is believed that this survey has been impacted by the fact that the target companies include mostly software and internet-related businesses, but in general, universities can also be better considered as structures that place importance on human networks of faculty and students than simply repositories for technologies and knowledge.

Finally, companies were asked for their assessment of the various services available within the Science Park. The Beijing Innovation Incubator Co., Ltd., which manages the Tsinghua Science Park, provides a variety of services to tenants, including help with legal procedures, holding seminars, providing information on technology platforms, and networking activities. Of these services, the holding of policy

seminars is comparatively valued to be high by the companies. Networking activities such as the holding of business exchanges are also comparatively valued to be high by tenants, suggesting a high degree of awareness by companies of the difficulties involved in networking. Conversely, the provision of marketing support and support in relation to intellectual property and legal procedures are not so highly regarded.

3. ECONOMETRIC ANALYSIS

Here, we conduct a quantitative analysis of the effect of businesses setting up within the Science Park by the two stage model, i.e., producing innovation output in the form of product and process innovation from their industry-academia cooperation or R&D activities, and then whether or not this innovation leads to the production of economic value in the form of increased sales. This method of considering the two steps of innovative output and economic value were proposed by [1]. More specifically, for an estimate for the stage one, regression analysis is conducted on the explanatory variables for whether or not there is product innovation, process innovation, and intellectual property rights.

The explanatory variables used in the estimate are the three variables of the source of information for the innovation, cooperation with the university, and evaluation of the Science Park services. Each of these variables is comprised of categorical data with about 10 items of varying importance, and the scores from the previous section are used to aggregate this data so as to perform principal component analysis, where the first three components are used. We could interpret first three factors of each of three variables by the signs of coefficient to the original dataset as follows (the results of principal component analysis are provided upon request to the author).

(1) Innovation information sources
- First principal component: whether it is a supply-side or a demand-side factor
- Second principal component: whether technical information or business information
- Third principal component: whether the emphasis is placed on in-house or external information

(2) Relationship with the university
- First principal component: whether emphasis is placed on a more formal, contract-based relationship, or a more informal relationship
- Second principal component: whether knowledge is formal or informal
- Third principal component: the degree of seriousness of industry-academia cooperation

(3) Evaluation of Science Park services
- First principal component: whether the emphasis of the service is internal or external
- Second principal component: whether support is administrative or informational
- Third principal component: whether importance is placed on business-oriented support or technology-oriented support.

The regression results are shown in Table 1. In relation to the dependent variable of innovation output, since all of these variables are dummy variables, the model was estimated using probit. For the first principal component with regard to innovation information sources, statistically significant negative coefficients are seen with relation to the product innovation and process innovation model. Furthermore, for process innovation, significant positive factors are seen for the second and third principal components; however, for other innovation indicators, no statistically significant coefficients are obtained and, in general, the signs of the coefficients do not change from negative for the first principal component and positive for the second and third principal components. Thus, companies that conduct innovation activities grounded in in-house competitive advantage (third principal component), complemented by external technical information (second principal component), to meet the needs of customers (first principal component) have high performance.

Table 1: Results of innovation performance regressions

	(!)	(2)	(3)
	product	process	patent
Innnovation Source 1	−0.748***	−1.941***	−0.039
(Supply vs Demand)	(0.23)	(0.57)	(0.13)
Innnovation Source 2	0.039	0.861***	0.330**
(Technology vs Business)	(0.17)	(0.33)	(0.15)
Innnovation Source 3	0.002	0.869**	0.239
(Internal vs External)	(0.22)	(0.35)	(0.19)
University Linkage 1	−0.022	−0.336**	−0.057
(Formal vs Informal)	(0.15)	(0.17)	(0.16)
University Linkage 2	−0.028	0.099	−0.293
(Explicit vs Implicit knowledge)	(0.14)	(0.16)	(0.19)
University Linkage 3	−0.105	0.267	−0.401**
(Serious vs Less serious)	(0.18)	(0.19)	(0.18)
SP Service Qualification 1	0.281*	0.156	0.467***
(Internal vs External Linkage)	(0.16)	(0.20)	(0.17)
SP Service Qualification 1	−0.407*	0.066	−0.537***
(Administrative vs Informational)	(0.23)	(0.23)	(0.19)
SP Service Qualification 1	0.311	0.427*	−0.039
(Business vs Technology)	(0.21)	(0.25)	(0.19)
Constant	0.789***	1.578***	−1.255***
	(0.29)	(0.57)	(0.29)
Observations	69	69	69

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Next is cooperation with the university, but overall this does not exhibit statistically significant coefficients. In other words, tenants have not effectively utilized in their innovative performance the merits of being in the Tsinghua Science Park, in close proximity to one of China's leading universities, Tsinghua University. With regard to a model regarding the existence of intellectual property, for the third principal component a statistically significant negative coefficient at 10% confidence is obtained. This is indicative of how serious the company is about industry-academia cooperation, for which monetary expenditures are incurred for contract research; yet, businesses with a low commitment in this area tend to have a better patent performance.

Finally, regarding evaluations of the services provided by the Science Park management company, for product innovation and patents, statistically significant positive and negative coefficients are obtained, respectively, for the first and second principal components. In other words, the innovative performance of companies was higher for companies that

regarded internal business support such as human resource services over external networking with other companies, and companies that regarded information-related services higher than procedural services and other administrative procedural-related support. What is common to both of these cases is that with human resource-related services, the Science Park management company has a much greater likelihood of affecting the innovation performance of tenant companies.

Next, for the second stage of estimates, a logarithm of sales as of 2008 will be used as the dependent variable. Since there are substantial numbers of 0 sales firms, we use Tobit model to estimate this model. The results are shown in Table 2.

Table 2: Results of business performance regressions

	(1)	(2)	(3)
	TOBIT	TOBIT	TOBIT
SP Service Qualification 1 (Internal vs External Linkage)	−0.410	0.065	0.213
	(1.10)	(1.11)	(1.19)
SP Service Qualification 1 (Administrative vs Informational)	−2.881*	−3.193*	−3.361*
	(1.59)	(1.64)	(1.74)
SP Service Qualification 1 (Business vs Technology)	0.998	1.741	1.843
	(1.90)	(1.95)	(1.91)
Log(Age)	10.54***	8.883***	8.871***
	(3.30)	(3.13)	(3.10)
Product Innovation Dummy	8.587*		
	(4.63)		
Process Innovation Dummy		0.362	
		(4.06)	
Patent Dummy			−1.563
			(5.13)
Constant	−21.34***	−13.73**	−13.15**
	(7.38)	(6.11)	(5.38)
Observations	69	69	69

*** p<0.01, ** p<0.05, * p<0.1
Standard errors in parentheses

The indicators that should be noted here are those variables related to the evaluation of services from the Science Park management company, and the effect they have on the business performance of the tenant businesses, but these indicators displayed statistically significant negative coefficients for the second principle component. In other words, for companies that regarded information services, such as human resource management services, higher than procedural support services, the business performance as seen in the level of sales is better. Furthermore, looking at the relationship between sales and innovation output indicators, for Model (1), only product innovation displayed as a statistically significant coefficient. Taking this result together with one of model (1) of Table 1, for companies that regarded information services such as human resource management services higher than procedural support services, increasing the rate of product innovation success has the two-stage effect of having a positive effect on business performance, and at the same time, boosting business performance directly.

4. CONCLUSIONS

This study developed a framework for an analysis of the science park model for promoting the development of regional technologies and economies, by conducting an empirical study of the Tsinghua Science Park in Beijing. The method of analysis involved the designing of a questionnaire, with reference to literature about the Science Park and industry-academia cooperation, and then using this survey to gather data from technology venture companies within the Tsinghua Science Park. Using this data, in addition to clarifying the condition of tenants within the Science Park, the two stages of a model of innovative output and a model of the determinants of business performance are used. Furthermore, a quantitative analysis was performed to investigate the effect on each of these stages of the sources of innovation information, cooperation with the university, and the services provided by the Science Park management company.

First, with the exception of major foreign companies, most of the tenants of the Tsinghua University Science Park are IT companies focused on the internet/software, and most of these are young high-tech ventures. Most of the founders of these companies are highly educated and hold PhDs or MAs, but since most of the companies were started with personal funds or loans, they are small companies quite vulnerable financially. Thus, these companies are under intense pressure in a management sense to develop their own products quickly and get them to the market, which is more important to them than taking the time to develop joint research opportunities to utilize the benefits of their proximity to Tsinghua University.

From the results of the quantitative analysis, it is found that for companies that had their internal innovations grounded in their own competitive advantage, having this then complemented by external technical information to meet the needs of their customers, these companies had a better performance in terms of innovation. However, in terms of taking in technical information from outside the company, it is found that in most cases this involved the cheap and simple informal methods such as having access to university faculty and technical documentation, as opposed to the more formal methods of conducting joint research with the university.

REFERENCES

[1] Crepon, B., Duguet, E. and J. Mairesse (1998), Research and development, innovation and productivity: An econometric analysis at the firms level, Economics of Innovation and New Technology 7, 115-158

[2] Mian, S. A. (1997), Assesing and managing the university technology business incubator: An integrative framework, Journal of Business Venturing 12, 251-285

[3] Motohashi, K. (2008), Assessment of technological capability in science industry linkage in China by patent database, World Patent Information 30(3), September 2008, Pages 225-232