Lund University
Centre for East and South-East Asian Studies
Masters Programme in Asian Studies
East and Southeast Asia Track
Spring Semester 2008

Promoting Innovation through Incubation in Beijing

An Innovation Systems Approach to Characterizing
High-Tech Business Incubators and Start-Up Companies

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ABSTRACT

Taking an innovation systems approach, this study sought to characterize high-tech business incubators and incubated companies in Beijing in terms of their institutional environment, interaction with other entities in the innovation system, and knowledge content. In-depth interviews were conducted with entrepreneurs and incubator managers and a survey based on these interviews was carried out. The empirical material reveals that the incubators generate a few positive externalities, but only to a small extent facilitate the establishing of vertical and horizontal linkages and mitigate imperfections in the institutional environment. Such imperfections consist of lack of capital, lack of skilled labor, lack of business information, and lack of intellectual property protection. These factors are all partially rooted in various aspects of the broader institutional environment. The preliminary results further suggest that the incubated companies overcome shortcomings in the institutional environment by forging ties with universities, research institutes, competitors, suppliers and government.

Key words: Business incubators, start-up companies, entrepreneurship, Beijing, China, innovation system, technological change, technology transfer

ACKNOWLEDGEMENT

This thesis would not have been possible without the entrepreneurs and business incubator managers in Beijing who generously took their time to speak with me. I want to thank them for that. I am thankful to Fu Bin and Zhu Jie who, despite their busy schedules, assisted me in the interviews. I would also like to thank my supervisor Stefan Brehm at the Centre for East and South-East Asian Studies at Lund University, who suggested the theoretical point of entry for my thesis and provided support and feedback during my fieldwork. The Swedish International Development Cooperation Agency gave generous financial support that helped me carry out the fieldwork, for which I am grateful. Finally, I would like to thank all the teachers and classmates in the Asian Studies Programme for making the studies an amazing experience.

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INTRODUCTION

Technological development in China: a top-down story

China ranks third in the world in total research and development spending and is by 2010 predicted to have the same number of engineering graduates as the United States (Forster 2006). A number of bold projects have been carried out, including contributing to the mapping of the human genome and being the third county to send a man to space. New directives, *Guidelines on National Medium- and Long-Term Program for Science and Technology Development* were issued by the State Council in 2006. They leave no one doubting China's ambition to distance itself from the image of the sweat-shop economy. Biomedicine, civil aviation and new materials are some fields where high-priority projects have been initiated. The Ministry of Science and Technology committed in 2005 "to propel China to the top of life sciences by 2020, when life sciences output is supposed to contribute 7 percent to 8 percent of GDP" (Khanna 2007).

The main feature of these technological advances is the top-down fashion in which they are implemented. It has led some to wonder if the manpower to fill the shining new laboratories exists in the same abundance as the capital that finances them (McGregor 2006). In other words, how are China's high-tech ambitions carried out on the ground? The most important program for high-tech industries is the Torch Program, launched in 1988. Part of the program was to establish high-tech industrial development zones across China, mainly focusing on new technology fields (China Torch Center 2008). Within these parks, special high-tech business incubators were set up to help entrepreneurs start up their own companies and transfer technological solutions from universities, research institutes and overseas.

High-tech business incubators in Beijing

China's first business incubator, Wuhan East Lake Start-Up Service Center, was established in 1987 (Beijing Business Incubation Association 2005: 2). In the following decades, the directed effort of the Torch Program resulted in a surge in business incubators across the country. Beijing in 2006 had 39 registered Science and Technology Enterprise Incubators and 34 University Science and Technology Parks, many of which

were also registered as Returnee Students Start-Up Parks (Beijing Business Incubation Association 2006: 47-59). The incubators were seen as vehicles for implementing the Torch Program's main objective of "commercialization, industrialization and internationalization of R&D by small [and] medium sized enterprises" (Shi and Li n.d.: 3). The effort has been directed from the Torch Center, created as an implementation entity for the Torch Program under the Ministry of Science and Technology (ibid). One of its eight explicit tasks is to "draw up development plans and policy recommendations for technology incubator centers and to review overseas scholar innovation parks" (Shi and Li n.d.: 4). Plans and policy recommendations at the central level are manifested in concepts and slogans at the local level. Beijing Commission for Science and Technology has integrated the incubator policy into its slogan of '1, 2, 3' (*Yi er san* 一二三) – one transformation, two enhancements, and three major actions – as well as the 'eight major theme-topic plan' (Beijing Business Incubation Association 2006: 10). The Municipal Party Committee and Municipal Government have incorporated the incubator build-up into the slogan of 'empowering proprietary innovative power and building an innovative type of city' (ibid). Slogans have much influence on the way objectives and trends in Beijing's incubator policy are formulated (see for example Beijing Business Incubation Association 2006: 11). The actual policy content, however, is closely tied to the national level policy recommendations.

In the early days of the Chinese business incubators, their main function was to provide low cost office space, public physical facilities such as business center, phone lines, and shared meeting rooms, as well as basic assistance with various registrations (Wang n.d.: 1). Most early incubators were comprehensive in the sense that they accepted enterprises from different industries to enter (Beijing Business Incubation Association 2006: 10). The directives then changed to promote the creation of specialized incubators, either focused on a certain industry (Beijing Advanced Materials Incubator, Beijing Zhongguancun Software Park Incubation) or a certain group of entrepreneurs (Tsinghua Overseas Returnees Park, Zhongguancun International Incubator). The incubators were also encouraged to create specialized service platforms to provide technological, managerial, and financial assistance.

How well this has been accomplished is up for debate. Beijing Incubator Association (2005: 4-5) claims in *Beijing Incubator Industry Development Research Document* that it has been done, but that significant challenges remain. Wang Rong, the director of Shanghai Technology Innovation Center, makes an equally ambiguous statement: "while the new directives have largely been implemented, new and small-scale incubators [do not have] enough capability to provide all these services for their tenant companies" (Wang n.d.: 2). This study investigates how well the policy statements describe the actual state of progress 'on the ground'.

In its 2006 annual report, Beijing Business Incubator Association (2006: 5) proudly presented numbers indicating a jump in aggregate revenue of incubated firms in Beijing from 3.58 billion rmb in 2001 to 25,1 billion rmb in 2005. Over the same period, the aggregate number of employees grew from 17,000 to 78,000 (ibid). For 2005, the number of incubated enterprises was 3580 and the number of graduated ones was 628 (ibid). In this study, I try to see the world from the eyes of these firms within the framework of this study.

Research problem, thesis purpose and research questions

The impressive number of China's engineering graduates, spectacular events such as manned space fairs and the contribution to the human genome project, and high-profile acquisitions made by Chinese giants Lenovo and TCL, have all been cited as proofs of China's inexorable rise as a technological superpower. Others have regarded them as top-down roll-outs of China's technology ambitions (Fei 2006), events that say little about the capability of the country's innovation system as a whole. Long-term success relies on the state of the country's small- and medium sized enterprise sector. Beijing's approach has been to attract overseas Chinese back to China and offer them assistance, financial and otherwise, to start up their own high-tech companies. Initiatives have also been launched to transfer technology from academia to industry. High-tech business incubators, located in the hearts of various science and technology parks, have been assigned as their breeding ground. The research problem underlying this study is: do these top-down initiatives result in synergies and collaboration 'at the bottom'? (Interview with Magnus Breidne, 11 June 2007) This would fill a research gap, as

previous papers on the topic of business incubators in China have been concerned primarily with policy developments (Lin and Jiang 2002; Huang and Li 2005) and case studies of role-model business incubators (Zhang 2001; Duan and Wang 2002). A number of scholars have shown that questions of synergies and collaboration in a context of innovation activity can be investigated within the framework of an innovation systems approach (see for example Nelson and Rosenberg 1993; Edquist 1997; Fei 2006), not least in the Chinese context (Lundvall et al 2006). This framework, which is outlined under the section *Theoretical framework* of this paper, emphasizes interactions between different entities in the system, and the institutional environment conditioning their actions. It also emphasizes empirical investigation. The research problem thus took me to Beijing, where I carried out interviews with managers of high-tech business incubators and incubated start-up companies. The early phase of the fieldwork alerted me that the research problem was too broad, with some aspects beyond the scope of a study this size. The research problem was consequently narrowed down to three research questions:

1. What is the function of the high-tech business incubators in the innovation system?
2. What are the most important aspects, from an innovation systems perspective, of the institutional environment in which the incubated companies exist?
3. What interactions are most important to the incubated companies in mitigating imperfections in the institutional environment?

How do the research questions provide insights into the research problem? The first question investigates the business incubators as the embodiment of the top-down policy and hence the link between 'the top' and 'the bottom'. Indeed, it does in a very literal sense constitute 'the space at the bottom'. The second and third questions outline the top-down aspects of the institutional environment and, in this light, determine what methods and interactions the incubated companies 'at the bottom' use to deal with these factors.

The thesis purpose is to provide preliminary answers to the research questions by overlaying the empirical evidence collected in the course of my fieldwork with material depicting aspects of the broader institutional framework. The purpose is *not* to answer the research questions on a grand level, depicting these aspects of Beijing's innovation system as a whole. The qualitative approach in this study is more suited to explore the

various aspects from the eyes of the interviewees and then uncovering some structural, underlying factors.

THEORETICAL FRAMEWORK

The concept of innovation

Most innovation theories have their origin in the work of Joseph A. Schumpeter (1883-1950). His definition of innovation centers on the production function, which describes the way in which quantity of product varies if quantities of factors vary. An innovation results from varying the *form* of the production function instead of quantities of factors (Schumpeter, 1939: 87). Schumpeter (ibid) also refers to innovation as "the setting up of a new production function". Whether these two definitions are the same is a question of semantics. 'Setting up a new' is covered by 'varying the form of' as long as the production function can take the form of the zero function. This also implies that both incremental and disruptive forms of innovation are covered by the definition.

As Schumpeter (1939: 87) points out, innovation in this sense can refer to a new commodity as well as new forms of organizations such as a merger or the opening up of new markets. Imposing restrictions on what is regarded a product, the outcome of the production function, would lead directly to a narrower definition of innovation. A common restriction in the literature is for the outcome to be of economic significance (Edquist 1997: 1). This restriction leaves Schumpeter's definition, 'varying the production function', intact, but the production function is now a function translating factors into *economically significant* products. In order to keep the approach as general as possible, I will use this still very broad definition of innovation. However, to accommodate many narrower definitions of innovation that exist in the literature, as well as make it practically applicable to the particular focus of this study, I will later specify the outcome, or the product, further. This will not mean modifying the concept of innovation, but only that we are looking at a subspace of innovation space.

While 'varying the form of the production function' is the most general form of the definition, what is known about production in the economic sense allows for a more

precise definition, one which is commonly used in the literature, without loss of generality:

> Recalling that production in the economic sense is nothing but combining productive services, we may express the same thing by saying that innovation combines factors in a new way, or that it consists in carrying out New Combinations. (Shumpeter, 1930: 87-88)

That is, under the restriction previously imposed, new, *economically significant* combinations.

The innovation systems approach – genesis and definition

Two sets of theories are crucial in understanding the processes and mechanisms through which innovation comes about. These are theories of interactive learning and evolutionary theories of technical change (Edquist 1997). Since at least the latter is primarily concerned with technical change, we narrow the focus to technological innovation. Lundvall includes other kinds of innovations, such as 'new forms of organization' and 'institutional innovations' (Lundvall 1992). However, I will treat these as inputs into or intrinsic in the system, not an actual outcome.

Theories of interactive learning place innovation in a context of interaction between organizations that exchange knowledge, information and other resources (Edquist 1997: 1-2). In Lundvall's words, "[i]n practically all parts of the economy, and at all times, we expect to find ongoing processes of learning, searching and exploring, which result in new products, new techniques, new forms of organization and new markets" (Lundvall 1992: 8). That is, complicated feedback mechanisms and interactive relations channel knowledge elements between entities in the economy. Hence the traditional model of the firm as innovating in isolation is challenged by a systemic view of innovation – an innovation system approach.

Evolutionary theories of interactive learning regard systems containing reproduction of existing entities, mechanisms that introduce novelties in the system, including random elements, and mechanisms that select among the entities present in the system (Edquist 1997: 6). It has been argued that these theories provide a more appropriate model for understanding some important aspects of the processes involved in generating and diffusing innovations than that of the isolated, profit-maximizing firm (ibid). Profit

seeking does not necessarily motivate all actors involved in an innovation system, such as those in the academic and political spheres. In addition, considerable randomness is involved in technical change, and innovation processes are time-consuming, open-ended and path-dependent (ibid). Nelson (1987: 16) thus claims that "technical change clearly is an evolutionary process; the innovation generator keeps on producing entities superior to those earlier in existence, and adjustment forces work slowly".

Together the two sets of theories provide a framework for how processes of innovation work and what mechanisms drive them, pointing to their systemic character and evolutionary nature. Yet not all scholars explicate the theoretical underpinnings of their systems of innovation approaches, and no consensus has been reached on how to define an innovation system. One reason for the conceptual vagueness appears to be that definitions have often been given that are practical for the particular study at hand. While it is important that empirical insights shape the approach, conceptual clarity is important for the comparability and generalization of individual works. The main features of the innovation systems approach, developed in the 1990s, are discussed below.

In the different definitions of innovation system, the subject of the system ranges from 'a set or network of agents' (Carlsson and Stankiewicz 1995) or 'institutions' (Freeman 1987: 1; Nelson and Rosenberg 1993: 4-5; Metcalfe 1997: 461-462) as well as 'their incentive structure and competencies' (Patel and Pavitt 1994: 79), to the even broader 'elements and relationships' (Lundvall 1992: 2). The action taking place in the innovation system includes 'interaction' (Lundvall 1992: 2; Nelson and Rosenberg 1993: 4-5) and 'activities that initiate, import, modify and diffuse new technologies' (Freeman 1987: 1), as well as 'creating, storing and transferring knowledge, skills and artefacts' (Metcalfe 1997: 461-462). The outcome, as defined in the various definitions, includes the 'innovative performance of firms' (Nelson and Rosenberg 1993: 4-5), the 'rate and direction of technological learning' (Patel and Pavitt 1994: 79), the 'production, diffusion and use of new, and economically useful, knowledge' (Lundvall 1992: 2), and the 'defining of new technologies' (Metcalfe 1997: 461-462). Stances on the scope of the innovation system also vary, mainly between national (Freeman 1987; Lundvall 1992; Nelson and Rosenberg 1993), regional (Saxenian 1994) and sectoral (Carlsson and Stankiewicz 1995).

Let us go through each of these components and see if we can arrive at a definition that is in line with the systems of innovation literature at large while also aligning with our previous definitions.

The end result directly ties into the definition of innovation in the previous section. We have decided to regard only the subspace of innovation space that constitutes technological innovation. As outlined in the preceding discussion, this is in line with the definitions of Metcalfe (1995), Nelson and Rosenberg (1993), and Lundvall (1992). In our definition, 'rate and direction of technological learning' (Patel and Pavitt 1994), as well as production and diffusion of knowledge (Lundvall 1992) are indeed determined by and taking place within a system of innovation, but they are not outputs.

As for the subject of the innovation system, most definitions keep this part very general. What do 'agents', 'institutions' and 'elements' actually mean? From Nelson's and Rosenberg's (1993, 9-13) discussion, it is clear that 'institutions' refer to entities such as firms and research laboratories, but also technology policies. Freeman (1987), who also uses institutions as the subject in his definition, focuses his description of the Japanese national system of innovation on a government ministry, company R&D, education, and industry structure. Apparently both sorts of institutions are important, but they have different roles in a system of innovation and should not be confused with one another. I will follow Edquist's (1997: 26) distinction between 'things patterning behavior', which he calls institutions, and 'formal structures with an explicit purpose', which he calls organizations.

The Oslo Manual, OECD's (2005) report on how to collect and interpret innovation data, suggests a number of organizations that are relevant in an innovation system. These include companies (competitors, suppliers, clients, etc), universities, research institutes, government bodies, and customers. Which organizations are relevant can only be determined through empirical investigation, and the OECD's heavy emphasis on data collection and input from decades of surveying makes *the Oslo Manual* a good source. However, to keep our definition as general and aligned with the literature as possible, the subject of our definition will simply be organizations.

What is the exact meaning of 'interact', which most scholars place in the center of the dynamics of an innovation system, and what are the 'activities' that Freeman (1987)

includes in his definition? Freeman (1987) specifies that the entities in his system 'initiate, import, modify and diffuse new technologies', while those in Metcalfe's (1995) are 'creating, storing and transferring knowledge, skills and artifacts'. Apparently, here are the biggest discrepancies between the different approaches – what is the object that is being conveyed within the system? All definitions can be aligned, and consistent with the view of innovation as the outcome, if each of the things mentioned – technologies, skills, and artifacts – are thought of in terms of their knowledge content. We thus adopt Lundvall's (1992) definition where the entities 'interact in the production, diffusion and use of new, and economically useful, knowledge'. Hence, while innovation is defined as carrying out new, economically significant combinations of *factors*, the knowledge that results in innovations is new combinations of *elements of knowledge*.

In conclusion, we define a system of innovation as *a network of organizations that interact, in ways conditioned by and conditioning the institutional set-up, in the production, diffusion and use of new and economically useful knowledge.* Organizations refer in theory to all relevant entities within the scope of the system, but on a practical level only the most relevant categories, including companies, universities, investment banks, research institutes, government organizations, and so on. Institutional set-up refers in theory to all things that condition the knowledge flow between the organizations, but on a practical level to laws, regulations, cultural norms, social rules, technical standards, technical and physical infrastructure, and so on. Knowledge includes that embedded in technology, skills and so on. This is a definition that in all essential ways covers the mainstream of systems of innovation approaches in the literature, is theoretically consistent with the theories they are rooted in, and sorts out some conceptual ambiguity. As a systems of innovation approach it also has the potential of predicting how the frequency, quantity and character of innovation are affected by changes in the socioeconomic environment, such as government policy.

Knowledge: the currency of an innovation system

Knowledge obviously holds a prominent position in our innovation system definition – one could say that it is the currency of the innovation system. In order to place Beijing's

incubators and incubated companies in this system of knowledge exchange, it is important to clearly understand what we mean by knowledge.

The knowledge debate has two different points of departure. One starts with the neural basis of knowledge. The other has its roots in philosophy, where Aristotele's definition in *Posterior Analytics* was the start of epistemology. These two schools of though follow parallel tracks and seldom meet. The concept of knowledge used in an economic context is a practical one without references to studies of the brain. Michael Polanyi, in his opposition to the positivist view of science, introduced the concept of tacit knowledge, condensed in his famous aphorism: "they know many more things than they can tell" (Polanyi 1962: 88). This leads to the conclusion that much knowledge is passed on through non-explicit means, such as tradition and apprenticeship.

Nonaka (1994) reformulated Polanyi's concept to fit into a spectrum where tacit knowledge is one extreme and explicit knowledge the other. While the former is often subconscious and internalized, the latter is explicit and conscious (ibid). Nonaka and Takeuchi (1995: 16) argued that companies need to codify and centralize as much of their employees' tacit knowledge as possible. Some have even dismissed the tacit dimension of knowledge and proposed that all knowledge can in principle be codified (Cowan et al 2000). Others, however, have pointed back to Polanyi, who regarded tacit knowledge as the context in which explicit knowledge is made sense of under cognitive limitations (Polanyi 1967). In the case of solving a mathematic problem, for example, tacit knowledge could be in the form of intuition and pattern recognition, rooted in experience-based learning, while the codification of this knowledge would be in the form of a series of distinct logical operations (Ziman, 1979: 101-102). Or, as Johnson et al (2002: 251) put it, while parts of tacit knowledge may be codifiable, "there will always remain irreducible differences between the skills of a heart surgeon and the code-book she uses". In other words, the transformation between tacit and explicit knowledge is nonlinear and irreversible: knowledge is context dependent and information is lost when it is translated from tacit knowledge in our uniquely wired brain, into symbols and then back into tacit knowledge in someone else's differently wired brain. At the same time, following the 'code-book' may help the practitioner reconstruct the tacit knowledge underlying it, not by linear conversion but by trial and error and complex experience-based processes.

Hence, the tacit and explicit dimensions of knowledge are interdependent and supplementary, rather than substitutable (Tywoniak 2007: 54). In this paper, tacit and explicit or codified knowledge are regarded in this way.

Even when knowledge is codified, there is still a question of accessibility. Johnson et al (2002: 252) note that it often takes "enormous investments in learning before the information has any meaning". A codification or artifact may be meaningless unless combined with the right knowledge about how to interpreted it. In this paper I will refer to information that requires a high degree of preexisting knowledge to makes sense of as 'high-complexity knowledge'.

The question of scope

The question of the scope of the innovation system also needs to be addressed. Even when the relevant outputs are limited to certain geography or sector, the relevant factors determining these outputs may not be. For example, as the China case highlights, visa policies in the U.S. may affect innovation that takes place in Beijing. A comprehensive innovation system would have a national, regional, global and so on layer, each one of which might be relevant to different degrees in answering particular research questions. Where the boundaries are drawn depends on the circumstances (Carlsson and Stankiewicz 1995: 49) and practical considerations.

In the current study, I will not beforehand attempt to define what innovation system is the 'relevant' one; the innovation systems approach does not provide the tools to do so. Instead of limitations on the theoretical level, my approach is to explore on the field which factors are, indeed, relevant.

METHODOLOGY

Design, selection and method

The initial focus of this study was the value that business incubators bring to their incubated companies. However, the early phase of the fieldwork showed that this value was in many cases highly limited and that such a focus would be too narrow to capture the factors that affect the companies the most. It also became clear that the function of the

business incubators cannot be understood without viewing them in the context of the broader environment within which the incubated companies exist. Only by doing so can one answer the research questions posed in the beginning of this paper, of the function of the incubators in the innovation system, the institutional environment of the incubated companies, and the interactions they take part in to mitigate environmental problems. When the phenomenon under study cannot be separated from its context, and the researcher has little control over variables, both true in this case, case study is an appropriate empirical research method (Yin 2004). This case study has an exploratory element in that it explores what factors are important in the incubated companies' environment, and an explanatory element in that it ties to understand how they are mitigated. The unit of analysis is the incubated companies, while the incubators are considered a part of their environment. I chose to include interviewees from five different incubators in my sample. I was thereby able to avoid the drawback in some previous studies of incubators in China, where single, exemplary incubators had been chosen (Zhang 2001; Duan and Wang 2002), raising concerns about the validity of the conclusions. By including several incubators in my sample, I was able to distinguish between concerns typical for companies in a certain incubator, and those that were common across incubators. The inclusion of several incubators does not make it a multiple-case study. As is discussed further in this paper, the boundaries between incubators are regarded as partially artificial with respect to what this study investigates.

As the incubators are treated as a layer in the institutional environment, the innovation systems approach is useful. It seeks to depict how the institutional environment conditions the ways interaction takes place within the system, channeling relevant knowledge to where it can be recombined and generate innovations. In theory, the comprehensive environment conditioning this exchange can be reconstructed by placing relevant institutional layers on top of each other. Factors on the local, national, transnational, industry specific, and many other levels constitute the various layers. Indeed, in this framework the business incubators themselves form a layer that influences the way the incubated companies interact with their surrounding. Does this layer mitigate environmental imperfections? How do incubated companies access and retain the knowledge they need to innovate in this imperfect environment? What is the relative

importance of the different layers? These questions are reformulations of important aspects of the research questions from an innovation systems perspective. Answers are sought by overlaying the empirical material, showcasing the micro, individual enterprise perspective, with primary and secondary material, outlining the macro, broader institutional environment. All this is done within the overarching framework of the innovation systems approach. That is, the company is seen as an entity seeking to tap into and combine different kinds of knowledge into innovations by interacting with other entities in the system. This interaction is seen as conditioned by the institutional environment. The knowledge perspective is present throughout the paper.

The empirical material consists of in-depth interviews with 17 managers of incubated companies in four incubators, seven incubator managers in five incubators, and one director at Beijing Business Incubator Association. In addition, interviews were conducted with the head of the Beijing office of the Swedish Institute for Growth Policy Studies and a director at Peking University Student Employment Center. I also attended a class at Tsinghua University in the subject of innovation studies. Finally, the empirical material consist of documents such as patent information and market plans from companies, company lists, information and statistics from business incubators, survey data and statistics from Beijing Business Incubator Association, students' employment and preferences statistics from Peking University, and application forms, directives and policy documents from different government sources. These documents, when relevant, were used for triangulation. The fieldwork was carried out over a period of eight weeks, in June and July 2007. The sources to describing the broader institutional environment were primarily laws, policy papers, scholarly papers and books. In a fast changing field more updated newspaper articles and Internet sources were also valuable. I used English language sources whenever possible, but occasionally had to resort to Chinese language sources. This was especially the case for literature on the business incubators in China, where almost no non-Chinese sources exist.

The interviews typically lasted between one and two hours and were held in the private setting of the interviewee's office, an empty conference room, or a café. The interview was held in English when the interviewee was comfortable with that, as was the case with those who had stayed long periods abroad. In all other cases the interviews

were conducted in Chinese. A Chinese assistant was brought along to these interviews with the dual function of taking notes and helping out in the event of language problems. The fieldwork was carried out in accordance with the ethical guidelines outlined by the Swedish Research Council. This included making sure that the respondent understood the reason for, and purpose with, the interview, obtaining informed consent from the respondents, and guaranteeing anonymity. For this reason, I have numbered the interviews and listed, in the end of the paper, which kind of company each number is associated with. This information might be of interest, and there is no way of tracing the identities of the interviewees from this list. In a few cases, when the interviewee was neither related to an incubator or incubated companies, the identity of the interviewee has been disclosed. In addition to the ethical concern, I believe that the anonymity made the respondents more apt to provide answers without having to consider the impact on the image of the company.

To each interview I brought a set of questions. However, all interviews were semi-structured and topics were often discussed that were not included in the original set of questions. This helped opening my eyes for factors that I had not thought would be of any importance. Lists of linkages or important factors were in their original form based on OECD:s (2005) *Oslo Manual* for collecting and interpreting innovation data, but were revised after each interview to encompass the latest feedback. The final survey that was sent out to companies was indistinguishable from the original interview form. The survey was distributed first in person to all companies in one incubator and then sent out to more than 300 companies in two additional incubators. The response rate of this survey was low. Only 29 answers were recorded. This might lead to concerns of the experimental validity of the empirical results. However, the survey responses were regarded as additional qualitative material to use for triangulation rather than quantitative analysis. The next section sorts out some concerns and outlines the way in which the empirical material is treated.

Validity, reliability and limitations

Let us start with the issue of external validity. Are the results generalizable beyond the immediate study? There is first the issue of randomness of the sample. In the early

fieldwork stage, I relied on the incubator managers with whom I had first established contact to introduce me to managers of incubated companies. Some were more helpful than others, but the general tendency was to introduce me to exemplary companies. Therefore, I went over to establishing contact with the company managers directly. This was done by literally knocking on their doors, or by calling them in cases when I had access to lists of incubated companies. These companies were selected in a random manner. Surprisingly, I was more often turned down when I spoke in Chinese, and often not even transferred to the manager, than when I spoke in English. Phone calls in English appear to be treated with more importance than those in Chinese. Unlike previously, with this strategy I got to meet representatives of companies that were unsuccessful and unqualified. I also acquired the background knowledge to inquire about these companies in interviews with incubator managers. Nevertheless, my interviews with mangers of 17 incubated companies and seven incubator managers are far from statistically sufficient to claim validity for the conclusions on the city level. The survey response from an additional 29 companies is likewise insufficient for this end. My attempt to access detailed financial and technology related information that is stored in a government organization for each high-tech certified company, covering virtually every incubated company, failed. In retrospect this was not a big loss: this study demonstrates the unreliability of such information. Nor do I regard the lack of large quantities of data as a weakness. The interviews, survey responses, and documents all constitute valuable material for a qualitative analysis (Yin 2004). Rather than quantitatively describing the relevant innovation system as a whole, by analyzing this material I gained insights that allowed me to probe into the large material on institutional factors from the most relevant angles. Indeed, from an interpretive perspective, where we cannot simply tap into an objective reality (Alvesson and Sköldberg, 2000), interviews are the best tool.

Construct validity is also notoriously problematic in case study research, due to potential investigator subjectivity. Prestructured understanding on the part of the investigator may lead to the structuring of an account "in such a way that a potential multiplicity of meanings is neglected" (Alvesson and Sköldberg, 2000: 204). To counter this problem, I have used two remedies suggested by Yin (2004). First, I have compared the outcomes of the interviews with the less ambiguous statistical information from the

survey. Second, I have tested my hypotheses on some of my interviewees by the end of the interviews. Further, in the interpretive school of thought, where the view that detachment from the social world as crucial in order to achieve objectivity (May 1997: 11) has been abandoned, the issue of 'me' should be considered. With a background in engineering, there is a risk that I pay too little attention to economic details. On the other hand, I feel that my initial lack of knowledge about, for example, the flaws in China's financial system helped avoid bias when identifying the main obstacles in the institutional environment. Without presumptions on this part, I had to be open to what the interviewees told me.

There may also be bias on the side of the interviewees, each of which has its own vested interest. I have tried to overcome this problem by means of triangulation. I have been able to compare interviews from groups with different perspectives: the entrepreneurs, the incubator managers and Beijing Business Incubator Association. Again, it is also mainly in this context that my survey has been relevant: not as a source of quantitative data, but as means of triangulation, both to keep my interviewees' bias and my own presumptions in check.

Just as the various factors that the empirical evidence highlights cannot be assumed to apply to all companies in Beijing, neither can they be assumed to apply only to companies in Beijing. Without doubt, many of the factors affecting the companies in this study are not specific to Beijing or China, but lie in the very nature of being a small, start-up enterprise and apply anywhere around the world. How can factors specific to China be separated from those particular to start-up enterprises? This study is not comparative, and no transnational data can be relied upon. My approach instead takes as its point of departure the recognition that the empirical evidence describes some things in a static sense, with only minor insights into the relative importance of different factors. My solution has been to dig into the laws and literature describing the institutional environments that the empirical material suggests have a major impact on the companies in this study. In this way, I have been able to distinguish factors that are particular to Beijing and China. Their exact importance relative to other factors should be established in a large, transnational investigation beyond the scope of this study. When it comes to distinguishing between factors specific to a single incubator and those particular to

Beijing at large, my method of sample selection has been helpful. Instead of focusing on the companies in a single incubator, I have selected a broad sample. This highlights the assumption that borders between incubators are artificial with respect to some of the environmental factors that are interesting under an innovation systems framework. Likewise, instead of looking at a specific industry I have interviewed companies from different technology areas.

EMPIRICAL RESULTS

The function of the business incubators

1. Implementation and services

To ensure that policy is actually implemented by the incubators, meeting certain criteria is required for acquiring the incubator certification (interview with Long, H. 30 July 2007). Direct influence is often asserted through partial ownership. For example, investors in a specialized software incubator include the Ministry of Information and Zhongguancun Science Park Managing Committee of Beijing Municipality (interview 14). The university-associated incubators in this study were co-owned by the respective university and technology park committee. Long Huadong (interview 30 July 2007), a director at Beijing Business Incubator Association, asserts that central policy is more efficiently implemented in incubators where government asserts direct control.

Among five incubator managers interviewed in this study, three admit that their incubators provide little more than office space and basic services (interviews 3, 5, 19). Two of these incubators do, however, introduce intermediate service agencies that are able to provide qualified services to the tenants. A tenant in one of these incubators reports being disappointed with the "gap between word and action" of his incubator (interview 18). The services provided by the incubators look more impressive on paper than they actually are. The other two incubators in this study provide more sophisticated solutions, such as a software testing lab (interview 14), investment in incubated firms with high potential (interview 2), as well as more comprehensive service platforms. The founder of a firm in one of the incubators confirms that it helped introducing potential clients (interview 11). Both an incubator manager (interview 15) and Long Huadong

(interview 30 July 2007) at Beijing Business Incubator Association single out only two incubators in Beijing, one for its strong financial platform and the other for having a strong capacity for connecting research and business expertise.

The survey in this study, answered by 29 tenants in three incubators, asked managers to grade different aspects of the incubators in a survey. The highest grades were given to 'helps qualify for preferential policies' (an average of 4.5 out of 7.0) and 'cheap rent' (4.2). It is telling that none of these relate to services or anything that requires an effort on the side of the incubators. Enrolling in the incubator is mainly a way to achieve eligibility for government seed capital. The list continues with 'help with applying for government funds' (4.1), 'convenient location' (4.0), and 'reputation' (3.8). Let us remind ourselves that the first of these is the most basic of services and was part of the package from the earliest days (Wang n.d.: 2). Grades for different kinds of services were very low in the survey. The highest grades were given to 'legal and patent services' (an average of 1.6 out of 7.0), 'accounting and tax services' (1.5), and 'recruiting services' (1.0). The survey also shows that some degree of interaction takes place between the incubated enterprises, but that this interaction is not considered significant. This aspect was given an average of 2.1 out of 7.0. 'Proximity to market demand' was given a slightly lower rating, an average of 1.7 out of 7.0. A manager in an incubator adjacent to a number of well-known multinationals reports having no interaction with these or any other companies in the technology park, but regards them as enhancing the image of the location and contributing to attracting talent to his company (interview 10). It should be kept in mind that the size of the sample is too small for the results to be generalized to the larger population of incubated companies. However, triangulation supports the preliminary results. An incubator manager states that "incubation has become an industry" and "many incubators function only as office space providers" (interview 14).

2. New policy directives

With the *Guidelines on National Medium- and Long-Term Program for Science and Technology Development* issued by the State Council in 2006, the term 'proprietary innovation' (*zizhu chuangxin* 自主创新) became a buzzword. It is bound to be the slogan

also for Beijing's incubator industry in the course of the eleventh Five Year Plan (Beijing Business Incubation Association 2006). According to Beijing Incubator Association (2006: 11), government policy has shifted "from direct prodding to defining direction and guiding development", and policy on incubated firms has shifted to "supporting the excellent and the strong". This is manifested in the selective and competitive bidding for participation in government projects and acquiring of government funds (interview 10). Behind a language of political slogans (Beijing Business Incubation Association 2006: 11) lie four priorities for the further development of the incubator industry in Beijing: the (1) further specialization of incubators and their service capabilities, (2) tapping into an expanded pool of scientific and technological resources, (3) improvement of the incubators' comprehensive service platforms, and (4) improvement of capital employment and market niche identification (interview with Long, H. 30 July 2007).

3. Distorted incentives

Beijing High-Tech Enterprise Certification Conditions and Procedure (*Beijingshi gaoxin jishu qiye rending tiaojian ji guanli banfa* 北京市高新技术企业认定条件及管理办法) outlines the requirements for acquiring a high-tech certification. The provisions are based on a policy document from the Ministry of Science and Technology, *The Country's High-Tech Industry Development Zones High-Tech Enterprise Certification Conditions and Procedure* (*guojia gaoxin jishu chanye kaifaqu gaoxin jishu qiye rending tiaojian he banfa* 国家高新技术产业开发区高新技术企业认定条件和办法) (Policy document *guoke fahuozi* 2000, no. 324). All articles referred to below belong to this document. The company should conduct research and produce goods or services (article 5) within one of the following technological areas (article 4): (1) electronics and information technology, (2) biotechnology and medical technology, (3) new materials, (4) advanced manufacturing technology, (5) aeronautics and astronautics technology, (6) modern agricultural technology, (7) new energy resources and resource saving technology, (8) environmental technology, (9), technology transfer, (10) nuclear technology. Further, at least 30% of the company's employees should be technical employees with a collage degree or higher, at least 10% of the company's employees should conduct research and

development, and not less than 5% of the company's revenues should be used for research and development (article 5).

However, an outspoken incubator manager claims that virtually any company can get a high-tech certification through intermediary agencies that specialize in acquiring these (interview 8). Such certifications are desirable as companies who possess them gain access to certain benefits. There are also companies that lend frozen sums of money to boost the accounts (interview 8). In this way, companies can make it look as if they had bigger investments than they actually do. Sometimes referred to as 'packaged companies' (*baozhuang gongsi* 包装公司), front companies that don't actually qualify to enter the incubators have been able to sidestep the rules with the purpose of acquiring qualification for preferential policy. One of the interviewed companies functions solely as a sales office for another company (interview 17). This other company is certified as a high-tech enterprise and the owner is an overseas returnee. It also owns the interviewed company. In this way, both returnee status and patents could be demonstrated and thus the front company could enter the incubator and obtain seed funds and preferential policy. A manager in one incubator estimates that 20-30% of the companies in that incubator are front companies (interview 19).

A rough categorization of incubated companies with regards to knowledge content and linkages

A closer look at the data reveals that three major groups can be distinguished and that membership in these groups depend on the background of the founder. These are student companies, academic spin-offs and overseas returnees' companies. I do not include the 'packaged companies' that were discussed under the section *Distorted incentives*. I do not assert that all companies fit smoothly into these categories. My claim is that the groups capture and distinguish between important aspects of the knowledge content and linkages of these companies from an innovation systems perspective.

1. Student companies

All companies of this sort interviewed in the present study are run by students at Peking University and located in an incubator designated for this specific purpose. The student companies have a low degree of innovativeness (interview 8) and compete with prices (interview 4). While most of them are focused on marketing and distribution (interviews 5, 8, 23, 24), a few of them possess some degree of technical skills that are used to add value to their products (interviews 4, 6).

The technical knowledge at the core of their business is in codified form and accessed through classroom education and books. They translate updated, codified academic knowledge into commercial products. A retail data analysis company, run by full-time mathematics Master's and undergraduate students, bases its business on projects and labs in their coursework (interview 6). Naturally, teachers are frequently listed as one of the most important sources of innovation for these companies (interviews 4, 6, 23).

In the course of implementing their ideas, the student entrepreneurs meet problems they cannot solve with their technical classroom knowledge. Instead they expand their knowledge base by interacting with competitors (interview 6) and suppliers (interview 4) through Internet, internships and face-to-face interaction. Teachers are often relied upon for being introduced to the right people (interviews 4, 6, 23).

According to an incubator manager, only two or three of the 39 students companies have significant development potential (interview 8). The rate of failure is high. The students' incubator does not offer any services to mitigate the lack of experience. It does, however, through cheap office rent provide a platform for gathering entrepreneurial experience.

2. Academic spin-offs

Academic spin-offs are typically founded by academics in order to commercialize their research results. Their transfer innovative technological solutions from academia to industry. Technical knowledge has often been accumulated over a long period of time, during the course of their academic careers. One geographical information systems company, founded by a Peking University professor, is based on a project that had been researched for four years at the university before the company was founded (interview

13). A researcher at a research institute in Beijing patented his invention before he started his enterprise (interview 18).

With their dual roles as academics and entrepreneurs, the founders of these companies maintain strong links between research institution and enterprise (interview 9). In the case of the abovementioned Peking University professor, the research center provides research results, interns, and a recruitment base, while the company provides feedback and testing ground (interview 13).

A problem for the academic spin-offs is the lack of business related knowledge (interview 3). This is mitigated by the service platforms of the best incubators (interview 14), but entrepreneurs in other incubators express disappointment over the gap between word and action with regards to such services (interview 18).

3. Returnees' companies

The founders of these companies have pursued education and professional careers abroad. Many of them have PhDs from Ivy League universities in the United States (interviews 10, 11, 12, 21). Typically they have worked for leading multinationals in their respective industry. Some have worked for start-up companies in Silicon Valley or started their own companies in the United States (interviews 10, 11, 12, 21). For example, the founder of a digital storage company is Ivy League educated, worked with finance in a bank, started his own dot-com enterprise that "never took off", and worked for a leading storage company in Silicon Valley (interview 12).

Motives for returning to Beijing include the growing market potential on Mainland China, low operational and start-up costs, preferential policies that target Chinese living abroad, and homesickness (interviews 10, 11, 12, 22). Reasons for choosing Beijing over Shanghai include personal reasons, the relative availability of skilled labor and availability of universities, and the presence of multinationals' headquarters (interviews 10, 11, 12, 22). The founder of a company that targets the banking and telecom sectors believes that Beijing is the right place for that, while Shanghai is stronger in finance, manufacturing, and commodities (interviews 12).

The knowledge the entrepreneurs bring back is not only technical in nature, but also business related. Their long experience in industry abroad contributes to a significant

tacit element in their knowledge. The interviewees in this category had spent between 8 (interview 10) and 17 (interview 21) years abroad. Interviewees regard as the most useful knowledge they bring back that of how to run a company and implement projects efficiently, how to start up a company, team building and team spirit, and product quality (interviews 11, 12, 22).

Although the bulk of the interviewees in this category were returnees from the United States, there were also examples of returnees from other locations, such as England (interview 22). Personnel in a dedicated returnees' incubator reported that 12% of the returnees were from Japan (interview 19), while the share in the returnees' part of a software incubator was 40%.

Some of the returnees have successfully forged academic ties after returning to Beijing. A founder with a PhD degree and work experience from the USA writes course literature and teaches at Tsinghua University.

While the returnees bring back much knowledge and experience from abroad, they lack knowledge about the local conditions and business culture, which they have never experienced or been away from for a long time. An important function of the incubators is to mitigate this lack of local knowledge. Some of the interviewees emphasize the value of help with identifying and applying for funds, various registrations, and specialized information (interviews 11, 12).

The incentives for overseas Chinese to return to China are rooted in policy. A policy document from Beijing Municipal People's Government (2000: article 1) outlines the benefits "to encourage returned students to start business and work with a view to accelerating the development of the Zhongguancun Science and Technology Park and giving an impetus to the development of hi-tech industry and construction of innovation system". All articles referred to below belong to this document.

The benefits include: ability to obtain permanent Beijing residence permit (article 6), tax exemption on income earned from technology transfer, development and consultancy (article 10), tax-free purchase of one Chinese-made car (article 15), a more favorable pay scale if employed by a government institution (article 16), exemption from restrictions on personnel increase quotas and wage funds of work units (article 19), and eligibility for a Returned Student Business Development Award (article 20).

In addition, Zhongguancun Science Park has established a Returned Overseas Students Start-Up Fund (*guiguo liuxue renyuan chuangye zhuanxiang zijin* 归国留学人员创业专项资金), from which a maximum of 100,000 rmb is available for each start-up company. Additional preferential policies apply to all high-tech companies in Zhongguancun Science Park.

Identification of high-impact factors in the institutional environment

The survey carried out in the fieldwork included the question of what are regarded the major obstacles to innovation. The by far most frequently cited factor was 'lack of capital' with an average grade of importance of 4.9 out of 7.0. Only a few respondents did not give a high grade to this aspect. The three factors that followed were, in this order, 'lack of skilled technical labor', 'lack of business information' and 'lack of intellectual property protection'. In this section I will go through the empirical material relating to each one of these.

1. Lack of capital

Two incubator managers describe how venture capitalists are reluctant to invest in Chinese start-ups and capital is difficult to acquire (interviews 8, 14). This concern is echoed by many of the interviewed entrepreneurs. They say it is difficult to get capital for risky projects (interview 9) and small companies (10), a fact that vastly differs from their experience from the United States. The survey also singles out this factor as the most important obstacle to innovation.

All but a few (interviews 7, 20) of the interviewed companies find capital through personal means or informal channels, especially friends and relatives. The manager of one incubator estimates that at least 70% of the 104 companies in her incubator are entirely self-financed (interview 16). If the conclusion from another incubator (interview 19) is valid, many of the remaining companies are front companies owned by other firms. Very few incubators invest in their incubated companies (interview with Long, H. 30 July 2007). The ones that do (interviews 2, 15) focus on a very small number of companies.

One of the most common services that the incubators offer, however, appears to be the identification and application for government funds.

Seed capital is available from the government for companies with a high-tech certification. 90% of the incubated companies in one incubator received between 50,000 and 100,000 rmb in seed capital when they started their companies (interview 19). One entrepreneur was at the time of the interview in the process of applying for a larger government fund of half a million rmb, with innovativeness as criteria. It was more difficult to obtain than the start-up capital, he said - "it is actually impossible to lie" (interview 10). Some companies participate in government projects, for example within the Torch Program (interview 21). However, in one incubator with 110 companies, only 3-6 companies participate in such projects (interview 19). An Internet broadcasting service provider had to work for a long time for free for government agencies before it was allowed to partner with these agencies and become a paid supplier (interview 20).

How do incubated companies cope with the lack of capital? A company that is specialized on medical modeling resorted to importing and modifying an American DNA reagent, which is outside their core competencies, to generate fast return (interview 9). Another company is working on spinning off part of its business to raise funds (interview 11). The same company spreads the financial risk on a broad product portfolio and avoids focusing on a single product (interview 11). Thus, the lack of venture capital appears to lead to a lack of specialization due to the difficulty of pursuing long-term, high-complexity projects that require much research. The R&D in these companies has a heavy emphasize on the D (interview 9). Academic spin-offs and other companies with strong university links mitigate this problem through their continuous access to academic research (interviews 9, 12, 13, 21).

2. Lack of skilled labor

The difficulty of finding skilled labor is seen as a major obstacle to innovation for the incubated companies both by the deputy general manager of a software incubator (interview 14) and managers of incubated companies in different technology areas (interviews 9, 11, 13, 18). It is also confirmed by the survey results in this study, placing the factor second on the list of obstacles to skilled labor.

Managers complain that it is hard to compete for talent with multinationals who are more reputable and able to offer higher salaries - "everyone wants to work for Google" (interview 13). A returnee from the United States compares with Silicon Valley where people are willing to trade security and higher salary for the chance to get rich as the start-up grows (interview 12). In his opinion, young people in China have too few entrepreneurial role models. One manager says that he has to recruit from second order universities because the salary he can offer is only half of what graduates from Peking University and Tsinghua University demand (interview 18). He claims that it takes half a year to bring new employees up to an acceptable level (interview 18). An incubator manager puts forward its recruiting service as way of mitigating the problem (interview 14), but a founder who has used the service is not satisfied (interview 11).

Interviewees present a number of approaches to mitigating the problem. Entering an incubator is often the only way for small start-up companies to acquire a high-status location adjacent to multinationals such as Google, Microsoft and Sun. This is itself a strategy for attracting talents, who are drawn from all of China to such locations. This is referred by several managers as one of the reasons for the frequent high rating of 'convenient location' and 'reputation' as a major incubator advantaged (interviews 6, 9, 10, 12, 13; fourth and fifth ranking in the survey). Some companies keep their registration in the incubator after moving out (interview 8). One manager claims that Tsinghua East Gate, where the Tsinghua Technology Park is located, is "the most innovative area in China" (interview 10).

One of the preferential policies for the incubated companies makes it easier to acquire house hold registration (*hukou* 户口) in Beijing for the company's employees. This is regarded by some of the interviewees as an important advantage in attracting talent from other parts of China (interviews 9, 13). Other managers exploit China's flexible labor laws to hire and fire until they find the right match (interview 11). Some founders of academic spin-offs frequently hire their own students (interviews 9, 13). Entrepreneurs who have forged links with universities or research centers use these institutions as recruiting base (interview 11). One manager let Chinese MBA students help him within their coursework, and thus did not have to pay for it (interview 12). Another company has created a network of students at a university, which helps them with software

development (interview 4). The founder of an IT services company brought part of his team from his previous employer, an American multinational (interview 21).

3. Lack of information

All the interviewed incubator managers and a number of entrepreneurs stated that lack of information of various sorts is a major obstacle to the incubated companies. The incubators see it as their task to offer channels to the kind of knowledge that the entrepreneurs are lacking within their own companies. The most important kind is business related information (interviews 6, 21), but also the kind of novel, technical innovation that larger companies gain through research and development (interview 9). The interviews also shed light on the issue of local knowledge that often sets the incubated companies apart form their international competitors.

Let us first consider what makes the incubated companies competitive. The survey by Beijing Business Incubator Association (2006: 18) indicates that 40% of the incubated projects in Beijing in 2006 were innovations. Even if this number would turn out to be exaggerated, it is clear from the interviews in this study that some of the companies do introduce products that are new to the Chinese market or to the world. Some have innovated by adjusting existing products to suit the preferences of Chinese consumers. As the manager of a web analysis enterprise, an overseas returnee with complex technical and industrial knowledge, reports: there is no need to copy products from the United States directly – "it's enough to keep track of American trends and develop products in China according to the projections" (interview 10). Here, Internet is presented as a tool that in this way significantly lowers the information barriers and shortens the time gap between introduction of new products in the United States and China (interview 10).

A common way of gaining new, technical knowledge needed to innovate is research and development. However, many of the companies in this study do not have the time or capital to focus on anything but the product development part of innovation. As discussed previously, one way of overcoming this deficiency has been to forge ties with academic institutions and use their research as a basis for innovation (interviews 7, 9, 12, 13, 21).

An advantage in the competition with foreign companies with deeper pockets and more experience is local knowledge, which enables localized solutions (interview 10).

The small company size allows increased flexibility and adaptability to customer demands (interview 21). It is also common to compete with low price (interview 4). Relative to Chinese competitors, academic spin-offs compete with their technical knowledge (interview 13) and returnees' companies with their business expertise (interview 11).

4. Lack of intellectual property protection

The weak intellectual property rights enforcement in China serves both for and against some of the incubated companies. According to a survey carried out by Beijing Business Incubator Association (2006: 18), 18% of the incubated projects in Beijing are imitations rather than innovations. In the light of the preceding discussion about the difficulty of securing capital, imitation appears to be a natural method of accessing research and development in an embedded form without having to spend money on conducting it. For example, one of the students companies admits using intellectual property infringement as a means of accessing embedded technical knowledge instead of conducting research and development within the company (interview 4).

Another effect is that the incubated companies do not need to spend money on software licenses, thereby reducing the cost of research and development to hardware such as computers and servers (interview 20). However, interviewees also point to the damage caused by the weak enforcement of intellectual property rights. One web analysis company cooperated for two years with a major Chinese search engine company. Thereafter the cooperation abruptly ended, and the interviewee suspects that the solution had been copied (interview 10). A software company claims to have had unique solutions when it entered the market, but that it now has been copied (interview 20).

Some of the interviewees proudly mention patents that their companies have been granted for their inventions. Asked for the benefits of holding patents, one manager points out marketing purposes and the usefulness when applying for government grants besides intellectual property protection (interview 18). Indeed, application forms for grants and participation in government projects feature intellectual property related questions more as a rule than an exception. Patents are regarded as an important indicator of innovativeness. Interestingly, one manager classifies the technology for which he holds a

patent in China as ‘not at all innovative’ (interview 9). The technology is imported from the United States and merely modified.

ANALYSIS

What does the empirical evidence suggest about the function of the business incubators in the innovation system?

Let us try to understand the function of the business incubators in the innovation system by viewing the empirical material through the lens of cluster theories. Theories of clustering date back to Alfred Marshall (1890) and his notion of ‘external economies of scale’, used to describe the decrease in marginal fixed cost per extra unit of output achieved by horizontal and vertical integration of small firms. In other words, many small firms working together can generate the same economies of scale, due to reduced transportation costs, communication costs, etc, as large firm do internally. Based on Marshall’s work, Alfred Weber (1929) developed his Agglomeration Theory, where he considered transport costs, labor access, and demand.

These theories have evolved and their modern versions offer insights into present day small enterprise clustering. They fit extraordinarily well into the overarching framework of the innovation systems approach. Myelka and Fainelli (2005: 8-9) have summarized the literature and distinguish four factors. First, the vertical relationships between users and producers “reduce the cost related to information and communication, the risk associated with the introduction of new products and the time needed to introduce a product on the market” (Lundvall 1988; Lundvall 1992; Ernst et al 1998; Nelson 1993, all of which are quoted in Myelka and Fainelli 2005). Second, horizontal collaboration between same-sector enterprises “can yield collective efficiencies in the form of reduced transaction costs, accelerated innovation through more rapid problem-solving and greater market access” (Schmitz 1997, quoted in Myelka and Fainelli 2005). Third, agglomeration can generate positive externalities such as “the availability of skilled labor, of certain kinds of infrastructure, of innovation-generating informal exchanges and learning made possible through the adoption of conventions” (Storper 1995; Maskell 1996, both quoted in Myelka and Fainelli 2005). Fourth, political and social institutions

and policies "play an important role in the development of partnering activity" (Best 1990; Brusco 1982; Piore and Sable 1984; Morgan & Sayer 1988; Storper & Scott 1993; Wolfe and Gertler 1998, all quoted in Myelka and Fainelli 2005).

The preliminary results imply that the third and fourth of these factors capture the main aspects of clustering in the business incubators in this study, while the first and second are less applicable. First, the empirical evidence does not indicate that geographical proximity is an important factor for the establishing of vertical relationships for the incubated companies. Many suppliers are in Shenzhen, in the other end of the country. Second, the study suggests that little horizontal collaboration takes place between companies in the science park. The interview and survey results indicate that most managers hardly meet each other within the incubators. However, the material indicates that collaboration between companies and universities is more frequent. Third, agglomeration does generate positive externalities, most prominently with regards to reputation and the ability to attract skilled labor. The proximity to reputable multinationals and a location in a high-status science park does it part to these ends. Meanwhile, the incubators constitute an entry point into areas with highly developed infrastructure. A minority of business incubators provide additional technological and financial infrastructure in the form of services platforms, such as the software testing facilities of one incubator. Fourth, the incubators are entirely a result of policy issued at the central level. The empirical material demonstrates, however, that the evolution of incubator operations does not move in tandem with that of policy directives.

In summary, the business incubators in this study provide office space and generate some positive externalities, but largely fail to stimulate the creation of horizontal and vertical linkages. Such linkages would provide much needed channels for the business and technology related knowledge that incubated companies lack, especially within the areas highlighted above. While many of the problems faced by incubated enterprises are recognized and adjusted for on the level of policy, the extent to which these ideas are implemented in reality in the business incubators appears to be rather limited. The preliminary evidence suggests that the business incubators, as a group, do not add a layer to the institutional environment of the innovation system that mitigates environmental imperfections and facilitates the channeling of relevant flows of knowledge. My research

does, however, suggest that they function as an effective pipeline for tapping Chinese talent from overseas and bringing it back to China.

Broader institutional aspects of the empirical evidence

1. Capital related aspects

The empirical evidence suggests that a vast majority of the incubated companies are self-financed or rely on informal credit. Compared to other Asian countries, a disproportionally large share of private enterprise financing in China comes from informal sources. Private enterprises do not have the same ability to mobilize collateral as township and village enterprises and do not have the implicit guarantees of state-owned enterprises (Park and Shen 2003: 501). According to Farrell et al (2006), China in 2005 had $300 billion in non-performing loans, an estimated 40% of all loans. This implies that the preference towards lending to state-owned enterprises has a significant political component. Khanna (2007: 110) goes as far as to dismiss banking in China as being "of the Party, by the Party, for the Party". While the state controls the majority of shares in the big banks, using them to support the economic and industrial policy of the government, Minsheng Bank has entered the stage as an experiment with private banking. However, Khanna (2007: 112) concludes that Minsheng Bank is only symbolically private and essentially state controlled. He outlines the causal chain that would be triggered by a much needed bank reform: calling in bad loans, which would lead to the shutting down of bankrupt state-owned enterprises, releasing tens of thousands of laid off workers into the streets to join the rural migrants, ultimately ending in social unrest, something the Party wants to avoid at any cost (ibid 115). Hence, bankers are left with little incentive to lend to the riskier projects of small, private enterprises.

With the high rate of non-performing loans, why do Chinese continue to deposit money in the banking sector? First, the government's controls on capital, preventing Chinese from investing their money outside of China, leave them with few alternatives (Khanna 2007: 113). Second, the Chinese seems to be confident that the government would not allow the banks to go bankrupt (ibid).

Could China's stock markets be a source of capital for private firms? From the time of the reopening of Shanghai Stock Exchange in 1990, the rhetoric has gone "from chasting capitalist roaders to praising capital adequacy ratios" (Khanna 2007: 103). Once again, however, the story of China's equity markets is one of continual intervention. Most of the traded equity has been locked up in state-controlled organizations, and Khanna (ibid 101) dismisses the equity markets in a similar fashion as the banking sector – "of the state, by the state, for the state". In addition, the willingness to invest is negatively affected by the inaccessibility of reliable business information in China, discussed under the section *Information and knowledge related aspects* below.

In this setting, it is not surprising that China has relied more on foreign direct investment than portfolio flows and flows on venture capital from overseas (Khanna 2007: 116). It is also easy to see why the private enterprises in this study resort to informal credit. While a venture capitalist spreads the risk by investing in a number of enterprises, a self-financed enterprise has to find other ways of spreading risk. This is what takes as its expression what is demonstrated in the empirical material: a focus on quick returns, dispensing with R&D, and broad product portfolios.

2. Labor related aspects

The empirical evidence shows that many of the incubated companies have difficulties attracting skilled labor. China produces 600,000 university-trained engineers every year, a figure "often cited to illustrate the country's inexorable rise as a technology power" (McGregor 2006). However, according to a McKinsey study quoted in Financial Times, less than a tenth of each year's college graduates are deemed employable by multinationals (ibid). When it comes to engineering students, the study attributes the problem to a heavy theoretical curriculum, leaving the students "with little experience in problem solving or working in teams" (ibid). However, data from Peking University Student Employment Center (2007: 2), widely acknowledged to be one of the best universities in China, provide another explanation. It shows that 24.0% of the university's technical graduates in 2006 went abroad to study, another 40.5% went on to higher studies in China, and only 35.4% joined the workforce. Shen Wenzhong at Peking University Student Employment Center (interview 28 July 2007) reports that for this

minority of students, multinationals top the wish list. It is thus not strange that the empirical evidence in this study indicate that small enterprises have little prospects of attracting the few talents in competition with well-paying, reputable multinationals.

On the other hand, the interviews in this study also indicate that the difficulty in attracting qualified workers is partially off-set by flexible labor laws and government policy that makes it easier to obtain a Beijing household registration for employees. The most important labor law in China is the Labor Act, in force since 1995 (Gadient n.d.: 3). Since 2004, the protection of employees is centrally regulated by the state (ibid). The purpose is to strengthen the authorities' control over working hours, minimum wage, etc. No nationwide social security law exists (ibid 4) and truly independent labor unions are not allowed in China (Lee 2003: 82). In conclusion, as the empirical material shows, the enterprises in this study have relatively free hands in the hiring and firing of their employees.

3. Information and knowledge related aspects

The empirical evidence suggests that incubated companies have difficulties locating reliable business information. Morck and Yeung (2002) showed that most stock prices in China on any given day moved in tandem, giving little reliable information about the performance of individual companies. In almost no other country included in their comparison stock prices were as meaningless as in China. Can the business media be turned to for reliable information? The Party controls the media through the direct appointment of managers of national media, and indirect appointment of managers of lower level media by exercising power over the appointment of decision makers on the relevant levels (Esarey 2006: 3), as well as through a licensing system (Zhao 2004: 189). However, Zhao (2004: 179, 185) argues that the rapid commercialization of Party-controlled state media, especially since the mid-1990s, has created a media system that serves the interests of the county's political and economic elite. Business is politically correct and issues associated with it are not controversial unless they intrude into the political sphere.

At the same time, for media to be able to present reliable and relevant information, such information has to be accessible from companies. One might ask, for example, if the financial information in a company's annual report is reliable. The answer tends to be no, for at least two reasons. First, most of the domestic assets of Chinese companies are not publicly listed (Khanna 2007: 60). Second, financial analysts are not independent (Green 2003). As the empirical results indicate, not even the information released by the incubated companies is reliable.

As a plethora of literature has shed on the alternative in the absence of impartial sources of information is to turn to informal, social networks for information. It has been debated whether the importance of these networks has declined (Guthrie 1998) or not (Yang 2002) under the reform era. In any case, this study suggests that many entrepreneurs returning to China from abroad, lacking sufficient social capital in China, have a disadvantage in tapping into relevant networks for acquiring business information. It also indicates that the services provided by the incubators are largely insufficient in mitigating this problem.

4. Intellectual property related aspects

The empirical evidence suggests that weak enforcement of intellectual property rights constitute an obstacle to some of the incubated companies, and an opportunity to others. China's commitment to the WTO and the underlying TRIPS agreement obliges the country to implement and enforce intellectual property rights. In 2001, China adopted a new patent law in line with the TRIPS agreement. However, despite occasional high-visibility clampdowns on counterfeit markets in Beijing and Shanghai, *de jure* implementation has to a large extent come without *de facto* enforcement. The International Chamber of Commerce (2007: 3) singles out China as the worst country in the world, together with Russia, at battling intellectual property infringements. The Office of the United States Trade Representative (2007: 6) estimated in a report that 85-93% of copyrighted products sold in China were pirated. Other sources claim that the central government has shown a strong commitment to implement the different parts of the WTO agreement (National Board of Trade 2003: 4). Why then the poor progress? The Chinese idiom 'The mountains are high and the emperor is far away' (*shan gao*

huangdi yuan 山高皇帝远) has been used to explain this paradox (Rogler 2007: 26). As Li (2007: 15) remarks, "the tension between the central government's need to carry its policy initiatives /…/ and growing economic and political localism has been a common phenomenon across all the provinces in the country during the reform era". The incentives of local leaders do not always align with the objectives of the political center.

Chen (2002: 27) points instead to fundamental flaws in the legal system. He remarks that the relationship between the three branches of the state in China is far from clear and constantly in a state of flux. This leads to a situation of law-in-books but not law-in-action, where "a just law does not guarantee the justice through law" (ibid 26). Moreover, Chen points out, without the support of a culture of law little can be done with justice and fairness (ibid). However, while most Western observers seem to view law in China as "just another weapon in the arsenal of party control" (Saich 2004: 139), others contest this view. Peerenboom (2007: 218) argues that "while most commentators portray political ideology as the main obstacle to establishing rule of law in China, the more pressing obstacles at present involve the lack of institutional capacity".

Regardless of whether the political will is there or not, most observers agree that as Chinese companies keep climbing the value-added ladder, the need and pressure for intellectual property protection will increase (Rogler 2007: 16). As a sign of this, 2006 saw the first case of a Mainland Chinese company suing an American company for patent infringement (Economist 2006: 62). The empirical results in this study could also be interpreted to support the view as it demonstrates damage caused by intellectual property infringements to some start-ups. At the same time, however, the same results could be interpreted in other ways. They demonstrate, for example, that lax intellectual property enforcement lowers the costs of research and development for some companies. A logical consequence is also that intellectual property infringements speeds up the process by which newly introduced knowledge elements are disseminated within the innovation system. In conclusion, then, the intellectual property environment appears to have an adverse effect on the rate by which knowledge is introduced into the innovation system, but a positive effect on the rate by which such new knowledge elements are disseminated within the system. It is not obvious which of these counteracting mechanisms exerts the

strongest influence on the economy as a whole. It is possible that the trade-off is approaching the tipping point.

As for the degree of novelty of Chinese patents, it should be noted that China uses a 'first-to-file' system for patent applications (Sun 2003). This means that the first to apply for a patent in China gets it even if it is not the inventor. This explains why patented products are not necessarily considered innovative, indicated by the empirical material. Compared to the patent systems in the west, the Chinese system is "more oriented towards promoting technology diffusion rather than protecting inventors' rights" (ibid).

5. Synthesis

All aspects of the institutional environment discussed in this analysis can be viewed from the knowledge perspective inherent in the innovation systems approach. From this perspective, lack of skilled labor is nothing but lack of advanced, technical know-how. An institutional lack of capital requires 'know-who' (Foray and Lundvall 1998: 115): social knowledge about how to tap into the right networks. Lack of intellectual property protection is the difficulty in retaining valuable knowledge within the company, or the ease to acquire it from other companies. Lack of business information is in this case a low degree of codification of business related knowledge that needs to be compensated for by access to sources of tacit business knowledge. According to the empirical material, these are some of the most important aspects of the institutional environment in which the incubated companies exist. The empirical material also shows impressive signs of flexibility and creativity in the actions taken and relations forged to carve new channels for access to the desired knowledge, around the barriers in the conditioning institutional environment. This takes us into the next section that outlines the linkages of the incubated companies in this study.

What does the empirical evidence suggest about the linkages of the incubated companies in the innovation system?

Taking the empirical material as our point of departure, let us place the student companies, the academic spin-offs and the returnees' companies, one by one, within the

innovation systems framework. First, the student companies to some extent transfer codified knowledge from academia to industry. However, the complexity of the knowledge they transfer is much lower than that of the academic spin-offs. More importantly, the student companies function as vehicles for absorbing business related and technical knowledge. Second, the academic spin-offs transfer high-complexity knowledge from academia, local as well as foreign, to industry. This knowledge is more explicit in its character than that of the overseas returnees. Thus, the motivation for patenting it may be stronger. The academic spin-offs also function as vehicles for blending such knowledge with business-related knowledge. Third, the overseas returnees' companies transfer a high degree of knowledge, tacit as well as high-complexity explicit, from academia and industry abroad into China. Often the China-overseas links remains after the return to China. Thus, the founders keep track of international trends and competition. In general, these companies need to absorb knowledge about the local conditions in order to succeed.

It is here valuable to regard an important aspect of network relationships: they give access to various forms of tacit knowledge (Lundvall and Johnsson 1994: 40). Thus the notion of tacit knowledge constitutes an important critique of the notion that the interconnectivity brought by education and technology "makes the world flat" (Friedman 2005). Johnson et al (2002: 256) relates accessibility of knowledge to power: "[I]n a world of unequal power tacit knowledge may provide a protective belt against exploitation for individuals and groups. The process of codification affects and is affected by the distribution of power". The power relation works the other way around too: it may be used by the stronger group exactly for the purpose of exploitation. The notion that 'geography is dead', rests, as Morgan (2002: 26) argues, "on broader claims about the effects of globalization /…/ and digitalization /…/, neither of which can be sustained". Most importantly, the rapid diffusion of codified knowledge does not mean that tacit knowledge is as freely available (ibid). This is a reason why clusters like Silicon Valley remain strong in the age of globalization and universally accessible information. It is, of course, also the reason why China's government tries to attract overseas Chinese back to the mainland. Geographies remain important.

While the strength of many of the companies in this study is that they tap into networks outside of China that contain relevant tacit knowledge, it takes a lot of effort on their part to become a part of the same type of networks in China. For other companies in this study, especially those run by students, information barriers remain in spite of Internet access and advanced degrees. At the same time, the entrepreneurs in this study demonstrate great creativity in forging new links that allow them to overcome such barriers and compensate for the shortcomings in the institutional environment discussed in the previous section. These include establishing links with universities and research institutes to access to complex technical knowledge in the form of research results, and technical know-how in the form of students that are recruited into the company. They also include using personal networks or working with the government to access capital. Further the interviews provide examples of working with suppliers or government agencies to overcome various barriers.

What does the empirical evidence suggest about the scope of the relevant innovation system?

The innovation systems approach is not a formal theory. It does not, as Edquist (1997: 28) points out, "provide convincing propositions as regards established and stable relations between variables". It is better described as a conceptual framework useful for the analysis of innovation. As such, there is great uncertainty about what limitations to impose on innovation systems. I pointed out in the beginning of this paper, under the section of the theoretical framework, that I will not beforehand attempt to define what innovation system constitutes the 'relevant' one. My approach was instead to explore on the field which factors are, indeed, relevant. Interestingly, although many factors take a localized form, it appears that the underlying elements are in this case rooted in the central, national level. As discussed in this analysis, the lack of capital may have its roots in a structural problem in the banking and finance sectors stemming from the top-down approach that China's Communist Party takes in ruling the country. Likewise, it demands a media structure and degree of transparency that is not conductive to reliable business information. The lack of intellectual property rights enforcement has also been blamed on problems associated with implementation in a top-down fashion. Even if these are only

speculations, they demonstrate that factors on the national level are very important in understanding the institutional environment in China. If the claim that China's top-down approach is the root to some problems that incubated companies in Beijing face is a speculation, that of the impact of central policy is not. This study has demonstrated that policy initiatives from the political center, with minor adjustments on the local level, are responsible for the development of incubators in Beijing, as well as attracting overseas Chinese back to China.

CONCLUSION

The high-tech business incubator industry in Beijing is a result of national-level political initiatives. However, when these initiatives are interpreted and implemented on the ground, policy and action do not always move in lockstep. While some business incubator, notably those under direct control of government bodies, offer their tenant companies a wide range of services, others merely provide office space, reputation, eligibility for government funds, and help to apply for such funds. In this regard, the clustering that is seen in the incubators is highly artificial and achieved in a classic top-down fashion. At the same time, however, some positive externalities are seen. For example, the reputation that comes with a location close to well-know multinationals help attract skilled manpower in an environment where it is lacking.

Some important factors that impact the way the incubated companies innovate and do business are lack of capital, lack of skilled labor, lack of business information, and lack of intellectual property protection. Each of these may be rooted in aspects of a broader institutional environment. The lack of capital stems partly from structural problems in the banking and finance sectors. The lack of skilled labor is to some extent attributable to students' preferences. The lack of business information is caused by the prevailing media structure and lack of transparency. The lack of intellectual property protection may be rooted in a flawed legal system or difficulties in implementing legal reform on the ground. Some would argue that there is a top-down component underlying these aspects.

This study has also demonstrated the dynamics between institutions and linkages in the innovation system. When all the layers of the institutional environment are placed on top of each other, and the layer added by business incubator fails to make up for the

institutional imperfections in this environment, the entrepreneurs find other ways to meet their ends. They tap into various sources of knowledge by exploiting lax regulations, forging ties with universities and research institutes, working for their competitors, cooperating with suppliers and government agencies, and so on.

While things do not necessarily work the way they are indented to from a central policy perspective, space exist at the bottom for incubated companies to carry out their own creative ways of interacting in ways that help them overcome deficiencies in the institutional environment. New knowledge is introduced into the economy from overseas and from academia. This knowledge is combined and disseminated through interactions taking place within, and conditioned by, the institutional environment to create innovations.

The preliminary results of this study are valuable for further research for two reasons. First, it provides first-hand, empirical material about entrepreneurship in Beijing. Second, it demonstrates the strength of the innovation systems approach in capturing the nexus between institutions and interactions in a context of innovative activity.

LIST OF INTERVIEWS

Interviews outside the business incubators

Breidne, Magnus, Head of the Swedish Institute for Growth Policy Studies. Interviewed 11 June 2007.

Long, Huadong, Director at Beijing Business Incubation Association. Interviewed 30 July 2007.

Shen Wenzhong, Director at Peking University Student Employment Center. Interviewed 28 July 2007.

Interviews with business incubator managers

Interview 2, Manager at a university business incubator. Interviewed 14 June 2007.

Interview 3, General Manager at a university business incubator. Interviewed 15 June 2007.

Interview 5, Manager at a students' business incubator. Interviewed 28 June 2007.

Interview 8, Manager at a students' business incubator. Interviewed 7 June 2007.

Interview 14, Deputy General Manager at a software business incubator. Interviewed 18 July 2007.

Interview 15, General Manager at a software business incubator. Interviewed 18 July 2007.

Interview 16, Manager at a software business incubator. Interviewed 18 July 2007.

Interview 19, Manager at an international business incubator. Interview 19 July 2007.

Interviews with managers of incubated companies

In the students' incubator: interviews 4, 6, 23, 24, 25, 28
In the university business incubators: interviews 7, 9, 10, 11, 12, 13, 18, 20
In the international incubator: 21, 26, 27

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