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RESEARCH ARTICLE

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IT-Software SMEs in China, Technology Transfer from Universities and Entrepreneurship, a Successful Nexus?

Abstract Drawing on the empirical work of a broader study, this paper examines whether technology is being successfully transferred from universities to the IT-software SMEs present in China, and the effectiveness of entrepreneurship in effecting such transfers. A conceptual framework was generated to guide the investigation. Data were elicited using a detailed questionnaire which generated 53 usable responses; follow-up interviews with 17 of the 53 respondents; and four interviews with relevant government officials (civil servants from the Ministry of Science and Technology and state-owned banks). There were three main findings. Chinese software SMEs tend to be reluctant to adopt new technologies from local universities; there is a lack of common purpose between the parties; and entrepreneurs who did undertake such technology transfer felt the process was badly impeded by the lack of available finance, and expressed fears about poor protection of intellectual property rights in China. The majority of the sample firms acted opportunistically, taking advantage of the benefits offered under government schemes to earn rapid returns mainly using extant technologies. These conclusions suggest that the Chinese government's policies in this area of technology transfer have had only limited success.

Keywords entrepreneurship, technology transfer, universities, IT-software, SME, China

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1 Introduction

This paper reports on a study whose overall aim was to explore whether entrepreneurship among small and medium sized software firms is able to positively affect technology transfer from universities in China (Cao, 2009).

The importance of China's software industry is underlined by the identification of the sector in the 10th Five-Year Plan (2001–2005) as a "pillar" industry, perceived as essential to economic progress and national security. Further, development of the sector necessarily calls for a focus on SMEs, since much of the domestic market was fragmented, with thousands of small or medium sized enterprises, many of which employ less than 50 employees (Saxenian, 2003).

One of the key features of government policy in China in relation to technology development, which includes the IT-software industry, has been the establishment of science and technology industry parks (STIPs) (Science & Technology, 2004; Hu et al., 2010). These STIPs are located close to universities with the idea that this will facilitate the development of technology led products drawing on the intellectual base of the country's leading scientific universities and the creative minds found therein. This could lead naturally to the notion of new start-ups being created to deliver the technological developments which it was government policy to promote. Any such start-up businesses then have a choice between locating in the STIPs or staying outside them. Although there of course remains the clear possibility that large firms could be major drivers of technology development, the presence of SMEs in the field remained highly significant at the time of the 10th Five-Year Plan (Tschang and Xue, 2003). Allied to the presence of SMEs in the industry sector under study, and in particular new start-ups, the whole issue of entrepreneurship and its nature (see for example Schumpeter, 1934; Bygrave, 2004; Zhang et al., 2008) comes naturally into focus. This is further supported by previous evidence suggesting that entrepreneurship drives technology change and thereby the emergence of the hi-tech sector in China (Yu et al., 2009).

The main research question examined in this paper is: Whether technology is being successfully transferred from universities to the IT-software SMEs present in China, and the effectiveness of entrepreneurship in effecting such transfers. The SMEs are our primary units of analysis. Second level issues include: assessing how the SMEs get started including whether they get their technical know-how from a partner university and if not then from where; exploring what

may be the facilitating factors and impediments to technology transfer for China's IT-software SMEs; and whether the government's STIP related policy for technology development is working in the IT-software segment.

In order to achieve this objective the paper is arranged as follows. First we have a literature review with three sub-sections dealing respectively with: the development of the IT-software industry in China; technology transfer from universities, or otherwise; and entrepreneurship which is posited to be a catalyst for technology transfer. There is then a section dealing with an initial conceptual model of the forces impacting on the kind of IT-software SMEs under study and elaboration of the research questions to be explored, given the insights of the literature review. The fourth section outlines the methodological approach adopted. The fifth section reports the analysis and findings from the pool of primary data and the sixth section offers conclusions and discussion.

The empirical aspect of the study comprised: a survey using a detailed questionnaire undertaken among IT-software SMEs located in two of the three principal foci for the IT industry, notably Beijing and Shanghai; follow up interviews with questionnaire respondents; and four interviews with relevant government officials. The analysis of this pool of data comprised, primarily, a mixture of straightforward statistical methods and textual analysis. One of the value-added features of the paper is the rich source of detailed insight gained from the interviews with the entrepreneurs/SME owners and government officials.

As is explained in the third section, the precise questions considered in this paper had been at most "lightly researched" at the time of our study: Hence it is axiomatic that this paper adds new insights into the way in which a particular group of entrepreneurs, namely IT-software entrepreneurs, have responded and are responding to China's policies and special measures aimed at stimulating technology transfer from local universities. In particular, the soft data culled from the follow-up interviews offer a valuable insight into the thinking of the respondents as to why the observed outcomes are as they are, for example why they are not all clamouring to work with technology creators in universities. The model proposed in the third section is felt to be a realistic view of how the technology transfer process, with entrepreneurial skills as catalyst, still could work. Fourthly and finally, in the discussion at the end of the paper, necessary actions by the Chinese government to improve their overall technology delivery system are outlined. These four elements are the main among the potential contributions of this paper.

2 Literature Review

2.1 Scale and Shape of China's IT-Software Industry, and Related Government Policies

In China's 10th Five-Year Plan (2001–2005), computer software was identified as a critical or "pillar" industry. The government considered that this industry should be promoted along with more established industries such as computer manufacturing, telecommunications, lasers, and aerospace engineering. Furthermore, the software industry was considered essential to economic progress and national security (Saxenian, 2003).

At the beginning of the 21st century, it was reported by Tschang and Xue (2003) that China's software sector remained small, underdeveloped and extremely fragmented, consisting of thousands of small, under-capitalised firms with few competitive advantages compared with the foreign corporations which dominated the market. At that time, its exports were negligible, despite the fact that Chinese software output had grown on average by a rate of over 30% annually since 1995 and was predicted to continue this rapid growth for several more years (Hu et al., 2008). With regard to (former) Prime Minister Wen Jiabao's explanation of China's 11th Five-Year Plan (2006–2010), software would become a core industry and get more attention and support from the government (Hu, 2005). Indeed Quan (2007) claimed that China has already established a significant, dynamic IT-manufacturing sector. The dramatic growth over recent years is demonstrated in Table 1 below.

Table 1 Growth of China's IT-Software Industry 2000–2007

Year	Revenue (billion yuan)	Annual Growth Rate	Software Export (million US$)	Annual Growth Rate
2000	59.3	-	400	-
2001	79.6	34.2%	720	80.0%
2002	110	38.2%	1,500	108.3%
2003	163	48.2%	1,800	20.0%
2004	242	48.5%	2,800	55.6%
2005	390	61.2%	3,590	28.2%
2006	480	23.1%	6,060	68.8%
2007	583.4	21.5%	10,240	69.0%

Source: Ju (2008), "New Steps of China's Software Industry," Presentation to IPA Forum, Tokyo, the 28th October, 2008.

The Chinese software market used to be dominated by foreign corporations such as Microsoft, IBM and Oracle with packaged software sales accounting for over 65% of total sales, due to their well-known brands and established products. Clearly multinationals offered, and in fact continue to offer, strong competition in the packaged software sector, especially in middleware and certain consumer software, such as operating systems and office productivity products (Suttmeier and Yao, 2004). More recently the market as a whole has grown increasingly competitive, with big local software firms like Ufsoft and Kingdee holding 60% of China's accounting software market, by 2002, aided in part by the preferential purchasing policies of the Chinese government. However, much of the domestic Chinese software market remains extremely fragmented, with thousands of small or medium sized enterprises, who employ less than 50 people.

The industry has three main areas of relative concentration which are Zhongguancun and Haidian in Beijing, Shanghai, especially Pudong, and Shenzhen, in South China.

The Chinese government has adopted specific policies to support the industry. Besides its influence on the software industry, the Chinese government also had an early, complementary influence on the hardware industry. This is shown by its sponsoring of national research efforts on "core technologies" deemed essential to the nation's computer industry. Projects have included various, large scale, government funded projects for developing Chinese competence in core computer technologies, such as the Ministry of Science and Technology's 863 Research Programme, this and other government research projects became the basis for companies such as, most famously, Founder and Legend. A series of government "Golden" projects were started to expand the country's e-commerce and infrastructure, and various sector applications, e.g., e-government (Klotz, 2004).

In August 1988, approved by the State Council, the Ministry of Science and Technology (formerly called State Science and Technology Commission) took charge to implement the "China Torch Programme." The programme was established to keep in line with the general policy of reform and open up to the outside world, with a view to exerting the potential advantages of China's scientific and technological capabilities. It was also designed to promote commercialisation, industrialisation and internationalisation of new and high technology research products thereby to achieve the mission of revitalising the

country through Science and Education. Eight themes constitute the main content of the programme. Among them are four themes relevant to developing the software industry: namely, the establishment of the software industry base, an innovation fund for small technology-based firms, international business operation of new and high technology industry, and personnel training. Alongside the implementation of the "Torch Programme," several national high-tech industrial development zones have been established across China, which provide firms with first-rate infrastructure like roads, buildings, electric facilities and so on, and also a variety of preferential taxes and collective services. The first such zone was established in 1988 as a trial in Zhongguancun, Beijing (Gu, 1999).

On 24th July 2000, the national government took arguably its biggest step concerning the software sector in launching a policy package in "Document No. 18," entitled *Policies regarding how to encourage the development of the Chinese national Software Industry and Integrated Circuit Industry* (Guowuyuan, 2000), with provisions including: *VAT Refunds for R&D and Expanded Production*; *Tax Preferences for Newly Established Companies*; *Fast-Track Approval for Software Companies Seeking to Raise Capital on Overseas Stock Markets; Exemption from Tariffs and VAT for Software Companies' Imports of Technology and Equipment; Direct Export Rights for All Software Companies with Annual Revenues over One Million US Dollars; and the Right to Set Salary Levels and to Grant Bonuses to Investors.*

In 2002, the government then promulgated another important policy, "Document No. 47" entitled *The principle of rejuvenating the software industry* (State Council, 2002). This policy document explicitly stated that domestic software products should be the first purchasing option for government procurement. It requests that in the government's information engineering project, the minimum share of money for software should be no lower than 30% of the total investment. It also includes training and education of the software industry in the government's agenda and requests that during the tenth five year plan (2001–2005), the government should spend more than four billion yuan on R&D in the software industry.

2.2 Building Relevant Infrastructure and Technology Transfer

There is a large body of literature dealing with the overall issue of technology

transfer as seen, for example, from the review of Seely (2003). He reviews the literature post 1950 but the story as it relates to China starts much more recently and as we shall see very little relates specifically to our industrial segment explored here: the IT-software industry.

One starting point may be seen to be 1991, when, to try to help China to meet the challenge of worldwide technological revolution and develop new and high-tech industries, the State Council officially approved the establishment of the first batch of 26 state-level new and high-tech zones, and issued a series of related policies. By 2004, there were 53 state-level new and high-tech zones in the country, including the Beijing New Technology Experimental Zone (Science & Technology, 2004). This has a direct beneficial impact on the software industry among others. Among the benefits hoped for are: development of enterprise incubation capacity and the fostering of innovative personnel. By the end of 2000, there were already some 21,000 enterprises registered in these zones, many small ones but also some 1,250 whose annual output value exceeded 100 million yuan (roughly over £ 10m) and some foreign invested enterprises (FIEs). Another commonly used name for Hi-Tech Industrial Development Zones is STIPs (science and technology industry parks).

It is estimated that in excess of 50 percent (perhaps nearer 80 percent) of high-tech products are produced in new and high-tech zones. Nearly 300 scientific and technological enterprise incubators for SME creation are located in the new and high-tech zones (Science & Technology, 2004). According to Harwit (2002), a typical Chinese incubator has one or several floors of a publicly owned office building. The business plans and market potential of incoming tenants are checked to decide whether they fit in with the incubator's industry specialisation. Harwit categorises the Chinese incubators into three main types: university incubators, returned overseas student incubators and SOE-highlights incubators.

Working from a model initially with a focus more general than China, Eun et al. (2006) found that Chinese universities were more likely to set up their own firms (the type to which Harwit referred) to leverage new technology developments than to transfer it to "external" firms because of what they describe as the low absorptive capacity of industrial firms and the underdeveloped intermediary institutions. This issue of absorptive capability is also taken up by Guan et al. (2006), who also add that Chinese firms need to foster technology transfer and communications amongst trading partners, and nurture in-house innovation

capabilities. This emphasis on in-house R&D is underscored by Hu et al. (2003) and of course this view is arguably antithetic to the Chinese government model already outlined.

In contrast to the suggestion of Guan et al. (2006) and Hu et al. (2006), Kroll and Liefner (2008) found that while government-driven spin-off formation had (initially) proved an appropriate solution for technology transfer at Chinese universities, many of the companies thus formed performed poorly, suggesting that the notion of corporate self-reliance or transfer of technology from universities to "independent" firms may be important alternatives. However, especially when technology transfer is affected between two legally separate entities, facilitating soft-infrastructure becomes important as Li-Hua and Khalil (2006) note, suggesting that one key element is the diffusion of management of technology (MOT) expertise not only in firms themselves but also into engineering educational curricula. In another paper Li-Hua (2006) further proposed that for technology transfer to be successful, there should not be too big a gap between transferor and transferee, in terms of economic development.

Another source of technology for transfer into China's economy is that which comes from MNCs who make foreign direct investments (FDIs) in China. Wang et al. (2004) emphasised that two of the key soft factors required to ensure the effective transfer of knowledge from MNCs to their Chinese subsidiaries are the parent's willingness to make transfers and the subsidiary's ability to absorb. A slightly more unusual type of FDI is that of the foreign university's off-shore campus. Youtie and Shapira (2008) discussed how this has worked in the case of one US parent university, Georgia Tech.

Wang and Lu (2007) emphasised the role of entrepreneurial spirit within the university as vital for building and maintaining effective university-industry interactions. They even suggested that universities need Professors of Practice in post to offset the tendency to an excessively theoretical perspective (an issue which came up in the interviews conducted for our own study). The idea that entrepreneurship has a key role to play in the technology transfer process is one we incorporate into our own conceptual model set out in the next section. It is a view supported by earlier empirical work in the China setting by Watkins-Mathys and Foster (2006). With that thought, we move on to the next sub-section which deals with the nature of entrepreneurship.

2.3 Entrepreneurship

Given the important role which entrepreneurship is envisaged to fill in commercialising technology sourced from universities, this section discusses the theoretical concepts underpinning the idea of entrepreneurship.

Based on the results of previous research we began from the point of view that the calibre of faculty staff in China's universities should, or at least could, play a key role in affecting technology transfer (Zhou and Zhu, 2008); entrepreneurship drives technology change and thereby the emergence of the hi-tech sector in China (Yu et al., 2009).

We developed our understanding of entrepreneurship based on the definitions developed around technological entrepreneurship. The latter includes concepts of opportunity recognition, risk taking (Schumpeter, 1934; Gartner, 1988; Olsson and Frey, 2002; Bygrave, 2004; McClelland, 1961; Cunningham and Lischeron, 1991) and being able to translate the opportunity into entrepreneurial action (Cantillon, 1732, in Herbert and Link, 1988; Knight, 1921; Say, 1816, in Swedberg, 2000). Drawing on the work of Reynolds et al. (2001), Zhang et al. (2008, p735) usefully summarised technological entrepreneurship as follows:

> *....technological entrepreneurship is of the character of opportunity entrepreneurship, it can be defined from the point of view of opportunity discovery and exploitation, namely* '*discover and exploit market opportunity of technology*'

They further posited that factors influencing technological enterprise can be situated inside and outside a firm's boundaries.

Among external factors affecting technology transfer in China we incorporated the following perspectives: economic clusters, notably STIPs and their effect on innovation (Porter, 1998); the role of universities as sources of knowledge in effecting knowledge transfer to organisations (Wang and Lu, 2007); and the influence of government policy on technology transfer (Wang and Zhou, 1999).

The internal factors contributing to entrepreneurial action (Gartner, 1988; Bygrave, 2004) include the firm's internal resources and capabilities, which create value by successfully, commercialising technologies (Petti and Zhang, 2011). The entrepreneurs' social networks also play a role in opening doors in

the value creating process (Klepper and Sleeper, 2005).

3 A Conceptual Model and Research Questions Developed

3.1 Conceptual Model

In the light of the literature reviewed, together with our own intuitive insights, we developed the conceptual framework shown in Fig. 1. The framework was used both to inform the collection of data and also to explore and analyse that data.

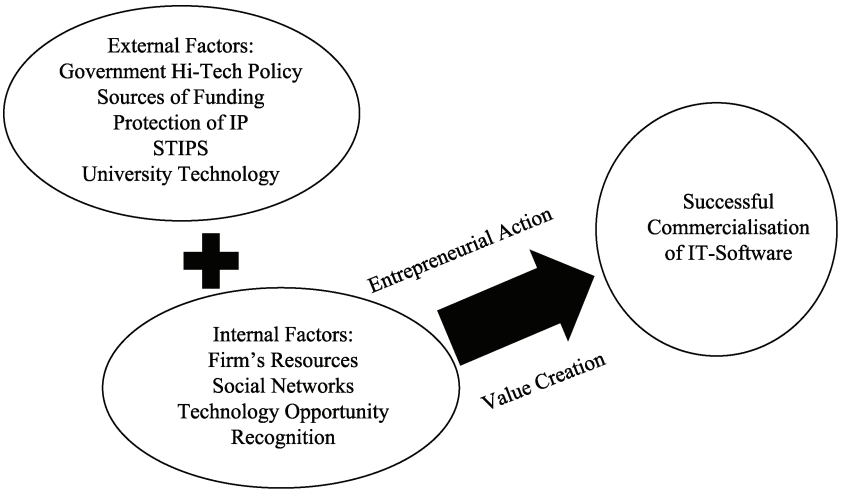

Fig.1 Conceptual Framework

This framework places entrepreneurial activity as the value creating process, which is at the heart of technological entrepreneurship. It also incorporates the external factors noted in previous research and which form the basis of our study: namely, the Chinese government's hi-tech policy, its cluster approach evidenced by the STIPs, the transfer of technology from China's universities to new or existing ventures, the general external operating framework for businesses, including sources of finance.

The external factors, together with those resources contained within a firm, plus the IT entrepreneur's social networks and ability to identify clearly the commercial opportunities for technologies, combine to translate opportunity recognition for the technology into entrepreneurial action and value creation.

These latter processes are vital in bringing the technology to the market place.

The role of entrepreneurship in effecting technology transfer was examined, therefore, using the conceptual model outlined in Fig. 1. In particular, the questionnaires and interview questions for this research were designed on the basis of this conceptual framework. In essence, the results affirmed the theoretical assumptions upon which the conceptual framework was based. In particular, the results provided evidence that entrepreneurial activity remained at the heart of technological venture and value creation; and that entrepreneurial activity influenced and was influenced by environmental factors such as government policy. However, the interaction between universities (as sources of technology and human resources) and new technology ventures (NTVs) was less effective, resulting in some NTVs finding these necessary resources elsewhere.

3.2 The Research Questions and Their Location in the Literature

Because of the policy imperative attempted by the Chinese government, as explained in the second section, investigation of the actual nature and success of IT-software SMEs was considered a topic of interest both from the perspective of understanding how the sector operates and also the nature of its contribution to the policy imperative. One part of the government's initiative had been, as explained above, the establishment of STIPs nearby key, national universities and the hope that they would in some way engender an entrepreneurial spirit in this and other key sectors of China's economy, with potential for technology transfer to allied manufacturing firms, thus delivering overall benefits to the national economy. In order to explore the impact or otherwise of entrepreneurship in this context, we examined, as described in the third section, the nature of that process conceptually both in the widest global sense and more narrowly as others reported to have found the phenomenon within China. This gave rise to the model outlined previously in Fig. 1 which informed the design of the questionnaire and follow-up interviews.

The main research question examined in this paper is: Whether technology is being successfully transferred from universities to the IT-software SMEs present in China, and the effectiveness of entrepreneurship in affecting such transfers. The SMEs are our primary units of analysis. Second level issues include: assessing how the SMEs get started including whether they get their technical

know-how from a partner university and if not then from where; exploring what may be the facilitating factors and impediments to technology transfer for China's IT-software SMEs. The kind of facilitating factors envisaged are shown in the two "input ellipses" shown on the left side of Fig. 1 impacting on the delivered outputs (the circle to the right in the figure). We were in turn able to review, at least partially, the success of the government's intended policy initiative and highlight areas within the policy arena which may require further attention if the government is indeed to play an active role in the development of the IT and in particular IT-software industry in China.

The precise questions formulated had been little researched at the time of the empirical study: Hence one of the important contributions of this work was to begin to fill that gap in the literature. There has been some other research, less sectorally specific, examining the role of universities as a source of entrepreneurial gain. For example, Zhou and Peng (2008) reported on how universities have actually operated as an enterprise launchpad, with the universities (rather than commercial companies) as the units of observation. They are sceptical about their initial capability to be truly both entrepreneurial and hi-tech, as we shall elaborate in the discussion of policy implications in the concluding section. See also Wang and Lu (2007) and Wu (2007), who looked at China's experience of university-industry interactions as a potential stimulus to hi-tech development but not specifically in the IT-software sector.

4 The Research Methods Adopted

The conceptual framework discussed in the previous section draws on the entrepreneurship literature to provide interpretive frames of reference (Archer, 1988) rather than a vehicle for testing hypotheses (Hammersley, 1996). Within this approach, the authors adopted a multi-method approach (Bryman and Bell, 2003, p486) that includes quantitative and qualitative methods: "a survey questionnaire among IT-software entrepreneurs in China and follow-up interviews with questionnaire respondents as well as interviews with relevant government officials."

The purpose of the questionnaire survey was to provide a snapshot picture of the Chinese IT software industry at the time of the research (Bryman and Bell, 2003, p486). The survey was carried out by adopting purposive and snowball sampling (Engel and Schutt, 2009, p96) which enabled the authors to obtain

relevant IT-software participants among SMEs in Beijing and Shanghai, two of the three major centres of concentration in China's IT-software industry. The questionnaires were issued with some help from the Chinese researcher's personal contacts who were familiar with the sampled population. This ensured that the questionnaires were delivered with some precision to the appropriate targets, and eventually helped to return a very satisfactory response rate (53 out of 100 questionnaires distributed).

The questions within the questionnaire were structured according to the authors' understanding of the conceptual framework. The questionnaire was first developed in English and then translated into Chinese (one of the author's mother tongue) and then tested for its clarity and meaning with five entrepreneurs who had agreed to take part in the survey. The pilot was arranged in Songjiang New High Tech Development Zone, Shanghai. The participants appeared to be able to understand all questions clearly except for very minor details, allowing the researchers to make necessary adjustments.

The authors used a range of statistical analyses (Bryman, 2004) ranging from simple mean and frequency tests to correlating key data (size, turnover, number of patents etc.) taken from the selected entrepreneurial enterprises. In addition, the questionnaire data were examined for useful descriptive elements that might assist in explaining aspects related to the framework.

The questions asked were in four sections eliciting data on: personal details; details about the company and reasons for starting the business; growth from start-up and environmental factors; intellectual property and innovation; competition with rivals and future planning. Where questions related to the degree of impact or perceived importance of different factors within the topic areas just noted, those factors were assessed on five-point Likert scales (where "5" connotes strong affirmation, and "1" little or no impact/importance).

Semi-structured follow-up interviews were conducted among 17 IT-software entrepreneurs and 4 government officials (civil servants from the Ministry of Science & Technology and state-owned banks). These interviews sought to explore in greater depth the experiences and views of those interviewed about technology transfer from universities (see Appendix for details). The authors collected the interview data using a mixture of electronic recordings and note taking as they anticipated that not all respondents would agree to being recorded.

The interviews were conducted in Chinese and the data analysed through a

process of sensemaking and using language as a contextualizing resource (Welsh and Piekkari, 2006). This process involved interpreting the interview data such that the interviewer is an active participant in making sense of the views expressed by the respondents. For this reason, and because the researchers were working between two languages, they chose not to use a proprietary software package to analyse the qualitative data. Instead, using the themes of the conceptual framework the researchers sought to draw out and interpret the views obtained from the respondents for each theme.

A first overview of the data coverage was undertaken to deliver thorough familiarity with the data set, with themes and concepts being sought out (i.e., naturally emergent themes were looked for) and cross-referenced to the themes that the authors hoped or expected to find relating to the conceptual framework. Other emerging implications that could possibly arise provided the inductive element of this research. The data from the interviews with entrepreneurs were managed by ordering and categorizing them into a matrix first. Each interviewee was allocated into a column, and each row denotes a separate subtopic, labelled or sorted by theme or concept. Then, in each row there was a summarizing synthesis. The use of these two techniques helped the authors to clarify the answers, show their appreciation and understanding of the answers, and also got the interviewees to give more examples, to extend their narrative. This interactive interviewing approach, involving both parties enabled genuine discovery to occur (Strauss and Corbin, 1998).

The summary activity statistics of the 53 firms, the educational profile of the respondents therein and profiles of the 17 interviewees are shown in the Appendix. The analysis of this pool of data comprised, primarily a mixture of straightforward statistical methods and textual analysis. One of the value-added features of the paper is the rich source of detailed insight gained from the interviews with the entrepreneurs/SME owners and government officials.

5 Analysis and Findings

In the questionnaire, in pursuit of our overall research aim, we collected data on several different aspects of the IT-software companies examined: factors of perceived strength, or otherwise, for the business; the role of social networks in establishing the business; factors affecting the acquisition of financial capital; and perceived influences on technology transfer from universities, both as

constraints and stimuli. We demonstrate these in tabular form, all the factors having been assessed on five-point Likert scales (where "5" connotes strong affirmation). The main findings from the quantitative analysis are presented in each sub-section, elaborated by reference to the soft data from the interviews which were conducted.

5.1 Self-Assessed Strengths of Sample Businesses and Their Technology Sources

The perceptions of the companies were very clear regarding what made their businesses strong: Technological capability was the outstanding factor, with intellectual property a clear second albeit lagging by some margin, as shown in Table 2. If we interpret anything between 2.25 and 3.75 as "middle ground," or neutral, in perceptual terms, the surprising finding here is the lack of importance attached to location and financial resources. This may be explained in part by the bias inherent in the sample certainly for location—all 53 companies were located in either Greater Beijing or Greater Shanghai region. Quite simply it may be that the firms are where they are and do not really see fit to ponder the matter further.

Table 2 Strengths, or Impacting Factors of the Business

Factor	Mean	Std Dev
Technological capability	4.23	1.41
Intellectual property	2.91	1.78
Staff	2.38	1.55
Networks	2.23	1.72
Financial resources	1.23	0.80
Location	1.19	0.68
Brand/s	1.09	0.49

Nevertheless, in the follow-up interviews several people explained why they had positively chosen to locate their firms outside the STIPs with their attendant government perks, for example, Mr Xie in Beijing. His main focus was on good transport links to other places plus proximity to his client, as he explained, "I located my company near to my clients, which helps us to communicate with the clients and promote our products. I think these benefits are enough for locating here; I don't need much else." An interviewee, from an earlier study by Watkins-Mathys and Foster (2004), also from Beijing, made the point that being

in the capital gave him access to a large client base, the chance to interact with inventors and scientists in the city's many universities and gave access to a pool of educated talent from which to hire. These factors he considered outweighed what he saw as the bureaucratic burdens of locating in a STIP.

Of the firms interviewed, 10 were located in a STIP, while the other 7 were not (see Table A3 in the Appendix). Despite the apparently weak impact of location as shown in Table 2, evidence from the interviews showed interest both in locating in a STIP at the start-up phase especially for the tax breaks (10 of 17) and proximity to universities (5 of 17) and in being there as the business grew for the benefits, or perks, available from government (6 of 17). In short, the motivations for going to STIPs may be more to do with crude financial incentives and the like than to hook up to the local university knowledge pool with a view to technology transfer. This sort of appetite for grasping structural, financial incentives was just part of a desire of the SME owners for rapid financial gain, very possibly using existing technologies rather than embracing new, potentially cutting edge technologies. A similar point was made by Wu (2007) in his study of the industrial linkages of two, elite Shanghai universities.

This leaves the issue of whence the companies' technology came. Question 18 on the questionnaire asked exactly that: The dominant response from 60 percent of respondents was that their companies were "self-innovated," just 17 percent got it from a local university. In the interviews 7 of the 17 stated that they had no university cooperation connected with technology transfer. In fact they said that the main reason for working with the university sector was as a source of potential employees.

5.2 Importance of Social Networks in the Establishment and Development of Software Firms

Because of the reported, widespread belief in the importance of social networks in Chinese life, both business and social, it was anticipated that their role would show up very strongly. Given that prior expectation, the data presented in Table 3 may be thought slightly surprising, or least to require some explanation. In the matter of access to capital monies, either at start-up or for further development, the rather low scores seem actually to reflect not so much that prior thinking is intrinsically flawed but rather to make clear that it simply is very tough for Chinese SMEs, certainly in the IT-software sector, to get their hands on capital.

In the follow-up interviews with the two bankers, they were quite candid in stating that they tended to provide funds to large well-established firms. Like bankers in many other countries, their institutions behave in a risk-averse fashion. In New York and London there are venture capitalists at work beyond the core banking sector: As yet this is an industry noted more for its absence than presence in China.

Table 3 Role of Networks in Establishing/Developing Business

Aspects affected	Mean	Std Dev
Garnering business opportunities	3.70	1.30
Initial establishment	3.25	1.36
Gaining initial capital	2.75	1.43
Finding good staff	2.74	1.43
Gaining access to further funds	2.62	1.33
Other	1.83	1.30

The one factor where networks showed strongly was getting business opportunities for their firms. This may be especially true if firms seek to gain government contracts. The point was made strongly to us by Mr. Xue who claimed that guanxi is a *necessary* condition to gain such contracts. Two other interviewees, Mr. Zhang and Ms. Zhou made a somewhat similar point "from the other end of the telescope," noting that their lack of local networks led to them lack confidence in their ability to compete.

5.3 Acquiring Venture Capital

The term venture capital (VC) is used slightly flexibly here to mean both VC as it would be understood in the U.S. and European markets and also long term and working capital available from other sources including commercial banks, which up to the time of the survey essentially means China's state-owned banks. (While there may be some who would jib at this use of the term VC, we would argue that it is quite reasonable because any investment in the early stages of a business start-up with some technical aspect necessarily carries a higher than usual risk for the lender). The slightly odd outcome here is the apparent difference in perceptions as between the scores summarised here and those shown in Table 3 concerning raising capital monies at two different stages of the firm's development.

Table 4 Factors Affecting Acquisition of Venture Capital

Factor	Mean	Std Dev
Social networks	3.57	1.42
Business plans	3.57	1.42

The raw scores for the earlier factors (in the preceding sub-section) showed that 17 and 15 of the 53 respondents rated networks unimportant (score 1) to access capital. By contrast, for the section of the questionnaire which focuses on what helps to gain VC, 17 respondents rated networks as highly important (score 5). It may well be that the differing scores show a differing mental focus in respondents, moving from one where the network was the prime focus first time round to one where the network becomes one of several choices which may influence another common, variable, viz VC. In the raw scores, a few more people rated business plans at 4 or 5 than did so for networks. Strangely, 9 rated a business plan as unimportant as compared to 7 who rated networks at the minimum score. This non-trivial rating for a negative perception appears to reinforce the point made in the preceding sub-section concerning the sheer difficulty of accessing capital for the Chinese SME.

The importance of a good business plan, and notably as a tool to access VC, resonates with views in the UK and other western settings. For example, Watts and Wardle (2006) emphasise the importance of business planning in growth oriented SMEs. Meanwhile Wu et al. (2010) focus on the need to develop strategic planning models tailored to the promotion of technological development in China (they examined a multi-industry sample). Among our interviewees, 47 percent thought a good business plan more important than networks, and another 29 percent thought them both very important. However, when it came down to what really happens, the modal behaviour reported was for these software SMEs to be self-financing, probably due in large measure to the difficulties for SMEs of accessing external funding, especially in a relatively high risk sector.

5.4 Constraints to Technology Transfer from Universities (to Software SMEs)

The focus here is on the influences of structural factors, as perceived by the entrepreneurs in the sample, rather than the technologies which might have been transferred, or not. The data in Table 5 below show that there was no single, outstanding perceived impediment to technology transfer from local universities.

All the factors have a mean score within the "middle ground" as previously identified, and the standard deviations are all fairly small, indicating consistency within factor ratings. However, within this muted response profile the two factors flagged as slightly greater impediments are: lack of intellectual property rights (IPR) protection in the China environment, and inadequate VC access. The latter impediment was also highlighted by Wu (2007) in his study of an even more limited observation frame than ours, the industry links of just two universities in Shanghai. Cao et al. (2009) report a parallel frustration from entrepreneurially oriented faculty within key universities, who rue a perceived lack of start-up finance.

Table 5 Factors Constraining Technology Transfer from Universities

Constraint	Mean	Std Dev
Lack of IPR protection	3.19	1.19
Inadequate VC	3.09	1.08
Lack of entrepreneurial innovatory skills	3.00	1.11
Shortage of personnel with relevant skills	2.94	1.02
Lack of internationally competitive innovation	2.81	1.04
University bureaucracy	2.70	1.09
Government policies	2.60	1.18
Other	2.33	1.11

The IPR issue is part of a wider problem of weak enforcement of the legal code in China, even where appropriate legislation does exist. In the follow-up interviews, three laid great stress on the negative influence of what they see as a lack of IPR protection. Respondent Cao noted, "I feel the protection of IPR in China is not very good. That is why we apply for patents in America. In our opinion, if we apply for patents in China, it is very difficult to deal with (consequent) litigation especially implementation when our IPR is pirated."

Mr. Cheng, meanwhile was minded to work round the issue rather than see it as a problem. As he stated, "The protection of the IPR is not good enough but it affects us little, because we mainly sell a service." As for the pirating of their products, several interviewees took a pragmatic view along the lines that China is a big country and if the pirates are smart enough to offload their pirated goods well away (geographically) from the originals little real damage is done!

In summary, approximately 50 percent of interviewees felt there was weak to

poor IPR protection in China but 7 of the 17 (41 percent) thought that fact had a relatively small influence. This is in accordance with widely recorded views of China's legal system adequacy, or lack thereof, see for example Tam (2002).

Five interviewees noted that support from venture capitalists is actually, or should be, very important to aid technology transfer from universities. However, the reality is that venture capitalists are only really interested in larger companies, or looking for projects with higher market returns guaranteed. They tend not to be patient with a long term R&D process and the interviewees generally found it hard, therefore, to get support from venture capitalists. This negative view was encapsulated by Mr Lu: "The banks are only interested in giving me a loan when my business is doing well, but in the early stages, or if I am having difficulties and require capital for developing my business further, they don't really want to know."

Some respondents expressed themselves reluctant to cooperate with universities for technology transfer. The main reason for this was the feeling that Chinese universities tend to be more concerned with academic matters, and normally the products transferred by them are not practical and hence cannot be applied directly in the real commercial world.

The rating of the skilled personnel issue, as a moderate constraint, is again one that one hears widely in China. It is not hard to find people who have passed exams and hence appear qualified; there are lots of universities churning out graduates. The cry is, however, that they often do not know how to think and they lack basic business skills. With these two deficiencies, they are not ideal aids to the entrepreneurial task, especially in smaller firms which have to operate on a lean basis. However, as the next section shows, this same issue was seen by the 53 firms in a more positive light when they were asked a similar question in affirmative form.

5.5 Stimuli to Technology Transfer from Universities (to Software SMEs)

Following on immediately from the final point of the last sub-section, the sample rated the availability of skilled personnel as the most important factor among the set of suggested stimuli which could enhance the process of transferring technology from universities to IT-software SMEs, see Table 6. This apparent contradiction is probably explicable by seeing that the SME owners are looking

for scientists and engineers as well as those "with a business brain." The factor rating in the previous sub-section may focus on the latter while the affirmation here may refer more to the former, who are certainly needed in technology based firms, such as our sample, many with a requirement to develop R&D capability on a regular basis in order to remain competitive.

Table 6 Factors Acting as Stimuli to Technology Transfer from Universities

Stimulus	Mean	Std Dev
Availability of skilled personnel	3.50	1.09
Competition	3.40	1.01
Government policies	3.19	1.02
University networks	3.11	0.87
Entrepreneurial culture in universities	2.94	1.06
Availability of business advice for science park/university based start-up	2.72	0.99
Access to financial & legal advice	2.60	0.95
Other	2.60	0.91

Free market economists would be unsurprised by the appearance of competition as the other highly rated stimulus in this section. Competition fuels both affirmative desire and generates fear of failure, or relative failure. In a hi-tech sector what more obvious than to look to the mass of universities for fresh ideas and talent as means to maintain competitive edge. The comments of Mr Li apply here: "Our competitors are other small or medium sized software companies. I think our advantages are our learning capability and being close to the talent pool, Tongji University…. Learning capability is necessary for a company to survive. Therefore, our resources include the tangible and intangible ones…. To compete successfully, we of course need to enhance innovation. I think what we have to do is to figure out the market trend and develop products accordingly by learning; and this is the priority for us at the moment….. We also have some interaction with some international competitors by utilizing the Tongji University as a platform for doing so." That the talent of Tongji's staff is seen to be a positive factor fits with views expressed in the earlier paper of Zhou and Zhu (2008).

From the perspective of the Chinese government, the less than wholehearted endorsement of business advice in the STIP environment and allied access to specialist financial legal advice would be disappointing because it basically

means their policy is not working very effectively. Perhaps there is some solace for them in the fact of the slightly more positive view of "government policies" in general. Some interviewees liked the regime of incentives such as tax-breaks but not all, as noted previously. There is one important caveat to make related to the perceived success of the STIPs and allied government programmes. When we or others make critical comment based on our empirical work, we cannot say how much worse the overall position would have been in the innovatory achievement of China's economy had the criticised policies not been implemented; we have no reference projection.

One problem regarding the government's activity, as perceived by our SME owners, was that they simply do not believe that government officials know what is required to help to make the market-based element of China's mixed economy work. The view expressed to us during interviews was that bureaucrats do not "...normally investigate and research enterprises' real needs carefully in advance," because they lacked relevant expertise in software to really make informed decisions, see Cao (2009, pp184–185 and 235). In addition, university faculty interrogated by Cao et al. (2009) in their study expressed doubts as to the degree to which commercial pursuits can co-exist with academic ends.

Perhaps unsurprisingly in a country with a governance structure such as China's, the government officials interviewed repeated more or less the expected party line. The government policies in the area under discussion are a key enabler for hi-tech industries such as IT-software and they think they work. The one real concession of weakness came on the IPR issue, where they admitted that firms cannot rely on the law for effective protection of their IPR. The perception of inadequate IPR protection by the sample's entrepreneurs and the endorsement of that view even by government officials is just part of a wider "weakness of the legal system and weak civic accountability" inter alia, see Snell and Tseng (2002, p449).

5.6 Some Linkages for the Sample SMEs

Finally we report some correlation analyses which were conducted, firstly amongst four economic activity variables and secondly between variables measuring government policy impact at the start-up stage of the business and later as it developed. Unfortunately, the data set was not the complete because some of the 53 firms declined to disclose what they thought to be "confidential"

or even competitively sensitive data, although the variables listed below would hardly be seen as "secret" in the UK environment. Because the omissions were varied as between firms, each correlation was based on a slightly different sample size, ranging from 26 to 49.

The four economic activity variables used were: employee number, turnover, growth and R&D input. Considering the most recent year's data collected (2006) there were modestly significant (at the 0.1 to 0.15 level) correlations between employee numbers and both turnover and growth and, more interestingly, a weak relationship (p = 0.178) between growth and R&D. The first two are entirely unsurprising but the R&D finding is more useful showing that those who have already achieved a degree of business growth are seeking to invest for continued success by undertaking R&D spend. When the same analysis was run on aggregate data for several years to 2006, similar results emerged but with slightly higher significance levels.

For the second analysis, significant correlation (p = 0.01) was found between perceived utility of government support policies at the start-up stage and their perceived utility in the later development stage. From a government point of view this suggests that at least the believers continue to believe as their firms develop. Nevertheless, if we link this back to the role of government via STIPs and other similar policies discussed earlier, we see some sort of belief in the Ministry of Science and Technology (MOST) policies but the reasons for corporate buy-in just may not be those planned by Beijing man.

6 Conclusion and Discussion

We can summarise the outcome of our empirical work in three main findings as follow. Chinese software SMEs tended to be reluctant to adopt new technologies from local universities, essentially because there was a lack of common purpose between the parties. Those entrepreneurs, who did undertake such technology transfer, felt the process was badly impeded by lack of available finance (a finding supported by Zhang and Si, 2008), and expressed fears about poor protection of intellectual property rights (IPR) in China. The majority of the sampled SMEs acted opportunistically, taking advantage of the benefits offered under government schemes to earn rapid returns often using extant technologies. Overall, the experience of our sample indicates that it is only to a limited extent that technology is being successfully transferred from universities to the

IT-software SMEs present in China, and entrepreneurial skills are not facilitating such transfers as policy makers would have hoped.

Put another way, a creative nexus of entrepreneurship and technology transfer from local universities in China to its IT-software SMEs for which policy makers hoped has not taken root. Entrepreneurship has yet to play a significant intermediating role to enable technology breakthroughs conceived in China's universities to bear fruit in its IT-software SMEs. The pragmatic explanation for this failure appears to be that many of those firms simply are not trying to affect transfers of technology from their local universities and feel they can find a higher calibre of resource elsewhere, for example relying on themselves for technological developments. We noted above that their reluctance stemmed from "a lack of common purpose between the parties." Those interviewed in the empirical phase of the project saw the residents of their neighbouring universities as rather unworldly in business terms, more interested in theoretical papers than practical developments. It was also noted that there is still in China a lack of entrepreneurially primed, young talent or even young talent with a fair appreciation of the basics of business.

The STIPs, which are intended to be a key element of the government's hi-tech development programme and are proposed to have particular relevance for SMEs, were found to be important but not necessarily in quite the ways anticipated by the bureaucrats. They provide a useful home for start-up and early development stage companies, including some FIEs. Residents benefit from the local infrastructure, proximity to universities (but perhaps more as a talent pool than as a source of transferable new technology) and various financial benefits (most especially tax breaks). This conclusion is very significant because it clearly suggests that one of China's key, industry development policies is not working as hoped, even in the well developed and more prosperous East region (see Foster, 2011). This is underlined by the study of Hu et al. (2010). They examined the efficiency, or relative efficiency, since they use a DEA (data envelopment analysis) model, of STIPs across all three of China's designated development regions, using the individual STIP as the unit of analysis. They found that the relative efficiency of the regions is basically East, Central, West which is what one might expect. They claim further that, after taking account of environmental influences, only STIPs in Beijing, Shanghai and Hangzhou can properly be thought efficient. The only caveat to this finding is that as Schminke and Van Biesebroeck (2011, p22) say: "The positive results for in-park locations are in

line with conjecture [elsewhere] that previous evaluations came too early to assess the full potential of technology parks." Their own positive findings are particularly focussed around the idea that, by 2011, technology parks [including STIPs] were tending to have positive results with regard to export performance.

Our findings regarding the initially limited role of universities in inspiring the development of entrepreneurial firms, in the IT-software sector in our case, have a certain resonance with the findings of Zhou and Peng (2008), albeit their study looked at universities as the units of observation rather than extant firms. They note (p.637):

> *As a developing country, China starts from a university-run enterprise model, forming firms within the university. These generally operate in non high-tech mode to gain experience and raise capital, as well as develop research capacity, and then upgrade to a high-tech entrepreneurship mode. A few elite universities will become entrepreneurial universities within 10–20 years.*

Finally, we consider what the foregoing tells us in terms of the conceptual framework set out in Fig.1. Based on our pool of empirical data, it seems clear that the external factors in the framework play a less significant role than the internal factors in driving entrepreneurial action and value creation in technology entrepreneurship in China's IT-software SMEs. That the internal factors were more significant arguably fits, or at least is in no way dissonant with, the position laid out by Petti and Zhang (2011). For, as we have seen: the government's policy was less than effective including the failure of STIPs to deliver in the fashion envisaged by policy makers; funding was perceived by the sample to be inadequate and hard to access; IP protection is still seen as weak in China; and technology developed in the university sector appears not to be being effectively transferred to IT-software SMEs in China.

However, that is not to say that our model is intrinsically ill-conceived, rooted as it was and is in a wide ranging literature. Rather it suggests that policy makers must reflect on how they may act to change affairs so that their policies do operate more effectively as they are implemented. It seems clear that this will include policy makers "training themselves" to be much more commercially aware and helping technology-oriented academics in China's universities to develop business awareness. The action required by civil servants would apply

not only to those at the MOST, but also to those responsible for complementary finance issues.

In terms of further research spinning out of the research reported here, at least four ways forward suggest themselves, although there may well be others. These are:

- Testing the finding of the relative importance of the internal and external factors in our model (See Fig. 1) by reference to further samples in the same sector and comparison with the relative impact within other sectors of China's economy.
- Testing the stability of the conclusion regarding the importance of entrepreneurial skills as facilitators of technology transfer from local universities in China to its IT-software SMEs, in particular the apparent shortfall of individuals imbued with the necessary entrepreneurial spirit and skills. This is again a matter for replicatory studies, including comparison of the IT-software sector with other industrial segments.
- Exploring the role and utility of STIPs for a wider cross section of industry segments thereby further exploring the overall success, or otherwise, of the government policy represented by the development of STIPs (and other hi-tech development zones) in China.
- Further and more detailed exploration of the funding methods available for growth oriented SMEs in China, with a view to making recommendations to the Chinese government beyond the obvious one, already made here, that better development funding sources are required for SMEs with a non-trivial risk profile.

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Appendix

Table A1 Business Activity Statistics for Sample, Year 2006

Year 2006	Mean	Std. Dev.
Employee number	97.04	314.76
Turnover (US$m)	2.337	4.003
Growth rate (%)	122.64	117.84
R&D input (US$k)	246.2	230.1

Table A2 Qualifications Held by Owners at Business Start-Up

	Frequency	Percent
Unknown	6	11.3
BA	4	7.5
BSc	8	15.1
Journal College	1	1.9
MA	4	7.5
MSc	19	35.8
PhD	11	20.8
Total	53	100.0

Table A3 Profiles of the Entrepreneurs Interviewed

Person	Status	Qualifications	Start-up year	Located in STIP or not	Turnover (yuan m, 2006)	No. of Employees (in 2006)
Chen	Chinese	BSc	2002	Y	10.2	45
Chi	Chinese	MSc	2001	Y	17.5	52
Dai	Chinese	BSc	2002	N	8.7	32
Gong	Overseas/ Chinese	MSc	2004	Y	12	15
Wu	Chinese	PhD	2001	N	15	15
Li	Chinese	PhD	2001	Y	(kept confidential)	36
Liu	Chinese	PhD	2006	Y	0.6	8
Liu	Chinese	PhD	2003	N	6.5	40
Lu	Chinese	MBA	2001	Y	60	90
Tan	Overseas/ Chinese	PhD	2005	Y	(still in R&D stage)	20
Cao	Overseas/ Chinese	BA	1995 in USA	Y	80	17
Wang	Chinese	BSc	1999	N	(kept confidential)	33

(*To be continued*)

(*Continued*)

Person	Status	Qualifications	Start-up year	Located in STIP or not	Turnover (yuan m, 2006)	No. of Employees (in 2006)
Xie	Chinese	MBA, MSc	1999	N	60	210
Xue	Chinese	MSc	2005	N	6	97
Yao	Chinese	BA	2005	N	3.5	1
Zhang	Chinese	BSc	2001	Y	93	34
Zhou	Overseas/ Chinese	MSc	2004	Y	20	22
Mean	-	-	-		28.07 ≈ 3.42mUS$	45