Essays on Institutions and Pre-founding Experience: Effects for Technology-Based Entrepreneurs in the US and China

By

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Submitted for the Sloan School of Management in Partial Fulfillment of the Requirements for the Degree of

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Abstract

This dissertation is composed of three essays. I look at the role of two different but critical factors in shaping entrepreneurial outcomes: individual level career history and the institutional context. My work spans two outcomes in particular: individual decisions to choose high-tech entrepreneurial activities and the strategies and outcomes of the entrepreneurial firms that are established.

Following an introductory chapter that overviews the entire dissertation, Chapter Two discusses the use of alumni surveys as a methodology. The first of my three empirical essays is Chapter Three, entitled "*Cutting Your Teeth: Building on the Micro-Foundations for Dynamic Capabilities* with Edward Roberts, and investigates whether prior founding experience improves subsequent start-up firm performance. We draw on two strands of psychological theory – availability and partition dependence – and tie them together with the idea that variation in managers' cognitive representations of the competitive landscape drives differences in firm outcomes. The results of the study are consistent with an account where improved cognitive representations form dynamic capabilities and competitive advantage but appear less consistent with passive inheritance of search routines as a source of dynamic capabilities. We examine performance produced by variation in career experience driving differences in psychological biases.

The second essay, "*Who has 'The Right Stuff'? Human Capital, Entrepreneurship and Institutional Change in China*", examines a model distinguishing barriers to entry from barriers to growth. It exploits a natural experiment to identify effects on individuals at different locations on a talent distribution. The paper asks whether the 1999 Chinese Constitutional amendment increased entrepreneurship among those individuals with higher (or lower) levels of human capital. The type of institutional environment that results in higher quality entrepreneurs is a question that has not been systematically explored previously. I find that the greatest increase in entrepreneurship in the post-2000 institutional development was among individuals at the top of the talent distribution. The findings suggest that entrepreneurship among high quality individuals is driven less by the relaxation of constraints to entry (which are relatively easy to overcome) and more by constraints to firm growth.

The final essay chapter is a cross-country comparison of the MIT and Tsinghua datasets. There are some relatively subtle differences that in combination with the differences in the environment for entrepreneurial firms and the institutional history of China have led to vastly different outcomes for the entrepreneurial firms from MIT and Tsinghua. The shorter time frame in which entrepreneurial activity has been occurring in China resulted in a younger, smaller set of entrepreneurial firms throughout the country. Similarly, the younger age of Tsinghua entrepreneurs contributes to a different mix of idea and team sources (fewer from

work experience) that might also partially explain the differences in firm outcomes. While firm size in terms of employees is roughly similar, the MIT firms are much larger in revenues than the Tsinghua firms. It is clear that the broader environment exerts a strong impact on the outcomes of entrepreneurs, their processes, and their firm outcomes.

Thesis Committee:

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Dedicated to my mother and father to whom I owe my insatiable curiosity and my education. I offer my sincere appreciation. In addition, I dedicate this work to the memory of Anoopa Sharma, a dear friend who inspired many.

Biographical Note

Born in Annapolis, Maryland and raised in Marietta, Ohio, I attended Duke University from 1998 to 2002, receiving a Bachelor's of Science degree. At Duke, with the help of a committee, I designed a personalized curriculum focusing on the biological basis of behavior and integrating pre-med coursework with philosophy of mind and neuroscience. In the fall of 2001, I did a study abroad semester with the School for International Training in North India. In my senior year I won the Duke Start-up Challenge with a biotech company, Sun Dance Genetics, that was meant to help the villagers I met in India with a drought-resistant variety of corn.

Before returning to school at MIT for the doctorate degree, I worked for three years. Two of these years were spent in the Duke-UNC Brain Imaging and Analysis Center working on neuro-imaging and an NIMH-sponsored study of cognition in schizophrenia. This work resulted in two book chapters and a peer-reviewed publication in *Biological Psychiatry.* I worked in the Duke Center for Health Policy for a year, funded by the Robert Wood Johnson Foundation and published multiple book chapters on medical malpractice and the design of programs to boost innovation in vaccines.

While at MIT, I have published in the *Strategic Management Journal (SMJ), Research Policy,* and the *Journal of Economics & Management Strategy (JEMS).* I worked as a teaching assistant for Professors James Utterback and Edward B. Roberts. I was a recipient of the 2007 Ewing Marion Kauffman Foundation Dissertation Fellowship award, for which I am very grateful. In the fall I will join the faculty at Stanford's Management Science and Engineering group as an Assistant Professor.

Acknowledgements

It is said of the process of innovation that to see a little further, one must stand on the shoulders of giants (Isaac Newton, in reference to Robert Hooke and Descartes). Similarly, it is not by the sharpness of my sight that I managed to write this dissertation, but thanks to my advisors on whose shoulders I have been standing.

Coming into the program as a dyed-in-the-wool empiricist, it was only through the persistent efforts of Diane Burton that I slowly began to be able to discover, think about and discuss the more theoretical underpinnings of my research. If for nothing else, I owe her a great debt for this facet of my research, which is still developing. I also owe to Diane's urging and encouragement one of the compliments I hear about my research, which is that I appear to have read broadly across the prior literature. Diane has always urged me to think about the spectrum of (often disjointed) literatures related to the topics I am interested in and how to bridge those communities. This insight has served me very well, especially for the first and third chapters in the dissertation. Walking out of Diane's office after one of our meetings, I was frequently in awe (if not often overwhelmed) at the amount of reading and work she had recommended. She has also urged me more than anyone else to consider my identity as a researcher. While thinking in this way never came easy or painlessly, especially for an early-stage graduate student, I believe it has been extremely valuable for the long run.

Although my training and career in the 'natural' sciences came to an early end, when I first joined MIT, I felt an immediate bond with Fiona Murray as a former chemist and scientist herself. I felt that she knew where I was coming from and in a way she formed an intellectual bridge to the world of social science that I was entering. Through our conversations and as I read her work, I realized the overlap in our interests. Fiona has been tremendously supportive and generous with her time. When I was at crucial stages in formulating my job market paper and various materials, she spent hours talking to me and thinking about my research. This was simultaneous to the time when she was in the final stages of the tenure process and for this generosity I am ever-grateful. Her advice at this stage was especially critical. In addition, Fiona had an incredible ability to see what was often still very cloudy to me in my own research and to help to clarify it in my writing. She did all this while helping me to see the bigger picture and calming my anxieties with a very refreshing sense of humor.

Ed Roberts is both a large part of why I came to MIT and a major part of how I have been able to finish with a strong research agenda and my choice of academic positions. Much of my subsequent academic and intellectual trajectory was shaped by the fact that Ed Roberts took a chance on hiring me as a research assistant. He allowed me to work with him and David Hsu on the MIT Alumni dataset in the summer before I had even begun taking classes at MIT. I knew I was going out on a limb to even ask for this opportunity and I am indebted that Ed took the risk on me. This springboard to get an early start on understanding MIT and on research gave me a leg up in everything that has followed. Ed has been a tireless supporter and mentor over the years. There is no way that I would have been able to survive the four years without his support on many levels. I truly cannot thank him enough for everything that he has done from pointing out where I am failing to understand the real world of entrepreneurship, to access to the Tsinghua and MIT data I have depended on, to reading infinite numbers of drafts and giving feedback quickly, countless meetings and responding to my various emails at 1:00am night after night. I may owe my biggest debt of gratitude to him for years to come.

The legacy of working with this team over the years has been an uncomfortable but very stimulating pressure to consider the questions relevant to real-life phenomena, to develop the theoretical side of my research and to have uncompromising empirical standards. I am sure that no single project has satisfied all three, but the pressure from all sides I believe has stimulated my development as a scholar.

Literally thousands of people have made this dissertation possible (especially if you count all of the people who took the time to fill out my surveys!). While I cannot possibly do justice to all of them in this short space, I would like to point out several who have been particularly instrumental. David Hsu in particular has been a role model and mentor ever since I began the program and I have learned as much from him and his high bar for academic work as I have from anyone at MIT. I also want to thank Josh Lerner, Jim Utterback, Scott Stern, Antoinette Schoar, Pierre Azoulay, Yasheng Huang, Jordan Siegal, and Elena Obukhova who helped advance my thinking through many conversations, reading drafts and commenting on ideas. I'd like to thank Ernie Berndt for introducing me to the colleagues I met at the NBER from whom I have benefited greatly over the years. Mary Tripsas, Toby Stuart, Noam Wasserman, and Lee Fleming have all been very supportive in numerous ways throughout the years. Jeff Furman and several others at the NBER Productivity meetings have been helpful. I thank Yang Delin and Li Zhihua of Tsinghua University for their help in the Tsinghua survey.

I credit Ken Morse (as well as the rest of the MIT Entrepreneurship Center – Jose Pacheco, Audrey Dobek-Bell) for many conversations, allowing me to tag along on Silicon Valley trips, opening up his network of contacts in China, and actually for planting the seed of the idea that led to my job market paper. In an early conversation, I was suggesting several ways to make the resources of the Entrepreneurship Center easier to access for students. To my surprise, Ken didn't hesitate in responding, "No, I want to make it hard for them so that only the good ones can get through." I absolutely hated this response at the time, but I must have continued to turn it over in my mind because the argument in my paper written a couple of years later is strikingly similar. Noubar Afeyan, Doug Cole, Jon McGrath, James Nicholson, Zen Chu, Hanson Gifford and many other Boston-area venture capitalists and entrepreneurs introduced me around, encouraged me in my work and kept me tied to the "real-world." This dissertation could not have been done without the funding of the MIT Entrepreneurship Center and the Ewing Marion Kauffman Foundation, and I gratefully acknowledge their support. Without the support of friends and fellow students, the PhD at MIT would not have been worth doing or even possible to survive. Eun-Suk Lee, Ethan Mollick, Joelle Evans, Sung Joo Bae, Phil C. Anderson, Helen Hsi, Theta Aye, Sonali Shah, John-Paul Ferguson, Jason Greenberg, Steve Kahl, Lourdes Sosa, Nico Lacetera, Kevin Boudreau, Ramana Nanda, Rodrigo Canales, Jialan Wang and especially Yanbo Wang and Lynn Wu are the ones who made the experience not only bearable, but enjoyable as well. I thank Yanbo Wang in particular for his patience in guiding me through the complexities of and introducing me to China. All of these friends read numerous early drafts and gave invaluable advice and criticism as well as many laughs and the sense that someone else understands what it's like. My graduate student friends at other universities as well have been a source of support and of great fun, particularly Emily Cox, Noah Eisenkraft, Mike Roach, Henry Sauermann, Sylvain Bureau, Stine Grodal, Rory McDonald, and Jie Yang. I thank Wesley Cohen, Michael Lenox, Janet Bercovitz, Craig Fox and Scott Rockart for convincing me that getting a Ph.D. in a business school was not only a worthwhile activity to undertake, but also a good deal of fun.

I would never have made it through the process without the help of Sharon Cayley, who helped not only make sure that I made every deadline (and some that I didn't) but with support in many other ways as well. I'd also like to thank Keira Horowitz and Gayle Noble for their help and Pam Liu.

Finally, I thank my parents. I credit much of my academic success to my mother reading to me from a very young age and encouraging my love of books and of science. My parents have been very supportive, particularly in encouraging me to think for myself and to believe that I can do whatever I choose to do. These gifts are priceless, both in research and in life. I thank them for their love.

Chapter One:

Introduction

The process of commercializing innovation through technology entrepreneurship is complex and multi-faceted. My research is motivated by the current and future economic importance of high tech entrepreneurs. The universities, regions, and nations that gain an advantage in understanding and educating their young people about the process of high tech entrepreneurship will have an enduring leg up in terms of technological progress, economic growth and quality of life. The importance of high tech entrepreneurs will only increase as competition for innovation and economic growth increases. I stand on the shoulders of many in terms of the attention that human capital, work history and institutions have received. Yet there are still gaps in understanding the various mechanisms by which these factors impact entrepreneurial outcomes. While the field has made important progress, unanswered questions remain, particularly those that may help policymakers and entrepreneurs understand causal relationships. My work focuses on the role of two different but critical factors in shaping entrepreneurial outcomes: individual level career history and the institutional context. The research I am engaged in spans two outcomes in particular: individual decisions to choose high-tech entrepreneurial activities and the strategies and outcomes of the entrepreneurial firms they establish.

This dissertation is composed of three independent essays that examine various aspects of high tech entrepreneurship. The common thread throughout my dissertation research is that it essentially examines three specific mechanisms through which we may see a relationship between pre-founding experience and entrepreneurship. First, entrepreneurs may benefit from

the cognitive frameworks or skills gained during a previous start-up and may therefore experience higher performance in the next firm that they start. Second, the institutional environment may shape the types of individuals who decide to engage in entrepreneurship. Third, my comparative study of MIT and Tsinghua entrepreneurs and their firms reveals that much is similar in terms of the characteristics of the entrepreneurs and their start-up process factors. Nonetheless, some relatively subtle differences, in combination with the differences in the environment for entrepreneurial firms and the institutional history of China, have led to vastly different outcomes for the entrepreneurial firms from MIT and Tsinghua.

In Chapter 2, I discuss the use of alumni surveys as a methodology for creating entrepreneurship databases and review important aspects of the two primary surveys used in this dissertation, those of MIT and Tsinghua alumni. In Chapter 3, Edward Roberts and I look at evidence for a model where multi-functional experience (in this case, founding a firm) results in a more accurate cognitive map of the industry. This paper investigates whether prior founding experience improves subsequent start-up firm performance via more accurate mental models of the industry landscape. Distinguishing the effects of higher ability individuals selecting into serial entrepreneurship from this more nuanced story requires detailed data on each firm started by an entrepreneur, regardless of its success or venture capital funding. I exploit such data from the MIT Founder's Survey (Hsu, Roberts, Eesley 2007) to analyze multiple measures of performance with (and without) individual fixed effects as a control for underlying individual-level factors such as skill or persistence. While not definitive (micro-level data on mental models would provide direct evidence but is difficult to obtain), the results provide tentative evidence consistent with our model.

Chapter 4 forms a transition to the remaining chapters by recounting the history of China's development and reforms since 1978 that are specifically related to entrepreneurship. Next, I discuss some of the theoretical frameworks that have been useful in international research. The challenges faced by entrepreneurs are particularly salient in developing countries yet we know much less about high tech entrepreneurship outside of the United States and Europe. There is an increasing focus on international research and exciting results can be expected from the novel theoretical issues which data on entrepreneurship in other countries uniquely enlighten.

Chapter 5 examines a model distinguishing barriers to entry from barriers to growth. It exploits a natural experiment to identify effects on individuals at different locations on a talent distribution. The paper asks whether the 1999 Chinese Constitutional amendment increased entrepreneurship among those individuals with higher (or lower) levels of human capital. The type of institutional environment that results in higher quality entrepreneurs is a question that has not been systematically explored. The results have implications for our theoretical understanding of the interplay of institutional and individual factors in entrepreneurship, as well as important policy implications given the desire of governments to encourage high impact technology entrepreneurship.

The final chapter compares the MIT and Tsinghua data on founders and their entrepreneurial outcomes. We find that much is similar in terms of the characteristics of entrepreneurs and the start-up process factors between the MIT and Tsinghua alumni. Nonetheless, there are some relatively subtle differences that in combination with the differences in the environment for entrepreneurial firms and the institutional history of China have led to vastly different outcomes for the entrepreneurial firms from MIT and Tsinghua.

The shorter time frame in which entrepreneurial activity has been occurring in China resulted in a younger, smaller set of entrepreneurial firms. Similarly, the younger age of Tsinghua entrepreneurs contributes to a different mix of idea and team sources (fewer from work experience) that might also partially explain the differences in firm outcomes. The mix of funding sources and proportions of firms relying on technological innovation are strikingly similar. While firm size in terms of employees is roughly similar, the MIT firms are much larger in terms of revenues than the Tsinghua firms.

The difficulty in studying the institutional drivers of changes in the distribution of talent drawn into entrepreneurship is two-fold. First, one needs a context with an exogenous change in institutions. Second, obtaining detailed data on human capital levels for a comparable 'at-risk' set of individuals is difficult. For this study, I collected original data through a survey sent to all alumni of Tsinghua University (Beijing), including data on graduates from 1947 to 2007, along with interviews in the People's Republic of China during the summer of 2007. This is the first large scale dataset of technically trained Chinese entrepreneurs and the first alumni survey abroad. To study how different institutional environments may differentially impact the propensity for entrepreneurship among more talented individuals, a differences-in-differences approach is implemented. The data include panel data on income along with detailed work history and educational information.

In conventional analyses, lowering barriers to entry releases pent-up entrepreneurship among those with entrepreneurial ability, but who were previously constrained. My paper argues that reforms lowering barriers to growth encourage those of higher ability to choose entrepreneurship over wage work through an increase in expected returns. I find that the greatest increase in entrepreneurship in the post-2000 institutional development was among

individuals at the top of the talent distribution. The findings suggest that entrepreneurship among high quality individuals is driven less by the relaxation of constraints to entry (which are relatively easy to overcome) and more by relaxation of constraints to firm growth.

Taken as a whole, the essays in this dissertation provide a step away from the prior literature's attempts to define entrepreneurship and its drivers. Instead, I provide a view into the differences between entrepreneurs and evidence that the broader environment, specifically the institutional-level, can play a role in drawing into entrepreneurship those individuals who are more likely to innovate and to perform highly as entrepreneurs. The second chapter identifies a particularly important subset of entrepreneurs, those that have prior start-up experience, and identifies a novel theoretical driver of why they are so important in the economy. The fourth and fifth chapters go into greater detail in how the institutional environment and individual entrepreneurs interact to produce innovative firms.

Besides being important for our theoretical understanding of entrepreneurial decisions and firm heterogeneity in outcomes, the question of what is the optimal training for potential entrepreneurs has great practical importance both for engineering and science students planning entrepreneurial careers and for investors making critical investment and co-founder decisions. My work differs from prior literature in these areas in three ways: 1) by looking more at individual factors; 2) by using natural experiments to disentangle confounding factors; and 3) by examining how the institutional context may alter the links between human capital and entrepreneurship. In general, my research on firm performance examines individual level factors and idea quality effects on entrepreneurial performance. It is unique in distinguishing effects on different stages of performance, disentangling prior founding experience from underlying ability and again in examining different institutional contexts.

The overarching, fundamental questions which drive my research are: What determines the direction (and rate) of innovative activities? and What explains the heterogeneity in the ability of new firms to commercialize breakthroughs in science and technology? Most of the strategy and management of innovation literature on these questions has focused on the rate of innovation and typically in large, established organizations. However, much of the commercialization of breakthrough innovation in new markets occurs through entrepreneurial firms (Roberts 1991). An area that has received some prior attention is the role that human capital and work history play in both the sources of entrepreneurs and in determining their performance (Beckman and Burton, 2008, Beckman, Burton, and O'Reilly, 2007, Burton and Beckman, 2007, Lazear 2004). I am particularly interested in how higher ability individuals may be encouraged to become entrepreneurs by shifts in policy and the institutional environment, and in the strategic direction and performance of their new ventures.

The specific ways in which pre-founding work experience and human capital impact entrepreneurship, and how these mechanisms may be different across countries and institutional contexts, are still far from clear. The types of educational and career experiences that are important for entrepreneurship are still vague in the literature. Besides being important for our theoretical understanding of entrepreneurial decisions and firm heterogeneity in outcomes (Murray 2004, Burton, Sørensen, Beckman 2002), the question of what is the optimal training for potential entrepreneurs has great practical importance both for the students planning entrepreneurial careers and for investors and founders making critical recruiting and co-founder decisions.

Conclusion and Future Research

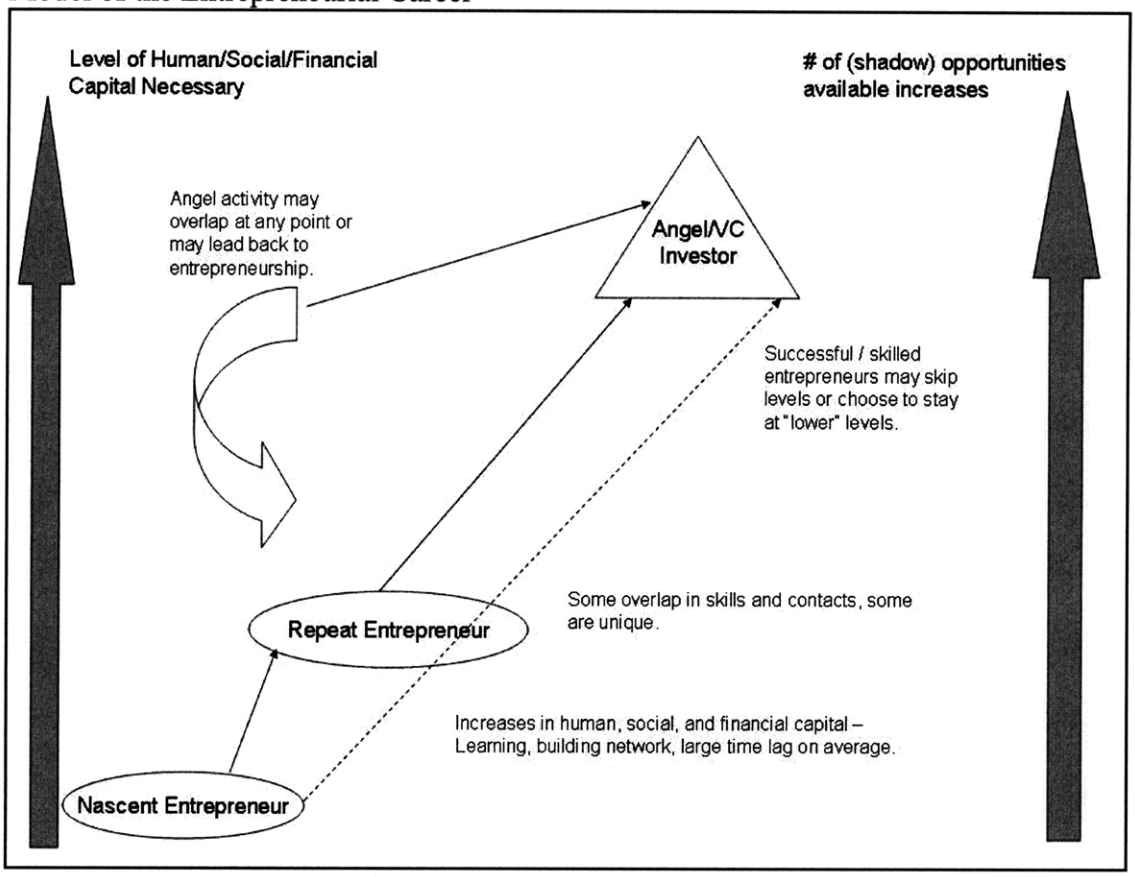
The most important lessons that motivate my dissertation research are two-fold. First, we have only just begun to understand the connections between levels of individual (and team) human capital or ability and the dynamics of firm founding. Entrepreneurs are a very heterogeneous group and yet implications from the current literature are mainly of a one-size-fits-all type. Second, if we hope to better understand the commercialization of innovation via entrepreneurship, we must do better at identifying causal mechanisms, rather than examining correlations where multiple interpretations are possible.

To mitigate the success bias inherent in past research I have used a methodology of unique surveys (of university alumni). The studies comprising this dissertation are not without limitations and frequently they raise more questions than they answer. The research would be of questionable value if it did not stimulate further thinking and areas for future research.

To summarize, I am particularly interested in how individuals may be encouraged to become high tech entrepreneurs by shifts in policy and the institutional environment, and the strategic direction and performance of their new ventures. My future research is motivated by two views: 1) there are fundamental differences in identifying, building and managing a high tech enterprise compared to running established firms or self-employment; and 2) high tech entrepreneurship is becoming a career choice and the entire process is worthy of systematic study. See Figure 1 for a conceptual model where primarily the lower left-hand corner is the only area to have received much scholarly attention. It is my hope that this dissertation contributes to our understanding of the process of creative destruction that drives entrepreneurial success, technological progress and ultimately, economic growth (Schumpeter, 1934).

Figure 1

Model of the Entrepreneurial Career



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Chapter Two:

Alumni surveys as a data collection methodology

Discussion of alumni surveys, their use and limitations[1]

Existing Alumni Survey Datasets

The use of alumni surveys as a data collection methodology for empirical studies of innovation and entrepreneurship is a relatively recent phenomenon. Since limitations of data access have traditionally been a key bottleneck in the progress of systematically understanding the process of the commercialization of new ideas through entrepreneurial firms, it is worthwhile to consider the advantages and disadvantages of this method. By way of introduction, this chapter will first discuss the few existing alumni surveys that have been used to yield insights into entrepreneurship. Through these examples the types of questions that an alumni survey is well-suited to answer become more clear. The following section will use these examples, along with the author's own experience with the Massachusetts Institute of Technology (MIT) alumni survey dataset and in designing and executing the first alumni survey overseas, at Tsinghua University (Beijing, China), to discuss the advantages and disadvantages of the alumni survey methodology. The Tsinghua survey is an interesting example since it was designed to allow comparisons with the MIT survey, but also to be an extension and improvement over that survey using the experience of working with the MIT data. In addition, the Tsinghua survey faced the challenges of needing to be translated and tailored to the Chinese context as the first non-U.S. alumni survey. Finally, along with

[1] We use the term "alumni" throughout to include both male alumni and female alumnae.

providing the survey instruments, I will offer some lessons learned that hopefully provide guidance to others interested in developing their own alumni surveys.

Type of Questions Appropriate for Alumni Surveys

The first formal studies of technology-based entrepreneurship were conducted in the 1960s (Roberts, 2004; 1991), and since then most of the academic literature on research universities examines faculty entrepreneurs, university spin-offs, and technology transfer (e.g., Dahlstrand, 1997; DiGregorio and Shane, 2003; Etzkowitz, 1998; 2003; Nicolaou and Birley, 2003; Vohora et al., 2004). The university's entrepreneurial influence can be seen as extending to its students as well. Far greater than the numbers of new ventures founded by university faculty and staff are those created by alumni who received their technical and/or managerial training and exchanged ideas with faculty while at leading research universities. The role of universities in fostering entrepreneurship via students and alumni still needs much systematic analysis, particularly as related to changes over time (Roberts & Eesley 2009).

It is widely recognized that one of the key institutions in the education of world-class technologists and scientists is the research/technology university. Research universities are important institutions not only for educating technologists but also for providing a setting for students and faculty to exchange ideas on entrepreneurial opportunities. In the U.S., alumni from leading research universities are responsible for numerous new ventures. Not only do professors educate students in the classroom and the lab, but the university also provides a social setting for the exchange of potentially valuable commercial ideas among faculty, students, and external visitors/speakers. Before turning to the MIT and Tsinghua surveys, it may be helpful to look at the other comparable alumni surveys.

Bill Barnett and Stanislov Dobrev (2005) collected a Stanford alumni database by surveying the alumni of the Graduate School of Business in 1997. This survey includes only MBA alumni and they received 5,283 completed (or partially completed) surveys for a response rate of 43 percent.[2] The dataset includes general demographics, career histories, including job changes, the features of previous job positions and the organizations where they were employed. The authors used interpolation where possible to handle missing values and excluded the rest of the surveys. By this method, only 2,692 surveys were complete. The authors examined the distribution of basic demographic characteristics between the full sample and the final sample after excluding missing cases and found no detectable bias. However, it is still unclear whether there is bias between the final sample and the underlying population. Their theory and data distinguish between self-employment and founding a new organization. One advantage of the dataset is the ability to observe a wide range of entrepreneurial firm ages. This wide variance was important for their questions about how demands from the environment and work roles shift as organizations grow and age. The mean firm age was 7.4 years and the mean employee size was 468.

Edward Lazear (2004) also used this dataset to ask whether entrepreneurs tend to be generalists or specialists by matching the data with student transcripts and looking at the pattern of their MBA coursework and career history. Dobrev (2005) also uses these data to ask whether there appears to be evidence for social "flocking" behavior in choosing careers in finance or consulting.

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[2] Lazear (2004) notes that the response rate may have been even higher if one takes into account that some individuals were very old and others may no longer have been alive to receive the surveys. This rate compares well to previous organizational surveys: Kelly and Dobbin (1999) and Dobbin and Sutton (1998) reported 45 percent response rates; Milliken, Martins, and Morgan (1998) reported 18 percent; Lincoln and Kalleberg (1985), 35 percent; and Blau, Falbe, McKinley, and Tracy (1976), 36 percent.

Josh Lerner (2009) used Harvard Business School "class cards" that students complete on matriculation to provide data on 6,000 HBS students and the sections that they are in. The students received a survey at graduation where they were asked to indicate the jobs that they are entering, including entrepreneurship. The authors used these data to determine whether being in a section at HBS with former entrepreneurs influenced the likelihood that graduates would become entrepreneurs in their initial jobs after graduation. They find that having entrepreneurial classmates actually deters potential entrepreneurs, but it appears to be true for those HBS alumni who were most likely to fail had they become entrepreneurs. The results indicate a type of screening mechanism for bad business ideas.

Finally, Ron Burt (2001) collected a survey of women alumni of the Chicago GSB in 2000. Eight hundred alumni responded to the survey and the authors used both a second-wave non-respondent survey of 1,000 non-respondents and the school's alumnae database to check for non-response bias. The only bias detected was that women no longer in the labor market (retirees and housewives) were less likely to respond to the survey. Burt uses the survey to ask questions about how women use their personal and professional networks.

MIT Survey

In 2001, MIT administered a survey to all 105,928 alumni. The alumni could complete the survey online or return the hardcopy version. Most respondents (85.96%) completed the web version of the survey. This survey generated 43,668 responses. The 7,798 alumni who had indicated that they had founded a company were sent a survey in 2003 and 2,111 founders completed that more detailed survey, representing a response rate of 25.6%.[3] The survey

[3] Table 7 in Chapter 6 shows *t*-tests of the null hypothesis that the average (observed) characteristics of the responders and non-responders are the same statistically, for both the 2001 and 2003 surveys.

packet included a personalized letter, signed by the MIT President, the questionnaire, and a postage-paid envelope with address labels. Examining the firm names and founding years, we identified and dropped 44 duplicate observations where multiple cofounders reported on the same firm. Industries covered include aerospace, architecture, biomedical, chemicals, consumer products, consulting, electronics, energy, finance, law, machine tools, publishing, software, telecommunications, other services, as well as other manufacturing. Each founder reported information on up to five firms which he or she had founded up to the date of the survey, yielding a total of 3,698 firm observations. Further details of the survey and descriptive statistics are included in Chapters 3 and 6. Copies of the survey instrument are included in the Appendix.

This dataset has been reported on previously (Roberts and Eesley, 2009; Hsu, Roberts, Eesley 2007). Hsu, Roberts and Eesley (2007) analyze major patterns and trends in entrepreneurship among technology-based university alumni since the 1930s by asking two related research questions: (1) Who enters entrepreneurship, and has this changed over time? and (2) How does the rate of entrepreneurship vary with changes in the entrepreneurial business environment? The findings are based on merging the datasets joining MIT alumni and founder information from the 2001 and 2003 surveys (by matching anonymous ID numbers). New company formation rates by MIT alumni have grown dramatically over seven decades, and the median age of first time entrepreneurs has gradually declined from about age 40 (1950s) to about age 30 (1990s). Women alumnae lag their male counterparts in the rate at which they become entrepreneurs, and alumni who are not U.S. citizens enter entrepreneurship at different (usually higher) rates relative to their American classmates. New venture foundings over time are found to correlate with measures of the changing external entrepreneurial and business

environment. Details of the survey respondents and additional descriptive data and empirical results are provided in the following chapter as well as Chapter 6. Roberts and Eesley (2009) use these data as well to examine the role of MIT alumni entrepreneurs in the U.S. economy, the types of companies MIT alumni create and the MIT entrepreneurial ecosystem that has contributed to these outcomes.

Tsinghua Survey

Visiting MIT Sloan on a Fullbright scholarship, Professor Delin Yang of the School of Economics and Management at Tsinghua University was informed about the research generated out of the MIT alumni survey. When invited, he responded enthusiastically about doing a similar survey with Tsinghua University and served as the connection to the Tsinghua Alumni Association. He gained approval and support from them and from the President's office at Tsinghua to implement an alumni survey there.

I took the MIT survey as an initial template and created the initial draft of the Tsinghua survey so that there would be some overlap for comparison between the two surveys. Next, MIT Sloan doctoral student Yanbo Wang and I expanded the Tsinghua survey to include new questions and to tailor it more to the Chinese context. Delin Yang and Yanbo Wang translated the survey into Mandarin Chinese and then the survey was translated back into English by a separate person to verify the translation. The survey was pre-tested with 50 individuals (non-Tsinghua alumni) and found to take too long to complete. We shortened the survey before having the final version printed and entered into the online survey software.

The survey was sent to all Tsinghua University alumni who had an address on record (a total of 30,000 according to the alumni association). Like the MIT dataset, the Tsinghua dataset includes alumni across all schools at Tsinghua. The respondents could mail back the

paper copy or complete the survey online. A total of 48.6% of the Tsinghua respondents completed the web version of the survey and the rest sent back the hardcopy. In the initial section, completed by all alumni, a question was asked about participation in founding a firm. Specifically, alumni were asked if they participated in founding a company, "where founding indicates that you were present at the start of the company and other founders would consider you a co-founder." We also asked about privatizing a state-owned enterprise since this is also considered to be "entrepreneurship" in China. Those responding positively to either question were asked to fill out the Tsinghua Founders Survey section. We also asked a question about whether the individual had gone overseas to work or go to school. Those who responded positively to that question were directed to fill out the "Returnee" section of the survey. The survey packet included a personalized letter, signed by the Tsinghua University President, the questionnaire, and a postage-paid envelope with address labels. A total of 2,966 surveys have been received online and via paper and email (including 718 entrepreneurs).[4] Of the 2,966, we eliminate (for certain analyses) the 144 alumni who responded from outside of China since changes in policies in China should have less effect on them. The response rate is on the low side.[5] Fortunately, we have some data on non-respondents to the Founder's survey and can use these data to test for differences in observables between respondents and non-respondents to reduce the concern for bias. This will be described in more detail below.

We asked 45 questions about prior firm founding history and the entrepreneur's most recent start-up including: revenues, industry category, work experience, relationships among

[4] The results include 963 alumni responses received via the online survey and 2,003 responses received via email or hardcopy.

[5] Organizational surveys often have low response rates, particularly those of top management members. While low responses rates can introduce bias, we examine specifically whether there is systematic bias in respondent characteristics (Tomaskovic-Devey, Leiter, & Thompson, 1994). Response rates to surveys of managers in China have been in the 30-40 percent range (Peng & Luo, 2000; Tan & Litschert, 1994). In the U.S., response rates for entrepreneur surveys are often lower than those for managers.

the cofounders, sources of entrepreneurial ideas, timing and sources of financing events, commercialization strategy changes, causes of failure, exit routes, revenues and number of employees.[6] This survey was used for Chapter 5 of this dissertation to ask how the institutional environment affects the types of individuals becoming entrepreneurs.

The previous alumni entrepreneurship surveys have primarily been used to ask questions about the factors that lead certain individuals and not others to become entrepreneurs. These factors have included their educational and work history as well as their social networks and the institutional environment they exist in.

Asking questions about the individual choice to become an entrepreneur is natural for an alumni survey since the question requires data on individuals at risk of becoming entrepreneurs. New firm foundings are rare events, making sampling from the population at large difficult and expensive. Sampling from a university alumni population that is likely to experience entrepreneurship limits the generalizability, but improves the odds of obtaining unbiased data in sufficient sample sizes to make inferences.

University Entrepreneurship

There is a large literature on university entrepreneurship, defined in the more narrow sense above to include only faculty or technology from a particular university rather than the entrepreneurial alumni. Anne Miner and colleagues (2006) on have a recent review of the

[6] In addition to the survey data, the Tsinghua data includes extensive notes from interviews with 42 people (including entrepreneurs, investors, and government officials). The interviews included 26 Tsinghua alumni entrepreneurs, 2 Tsinghua staff (TLO, Science Park), 5 Chinese venture capitalists (VCs), 2 Government officials, 3 Other Chinese entrepreneurs (non-Tsinghua), 2 MIT Alumni (non-entrepreneurs), and 2 Tsinghua alumni (non-entrepreneurs). Unfortunately the interview selection procedure could not be randomized. The Tsinghua Alumni Association set up interviews for us and we specifically asked to talk with high-tech entrepreneurs and some who were not successful. Undoubtedly our interview population is weighted towards more successful entrepreneurs and those whose ventures are more high-tech than the average alumni. In addition, the majority of our interviews were in Beijing, though some were in Shanghai and Xi'an as well.

research on "university linked start-ups". There are also a few alumni surveys that have not asked about entrepreneurship specifically, but have asked typically about career histories. There is a tradition of using this methodology to ask other questions.

Advantages and Disadvantages

A survey of alumni has the advantage of being a well-defined population, not selected based on success in entrepreneurship or in traditional employment. Such a survey allows us at least six key advantages over existing datasets. First is the long time horizon in terms of many decades of graduates. The second advantage is having the control over the survey instrument to include measures not available in existing public datasets such as Census data (in our case, this included multiple measures of whether the firm was using an innovation strategy) and third is less success bias than existing datasets which include only firms that have survived, chosen an initial public offering of stock or received venture capital funding. The fourth advantage is having a well-defined, relatively homogeneous set of individuals at risk of entrepreneurship to ask questions about what leads individuals to entrepreneurship. Next, an alumni survey has the advantage of surveying a population with ties to a particular university and that bond is likely to encourage higher response rates than a more anonymous survey. Finally, the alumni survey can be an effective tool for generating data on entrepreneurship outside of the United States or in developing economies. In some cases, it would also provide access to pre-entrepreneurship measures of performance such as grades or honors received from the university.

The number of decades of graduation years covered by an alumni survey results in a very large number of observations and the ability to examine trends over time in education, career histories and entrepreneurship. The MIT and Tsinghua surveys resulted in respondents who graduated in the 1930s all the way up to graduates from 2001 (MIT) and 2007 (Tsinghua).

The entrepreneurial alumni founded firms (frequently at a lag after graduation) but over a similarly large span of decades.

Having control over the survey instrument allows the survey author to tailor not only the independent variables to her/his interests, but also the definition of entrepreneurship. Researchers using existing large scale databases are restricted usually to examining self-employment or defining entrepreneurship as those filing a Schedule C on a U.S. Federal tax return. These very broad definitions blend together doctors and lawyers with their own professional practices with those who have employees and are raising significant external capital for more risky ventures. Alumni surveys allow us to define entrepreneurship more precisely, a feature that is likely to be important if we believe that self-employment differs from what many typically think of as founding a new firm.

Many entrepreneurship studies in the past have been criticized for including only firms that were currently in existence and thus were the firms that had survived. More recent studies have used the Thomson VentureXpert database of firms funded with venture capital. In contrast with these databases, the MIT and Tsinghua alumni surveys resulted in a sample not selected based on entry or successful entry into entrepreneurship. Alumni surveys offer a methodology that suffers to a lesser extent from the survival bias inherent in prior methods. The MIT and Tsinghua surveys (in contrast with VC databases) include a great deal of variety across both industry sectors (spanning service and manufacturing industries) with varying degrees of technological reliance, firm sizes, operating years and outcomes. Using alumni surveys allows us to capture data on the majority of entrepreneurial firms that never attempt or are not successful in raising venture capital funding.

The fact that the respondents to an alumni survey had very similar educational

experiences at a common university allows for some degree of uniformity. This feature is attractive since other methods result in a very heterogeneous sample of individuals and ventures, making meaningful comparisons and analysis more challenging. While such a sample is not necessarily representative of the entire spectrum of self-employment (e.g., Blau, 1987; Carroll and Mosakowski, 1987; Parhankangas and Arenius, 2003), our focus is on the changing nature of entrepreneurship among technically-trained graduates. Responses also can permit comparison between those from the university who followed entrepreneurial paths and those who did not, providing a built-in control group.

Understanding the differences in entrepreneurship associated with premier universities in advanced economies and those in developing economies is important for at least four reasons. First, it informs public policy to understand the relative intensity and types of entrepreneurship. This is important both for policy makers in developing countries as well as those in advanced economies seeing increasing competition on the horizon. Second, international variation helps to inform the debate about underlying drivers of entrepreneurship and the environmental influences on entrepreneurial behavior. Thirdly, differences in country rules, regulations, cultures and histories may well permit analyses of impacts of such differences upon the rate and consequences of entrepreneurial activity. Finally, focusing on entrepreneurial behavior emerging from specific universities helps to inform university administrators regarding relevant factors they may be able to influence to affect entrepreneurship among the students and alumni. However, data on entrepreneurship across countries is rare and has proven difficult to systematically collect.

Drawbacks

The drawbacks of using an alumni survey as a methodology will depend on the precise research question being asked. However, in interpreting the results from alumni surveys, it is

useful to keep in mind three data-related issues: representativeness, response rates and self-reporting. The first issue is the extent to which inferences made from particular alumni datasets apply to entrepreneurship in general. The data for this dissertation come from alumni of very prestigious academic institutions in the US and in China. While what happens to these alumni is of interest in itself because of the stature of these institutions, we should consider the ways in which this particular sample may or may not be representative of the general population if effects on the general population is what the research question is attempting to answer. It is important to note that these are alumni and therefore the sample is not limited to those currently associated with these universities or to technology coming from the universities. While these individuals have all passed through these schools for either an undergraduate and/or graduate degree, they have had diverse experiences before matriculation, while at the university, and since graduation. Therefore, while there is no doubt that individuals in the sample are relatively homogeneous in some respects, they are quite different in others.

We do not claim generalizability across the spectrum of entrepreneurial activity; however, we believe that the Tsinghua and MIT samples represent an interesting and important population of individuals. National samples of entrepreneurship may be more representative of entrepreneurship broadly defined, but probably not of technology-based entrepreneurship. Moreover, comparing national samples of entrepreneurship is challenging, as data sampling strategies vary depending on the subject matter of study (compare, for example studies of self-employment [e.g. (Blau, 1987)] and manufacturing [e.g. (Dunne, Roberts, & Samuelson, 1988)]). With these caveats in mind, we note that there are very few datasets of entrepreneurial activity, especially for technically trained individuals, so in this sense the present study represents a step forward.

A second issue is possible response bias. For example, graduates who started a company but were unsuccessful may well not have reported these failed firms, either by omitting them from their responses or by not participating in the study at all. We also have the same individual reporting on themselves, the firm, and also the firm's performance. Alumni surveys as they have been implemented so far have the disadvantage of collecting data from only one founder. While that founder might offer some information on the other founders, it is preferable in future surveys to ask for contact information for the other founders. The co-founders can then be sent a survey in a second survey wave that would allow the collection of information from them as well as verification of the initial founder's responses. Next, there is the issue of self-reporting. Older respondents, especially those who have started multiple companies, may display a memory bias in which some companies, possibly those which were relatively unsuccessful, are not reported. This may lead to the appearance that younger entrepreneurs are starting more (though less successful) firms on average. Similarly, if cultural attitudes toward entrepreneurship have indeed changed over the years, younger entrepreneurs may have been more likely to respond to the survey and to indicate that they had founded a firm. Older entrepreneurs may also have been less likely to respond to a university survey due to the sheer number of years since their time as a student if such alumni ties weaken over time.

The potential drawback of response bias can be anticipated and addressed both by using methods known to reduce response bias and by assessing response-bias and using statistical approaches (such as weights) to correct for it. One approach to assessing non-response bias involves extrapolation. This method is useful when trying to determine the direction of bias and a survey of non-respondents or archival methods cannot be conducted (Lehman 1963, Donald 1960, Pace 1939, Rogelberg, Luong). It rests on the assumption that individuals who

respond less readily resemble non-respondents, so a common method is comparing characteristics of respondents who answered quickly with those who answered following a reminder or stimulus at a later time. Response bias is explored more systematically for the MIT and Tsinghua surveys in Chapter 6.

We have already seen from the existing examples of alumni surveys that this method is often used to ask questions about career dynamics. One drawback of this methodology is in testing theories of career dynamics that operating through social exchange or population ecology. In this case, there is a need to balance between the necessity of collecting complete population data to account for both "leaders" and "followers" in social processes and the time and expense required to gather such data (Dobrev, 2005). If the alumni sample is truly representative of the underlying alumni population on all dimensions that are of theoretical importance, then this is less of an issue.

Although one limitation of alumni survey data is that it is typically cross-sectional in the sense of coming from a survey given at one point in time, on the other hand our MIT and Tsinghua respondents graduated from the university and founded companies over an impressive span of time. There is also no reason why alumni surveys could not be performed annually to form a panel data structure, with the caveat that there may be selection issues in terms of who elects to stay in the survey for multiple years.

Finally, alumni survey data balances these drawbacks with the strong advantage of generating a representative sample of alumni not selected based on entry (or successful entry) into entrepreneurship. The university alumni sampling methodology imposes some desirable homogeneity on certain dimensions, such as levels of human and social capital relative to more general but more heterogeneous samples of entrepreneurs. However, there may be a trade-off between the higher rates of occurrence of entrepreneurial events in certain alumni populations

and sufficient variation in certain social attributes of individuals. The extent that this drawback is a concern will depend on the specific research questions, the alumni sample, and the social attributes being hypothesized about.

One final difficulty common to alumni surveys that can be dealt with but should be anticipated is that there is temporal right-censoring in that we cannot know who of the more recent graduates will become entrepreneurs (or repeat entrepreneurs if we are examining that) or how their firms will perform at later stages of their existence. This right-side censoring is especially an issue given the frequently long lag from graduation to first firm founding, as well as the potential long lives of the new companies that are founded. Similar difficulties are encountered with research on insurance and medical malpractice where there is a long lag between an event and the resolution of a court case. We use statistical methods in the regression analyses to adjust our estimates for this right-censoring.

Lessons Learned

The design and implementation of the Tsinghua survey is an improvement and extension of the MIT survey. Many lessons were learned through the experience of the MIT alumni survey that were incorporated into the Tsinghua survey. Further lessons were learned from the extension of the alumni survey methodology into the international context with Tsinghua University. The Tsinghua dataset is one of the first systematic large-scale records of high-tech entrepreneurial activity in China.

The MIT alumni founder dataset was designed and executed before my arrival at MIT by a committee that included staff of the MIT Alumni Association, their consultant who was an economic geographer, Professor Edward B. Roberts and David Hsu (who at the time was a post-doc at MIT Sloan). The fact that such a large group with diverse interests was designing

the survey led to some difficulties and frustrations from a research point of view. A size constraint that was imposed on the survey instrument forced the omission of many questions preferred by the academic researchers. The Tsinghua survey improved on this dimension since we had complete control over the survey design. The MIT survey was also performed in two waves while the decision was made to conduct the Tsinghua survey in a single wave. The advantage to first surveying all alumni and then sending a separate survey to founders is that the overall size of the initial survey instrument is reduced, providing a higher response rate. The disadvantage is that there is a large drop-off in respondents between the first and second waves.

After beginning to work with both the MIT and Tsinghua datasets, it has become apparent that we lack data that the literature has presented as important. For example, we do not have parental or family background information, including parental careers, religion or wealth. We do not have good measures of the skills or variety of roles played by the alumni prior to their becoming entrepreneurs. We also lack information on cognitive characteristics of the entrepreneurs, opportunity costs they might have perceived in becoming entrepreneurs, and information on their motivations in starting their firms. These deficiencies constrain our areas of current analyses while providing good opportunities for future research direction. For the present dissertation chapters, we regard these factors as unobserved, and to the extent that they are randomly distributed between founders and non-founders, the regression estimates are consistent. There is an inherent trade-off, common to all survey methodologies between asking more questions, thus lengthening the survey, and obtaining a higher response rate.

The experience of designing and implementing the Tsinghua survey also resulted in lessons on doing alumni surveys in an international context.

Comparison with other methods of generating entrepreneurship databases

The other methods for generating entrepreneurship databases have tended to rely on surveying existing small or young firms, leading to survivorship bias, or utilizing secondary data sources such as the U.S. Census, the Longitudinal Business Database, or the Dun & Bradstreet database of private firms. These large-scale databases have an advantage in being generally representative and having a large number of observations. However, they typically define entrepreneurship as self-employment.

The Global Entrepreneurship Monitor used adult population surveys in one of the only cross-national surveys of entrepreneurship. However, the GEM survey used "the widest possible definition of entrepreneurship" and has been faulted for the varying implementation of the surveys differing across countries.

The Dun & Bradstreet database has been used for entrepreneurship since it is one of the only public databases covering private firms. However, it gives little information on the founding team or the entrepreneurial process. The Kauffman Firm Survey (KFS) used the Dun & Bradstreet database as a sampling frame to conduct yearly waves of surveys to ask much more detailed questions about the founders and their ventures. This is an exciting database that should yield answers to many questions in the coming years. The KFS screened 32,500 sampled businesses (the response rate was 43%) to identify 4,930 eligible new businesses which have been followed up with to form a unique panel dataset (Ballou et al, 2007; Barton and DesRoches, 2007).

The Stanford Project on Emerging Companies (SPEC) sampled by firm, not founder (e.g., Baron, Burton and Hannan, 1996). The sampling criteria were that the firm was founded between 1983-1995 and had at least 10 employees at the time of the interview. Due to this size

constraint, they have a success-biased sample, however the data have been useful in multiple studies that have asked questions about the relationship between the founding team, work history, and new firm fundraising or outcomes such as an initial public offering.

No research methodology is perfect and each has its own advantages and drawbacks. Thus, it is important to choose the correct methodology for the question being asked. Until now, alumni surveys as a methodology to ask questions about the transition from employee to entrepreneur and about the entrepreneurial process have been a growing research approach that is likely to continue in the coming years. Alumni surveys offer several attractive properties, including the ability to relatively cheaply and systematically gather entrepreneurship databases both in the U.S. and abroad.

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Chapter Three:

Cutting Your Teeth: Building on the Micro-Foundations for Dynamic Capabilities

(with Edward B. Roberts)

Why do some firms outperform others over significant periods of time? Evidence appears to contradict the predictions of economic theory that over time, competition and imitation will eliminate differences between firms. The question of why firms are different from one another and what differences are relevant for competition has puzzled researchers. Extending earlier efforts to disaggregate the influence on business-unit profits of industry, corporate-parent and market share effects, scholars have examined the influence of firm-level effects (Schmalensee, 1985). Examining lower levels of analysis shows that industry-level effects are approximately half as important as business effects in determining business-unit profits (Rumelt, 1991, McGahan and Porter, 1997). Yet, with the exception of work on top management teams and entrepreneurship, much less work has looked at the influence of even lower levels of analysis (including individuals) on performance (Higgins and Gulati, 2006, Johnson, 2007, Mollick, 2008). Why do some firms outperform others even when in the same industry? Specifically, we extend the microfoundations of strategy (Gavetti, 2005) and seek to answer the question: When organizations are putting together new bundles of routines and capabilities, what determines who puts together the more valuable and difficult to imitate bundles?

Resource-Based View and Evolutionary Theory

The resource-based view (RBV) of the firm has been a central theoretical framework for explaining heterogeneity in firm performance. Differences between firms in the resources and capabilities they have gathered through superior information or luck generate differences in

firm performance (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984). Competitive advantage is sustained to the extent that competitors can be prohibited from replicating or substituting for the key valuable resources. Other scholars have put forth specific isolating mechanisms such as path dependence, social complexity, causal ambiguity and firm specificity that keep resources from being easily imitated (Rumelt, 1991, Hatch and Dyer, 2004, Dierickx and Cool, 1989, Lippman and Rumelt, 1982). Scholars have begun to theorize more explicitly about dynamic processes that allow some firms to produce more valuable combinations of resources. Much of this literature has revolved around the concept of dynamic capabilities and typically refers to a firm's coordinating and combining processes that allow it to reconfigure its competencies or bundles of routines and resources to better fit changing environments (Teece, Pisano and Shuen, 1997).

Drawing on evolutionary economics, the existing conceptions of the sources of dynamic capabilities have been guided by relatively passive, inertial mechanisms of incremental, local search. The main conceptual framework that has guided work in the literature is variation, selection, and retention of higher order routines that guide local search processes for more valuable bundles of capabilities and resources. Less is known about how managers may actively choose which bundles will be more valuable than others. Similarly, we lack a theory for why the managers of firms become motivated to change the bundles of routines and capabilities in certain ways and for how they know in what directions to change them. Zott (2003) develops theoretical propositions that local search drive choices between imitation and experimentation that result in differences in timing of implementation, costs of deployment, and learning (resource deployment costs decreasing over time). While this moves our understanding forward, we still lack a psychological foundation for identifying where

differences arise in cognition or beliefs about the future value of routines, resources or capabilities. As Gavetti (2005) points out, routine-based theories of managerial behavior have long been thought by scholars to be entwined with more cognitive logics (March and Simon, 1958, March and Olsen, 1976). We build on the theoretical framework for the psychological foundations of capabilities' development laid out around cognition by extending the theory to propose mechanisms by which differences in cognition emerge. We then empirically test whether these differences result in performance differences among firms (Gavetti and Rivkin, 2007, Gavetti, 2005). Prior work has shown that individuals with firm-specific human capital can be a source of competitive advantage (Hatch and Dyer, 2004). Our contribution is to use psychological foundations to show how even industry-specific (not firm-specific) representations embedded in individuals can function as a difficult to imitate dynamic capability, guiding firms to build competitive advantages.

This paper addresses the gap in our understanding of the sources of dynamic capabilities by conceptually linking the individual and firm levels. Extending the line of work that recognizes that strategy exists in managers' minds and arises from their cognitive theories about the world (Gavetti and Rivkin, 2007, Huff and Jenkins, 2002, Porac, Thomas and Baden-Fuller, 1989), we suggest a novel mechanism through which dynamic capability arises from improved cognitive maps of the industry landscape. We assert that improved cognitive maps of industry trends and causal relationships come from specific types of industry experience and guide the recombination of resources, routines and capabilities. We respond to calls in the literature for a research agenda to build the behavioral foundations of our understanding of the causal mechanisms driving the evolution of capabilities as well as the sources of inertia that dynamic capabilities are meant to overcome (Gavetti 2005).

Theory: Evolutionary Theory and Bounded Rationality

When organizations are in the act of assembling new bundles of routines and capabilities, what determines who puts together the more valuable and difficult to imitate bundles? Is it passively inheriting better local search routines/processes or is it actively finding more valuable bundles through more accurate cognitive maps of the competitive environment? The recognition that an impossibly large set of information about the world is required for a strictly rational conception of the decision making process led to the concept of bounded rationality to label this constraint on individuals (Simon, 1955). Two research streams emerged around mechanisms for dealing with the constraint of bounded rationality. One emphasized a history-dependent, experiential route of discovery, specialization via local search and the development of stable routines (Herriott, Levinthal and March, 1985). However, some scholars began to point out important limitations and difficulties arising from local search experience (Gavetti and Levinthal 2000, Levinthal & March, 1993). Instead, they emphasized an approach considering the imperfect cognitive representations that limit the link between choices and intended consequences. Studies exploring various decision biases have been numerous (Camerer, 1995, Nisbett and Ross, 1980, Tversky and Kahneman, 1992, Kahneman and Lovallo, 1993, Kahneman and Tversky, 1979, Kahneman, Slovic and Tversky, 1982, Fox and Hadar, 2006). Managers face numerous biases as they attempt to understand the competitive environment and its trends in enough detail to search for an effective strategy and cluster of resources that will provide competitive advantage (Gavetti and Rivkin, 2007). Representations have been identified by prior research as important in shaping decision making as well as focus and interpretation (Huff and Jenkins, 2002, Fiol and Huff, 1992, Walsh, 1995, Simon, 1991, Weick, 1995, Narduzzo, Rocco and Warglien, 2000). The idea that CEOs and members of the

top management team have variation in the complexity of their "cognitive maps" of the industry is not new to the literature (Calori, Johnson and Sarnin, 1994). We extend and build on prior research that has suggested that differences in managerial cognition lead to variation in strategic decisions (Tripsas and Gavetti, 2000, Adner and Helfat, 2003, Holbrook, et al., 2000). The current paper responds to calls in the literature recognizing the need to integrate psychological theory and the determinants of less biased representations under the cognitive foundations of dynamic capabilities.

Gavetti and Rivkin (2007) examine the choice of search mechanism by managers and theorize that the use of specific choice mechanisms is driven by environmental ambiguity (reduced with industry maturity) and firm inertia (increased with firm age). However, less attention has been devoted to the psychological biases and determinants of finding more valuable clusters of resources and capabilities within specific search strategies. Within cognitive search, what mechanisms lead to more accurate representations of the competitive environment and accumulation of more valuable capabilities? Gavetti (2005) further develops cognition as a micro-foundation for the development of capabilities by delineating a model where managers' cognitive representations of their environment drive organizational search and capability development. He examines the role of the location of an individual within an organizational hierarchy and theorizes that action generates information which contains signals about the environment and the relationships between actions and outcomes. These signals are then passed up the hierarchy and depending on the divisional structure and the similarity in product lines, individuals at the top or bottom of the hierarchy may develop more accurate cognitive representations. More accurate representations help guide the organizational search for more valuable combinations of capabilities.

Psychological Theory and Competitive Advantage

In addition to the location in an organizational hierarchy, other factors are likely to either bias cognitive representations or yield more accurate ones and more profitable combinations of capabilities. Psychological theory offers several alternative mechanisms that help to build our understanding of how to integrate individual-level psychological factors with firm-level dynamic capabilities and competitive advantage. Cognitive representations can be thought of in terms of NK models where sets of decisions correspond to different performance levels or peaks (Gavetti and Levinthal, 2000). They can also be thought of in terms of the subjective probabilities that individuals give to various events or the relationships between actions and the likelihood of specific outcomes. These representations can be inaccurate or overly simplified in several ways.

First, we know from work on availability heuristics that instances that can be easily recalled or scenarios that can be constructed with ease tend to bias the judged probabilities of such events upward from reality (Tversky and Kahneman, 1973). People with less domain knowledge tend to rely on the ease of recollecting instances, whereas domain experts tend to be biased as well by the number of cases that come to mind (Ofir, 2000). Either way, the bias produced is in the same direction and has been found in multiple studies (Ofir, 2000, Fischhoff, Slovic and Lichtenstein, 1978, Russo and Kolzow, 1994, Dubé-Rioux and Russo, 1988, van der Pligt, J., Eiser and Speark, 1987). The availability heuristic has been used to explain the "pruning bias" where individuals are given a set of categories containing reasons why, for instance, a car might fail to start (or why a business might go bankrupt). When the researchers "prune" categories and absorb them into the residual category, respondents appear to distribute the probability from the pruned categories across the remaining ones rather than add it to the

residual category. Pruning bias can also be explained by a different bias known as partition dependence (Fox and Clemen, 2005). Partition dependence is the term given to the phenomenon where assessed probabilities given by individuals for events can vary substantially with the way that the researcher partitions the categories. The phenomenon is similar to framing, the psychological bias where decisions have been shown to be influenced by the way in which alternatives are presented (Tversky and Kahneman, 1986). Psychological theory and research typically attempt to identify universal, generalizable, systematic biases in human decision-making rather than to identify which individuals may be more or less prone to biased perceptions and decisions. Similarly, in theories of dynamic capabilities and resource-based view, no individual has a more accurate cognitive representation of the competitive landscape than anyone else. However, given the prior research in psychology cited above it seems likely that some managers may hold more accurate and/or less biased cognitive maps or sets of subjective probabilities than others. This is particularly true if different demographic characteristics or work experiences lead to less bias in cognitive representations.

Individuals have varied educational and career experiences that may result in more (or less) biased perceptions, representations and thus strategic decisions. A rapidly growing area of literature examines prior career experience (Beckman and Burton, 2008, Boeker, 1989, Haveman and Cohen, 1994, Haveman, 1993, Phillips, 2002). A large section of this work has been interested in the knowledge, aspirations, skills, or routines that employees inherit from their firms (Agarwal, et al., 2004, Ciuchta, et al., 2009). However, employees may gain more than just task knowledge, skills or routines from their firms, they may also acquire cognitive representations of the competitive environment which have varying accuracy. A key question

is whether variation in career experiences might give rise to variation in the extent of the psychological biases that affect perception and decision-making.

Lazear (2004) argues that an important determinant of entrepreneurship is the breadth of an individual's curriculum background and number of different jobs. While the paper argues that leaders and entrepreneurs need a variety of skills, the study raises the question of the mechanism behind the correlations. If those who work for smaller firms are gathering more general skills as a result of taking on broader job responsibilities then this might allow them to identify and execute on more valuable business opportunities (Phillips and Sørensen, 2007, Wagner, 2003, Wagner, 2006).[7] Another interpretation is that more varied job role experiences are a source of diverse perspectives on the industry and more varied sources of signals from the environment.

This benefit from a wide range of functional experiences could be due to the more diverse signals from the competitive environment that the individual receives as much or more than it is due to a diverse set of skills or routines. An individual working on a single functional area may take actions and scan the environment for relationships between those actions and outcomes that form the basis for her beliefs about the competitive environment. Daft and coauthors (1988) have shown that scanning the environment is an important activity for company performance. Recent work experience that is heavily focused in a single, narrow functional domain can result in more focused attention on a subset of the competitive environment (for example, technology, to the neglect of shifting markets). The result is more detailed partitioning of that sub-area while other functional areas of the landscape become less evenly partitioned and detailed in the cognitive representation. The other areas are less

[7] Others have suggested that some individuals may have a taste for variety which drives both varied labor experiences and the pursuit of new business opportunities (Astebro and Thompson, 2007).

available to the mind in search and decision making over what capabilities will result in competitive advantage over time. More detailed partitioning of one sub-area leads to underweighting the probability and importance of constraints and negative events from other functional areas. In this way, strategic search and the bundles of capabilities a manager chooses to develop are likely to be optimized for one domain. The individual for whom cognitive partitions are more detailed in one area and constraints related to that function are more accessible will be resistant to strategic options that may fit constraints elsewhere but are less ideal in the domain where they have years of work experience.

However, for an individual, such as a founder or CEO who has responsibilities and decision rights that span multiple functions, the scope of scanning and monitoring the relationships between actions and outcomes in the industry must be much wider. While depth may be lost, a sense of the landscape of the competitive environment through multiple functional lenses (i.e., marketing, technology, finance, etc.) develops and must be integrated. Work experience that includes responsibilities simultaneously spanning multiple functional areas is particularly important for ongoing competitive advantage. The reason is that for individuals who rotated through functional roles one at a time over multiple years, their cognitive representations of customer trends or relevant technological shifts in the industry are likely to be several years out of date if they held those positions many years in the past. For the purposes of using cognitive maps to search for bundles of resources that will be valuable in the coming years, current beliefs and knowledge of industry trends is necessary. An individual in a position to perceive industry trends and constraints through multiple functional lenses in an up-to-date fashion will have more accurate cognitive representations of trends and a greater likelihood of identifying groups of capabilities that can be developed to profit from those trends.

Similarly, in academic fields, a lay-person can read the most recent scholarly articles, but without actually participating in research, making decisions on projects and getting feedback at conferences, it is difficult to develop a sense for the direction that the field is headed and to anticipate shifts that will be important (Cohen and Levinthal, 1990). Figure 1 represents the linkages.

If communication is imperfect across individuals, then there should be benefits to diverse functional experiences within the same individual rather than across a team. Prior work supports the idea that there are imperfections in communication across groups, incurring process costs that reduce efficiency and group output (Kurtzberg and Amabile, 2001, Steiner, 1972). The idea that individuals and teams with more diverse information may outperform others has not been connected systematically to psychological theories or to differences in mental models (Taylor and Greve, 2006). All else equal (including team size and conflict), teams with more cognitive diversity tend to be more creative and have higher performance (Milliken and Martins, 1996, Chatman, et al., 1998, Jehn, Northcraft and Neale, 1999, Harrison, et al., 2002, Williams and O'Reilly, 1998). When diverse experiences and cognitive approaches are combined in a single individual, the knowledge becomes more integrated. In addition, the coordination and access problems characteristic of teams are not present, yielding higher performance. The counter argument is that the diverse team members are likely to have higher expertise and knowledge in each of their areas of functional diversity. Then, despite the communication effect, overall team benefits might be higher.

Hypothesis 1a: Individuals with more diverse experiences and a greater span of functional decision rights will build more accurate cognitive representations, resulting in assembling more valuable combinations of resources/capabilities.

Simon (1955, 1991) proposed that decision makers should be modeled as bounded rational and as satisficing rather than as strictly rational and maximizing utility. Central to the idea of bounded rationality is the fact that humans have limitations to their memory and reasoning capabilities. Kahneman, Slovic and Tversky (1982), most notably, as well as many others have probed the heuristics and systematic biases that result from dealing with these cognitive limitations. If natural human limitations to cognitive functions such as memory or information processing drive these responses to bounded rationality, then we expect that individuals with greater cognitive capacity should be less constrained. With less of a constraint on information processing, biases and heuristics may not need to be relied on as heavily and more detailed perceptions and less biased cognitive maps would result. These cognitive maps may take the form of subjective beliefs about the probabilities of certain outcomes given specific actions on behalf of the firm. If there is sufficient variation in the population of managers in information processing capacity, then these differences may be large enough to lead to differences in the success rate of strategic search for clusters of capabilities that yield a competitive advantage.[8] Individuals who are less constrained in memory and information processing may take more away from prior experience and build more extensive mental models, allowing them to see more opportunities for how to recombine resources than others. Similarly, Shane (2000) shows how prior knowledge and experience shapes opportunity recognition. Previous work has already shown that subjective probabilities over events and outcomes that are internally inconsistent or poorly calibrated can result from limitations to human memory and information processing capacity (Kahneman, Slovic and Tversky, 1982, Gilovich, Griffin and Kahneman, 2002).

[8] Research on information technology adoption (also a method for improved processing of information) has also shown that IT improves firm productivity, particularly when coupled with organizational changes to take advantage of it (Brynjolfsson, Hitt and Yang, 2002)

Hypothesis 1b: Individuals with higher information processing capacity will build more accurate cognitive representations, resulting in guiding their firms to assemble more valuable combinations of resources/capabilities.

In psychology, a transfer effect is the beneficial impact of a prior event on the performance of a subsequent event (Finkelstein and Haleblian, 2002). The similarity between the characteristics of events influences the probability of positive outcomes from transfer (Argote and Ingram, 2000). The probability of negative outcomes can increase when events are dissimilar yet lessons from prior experience are applied anyway (Finkelstein and Haleblian, 2002). We suggest that a distinct but related mechanism to transfer effects occurs between individual representations and the organizational levels of analysis. Typically transfer effects involve learning a skill in one context but with a loss of performance when the skill is wrongly applied in a different context. However, different from learning specific knowledge or a skill, even if transfer is perfect, cognitive maps honed on one competitive landscape will lead to errors when brought to guide firm strategy in a new landscape. One can have a nearly perfect map of one country but it is of no use in discerning the topography of a different country.

Previous literature argued that an individual can bring transfer effects, perhaps in the form of routines from prior founding experience to the benefit (or detriment) of a new organization's performance, depending on the similarity of industrial contexts (Cohen and Bacdayan, 1994, Zander and Kogut, 1995). As Gavetti and Rivkin (2005) indicate, the problem in the case of forming strategy by analogy is that strategy development requires both a breadth of prior experience (which may not be available) and a good fit between the relevant dimensions of the current, novel situation and the prior situation.[9] Inferences may be misapplied or the wrong inferences may be drawn from the beginning (Finkelstein and

[9] Indeed, Henderson and Clark (1990) argue that if the environment is characterized by demands for innovations in the firm which do not match the organizational architecture of the manager's prior experience, learning by analogy may prove difficult.

Haleblian, 2002). Along these lines, we argue that cognitive representations developed in one context will not aid strategic search in a substantially different context. Furthermore, examining the impact of the similarity of experience will allow us an additional test of whether higher performance for subsequent firms is a result of improved representations or of higher skill levels. Unless higher skill individuals tend to remain in the same industrial context, better performance for those with experience in a similar industry compared to those with prior experience in a different industry supports better cognitive maps as the correct mechanism.

Hypothesis 2a: Individuals who remain in similar contexts will build more accurate cognitive representations, resulting in guiding their firms in assembling more valuable combinations of resources/capabilities.

Whether an event turns out as a success may influence what knowledge about the competitive landscape the individual takes away from a previous experience and how she or he applies that knowledge to future situations (Cyert and March, 1963). Politis (2005) argues that prior experiences of success or failure may condition the mode of learning from experience. Prior success can show a path forward, but it may not spur much additional thought about why the success occurred. McGrath (1999) emphasizes that failure can have positive benefits by increasing the search for new opportunities. Failure can create greater variety in actions as the individual searches for strategies to reduce uncertainty (March, 1991). Starbuck and Hedberg (2001) review the cognitive and behavioral research on how success impacts learning, and identify a number of interesting mechanisms at work. Yet their review shows the difficulty in formulating compelling arguments for success/failure having a straightforward impact on levels of learning. We elect not to hypothesize about failure directly since identifying failure is often difficult. For example, is it a failure to shut down a firm quickly rather than to continue it when a better idea is identified? The literature appears somewhat mixed on whether more knowledge

is gained from success or failure. However, prior arguments have neglected one important mechanism that yields improved cognitive representations from success experience, but not from failure. When an individual experiences significant success others often come to that person to seek their advice or involvement in new opportunities. This is less true for those who have failed. The flow of other individuals proposing new ideas not only increases the number of opportunities examined but may increase the detail and accuracy of representations through a sharp increase in the signals of trends in technology, competitors, and/or markets. It is clear that individuals do learn from failure as well as success and that learning from failure can enhance survival (Kim and Miner, 2007). Yet those who have failed lack this rich source of improvements in their cognitive map that may be more important for identifying new capabilities over and above just surviving.

Hypothesis 2b: Individuals who have experienced success will build more accurate cognitive representations, resulting in guiding their firms in assembling more valuable combinations of resources/capabilities.

If we fail to find support for these hypotheses then it casts doubt on cognitive representations as a source of dynamic capabilities, or at the very least, the theoretical link between multi-functional career experience, representations, and competitive advantage.

Empirical Strategy and Setting

Finding a setting where we can empirically isolate the impact of cognition separately from the inheritance of routines or resources is challenging. Beyond the inherent difficulties in assessing the quality of cognitive representations, attempting to test our hypotheses in a sample of existing large firms would be problematic for several reasons. One is that the original founders who guided the initial conditions and strategic search when inertia was lower may no longer be around to respond to questions. Second, the selection mechanisms may be far from

clear as to which managers are assigned to which projects and how much of the performance of those projects is due to the formal or informal control of managers in specific locations in the hierarchy. Using existing public firms only also introduces survival bias. Finally, transfer of resources or existing capabilities from other business units in the firm makes it challenging to identify the effects that interest us. These challenges mean that no dataset will be ideal along all dimensions; however, a novel survey allows us to make empirical progress, particularly on individual-level data and multiple measures of firm performance where prior work has largely relied on simulation analysis.[10]

The idea of organizational inertia is that elements of the organization are surprisingly resistant to change once established early in the life of the organization (Baron, Hannan and Burton, 1999, Hannan and Freeman, 1984). The closely related idea of imprinting is that both environmental conditions at founding and strategic decisions made by the founders early on are not easily reversible and leave a lasting imprint on the firm's subsequent development (Stinchcombe, 1965, Romanelli, 1989, Romanelli, 1991). For example, it has been shown that subsequent top manager backgrounds and later functional structures can be predicted by the founding team's prior functional experiences and initial organizational functional structures (Beckman, Burton 2008). In addition, the initial incumbents in functional positions appear to imprint those positions in certain ways that are strong enough to condition the likelihood that the subsequent holders of those positions may leave for other firms (Burton and Beckman, 2007). These studies provide evidence that founders bring blueprints or models that then shape the future directions of the firm (Baron, Burton, Hannan 1999). Other evidence shows that

[10] Simulations can be extremely valuable for clarifying theoretical insights yet may lack external validity or generalizability.

resources accrue to individuals and firms based at least partly on the structural positions of their former employers (Burton, Sørensen and Beckman, 2002).

In the model of Gavetti (2005) cognitive representations then guide search mechanisms and become important initial conditions that imprint the future directions of development for the company (Baron, Hannan and Burton, 1999, Stinchcombe, 1965). Furthermore, organizations are known to become less plastic as they age (Hannan and Freeman, 1977) so the cognitive maps available to managers in the beginning stages of developing a new business line or new venture are vital since hiring individuals with higher quality cognitive representations after inertia has set in will have less of a payoff. If more accurate cognitive representations of the competitive landscape function as dynamic capabilities that improve firm performance, then this is a source of competitive advantage which other firms clearly would not be able to imitate. It is impossible for competitors to go back in time and replace the founders with others who had different experiences and beliefs about the competitive landscape.

Data and Methods

At the founding of a new firm, resources are limited and existing firm capabilities are non-existent, allowing us to better isolate the impact of routines and cognition imported via the founders from prior work experience. The founders are a key input at the beginning stages of a firm and other work shows the importance of founders in framing the initial conditions for strategic search (Gavetti and Rivkin, 2007). We argue that the main difference is that founders who have had prior experience in a small, entrepreneurial firm are more likely to have utilized general skills and to have had a wider range of responsibilities compared to individuals in larger firms who typically have had more narrow functional roles. Prior work has already

shown that entrepreneurs and leaders appear to invest in more general human capital and diverse experiences relative to others (Lazear, 2004).[11]

Our identification strategy begins with the selection of the setting of company founders as a more narrow and ideal empirical sample to test our hypotheses because of the factors discussed above. In particular, it better allows us to isolate the impact of routines vs. cognition from the complicating factors of existing firm capabilities and resources that would otherwise impair the identification of the effects we hypothesize about in other settings.

We take advantage of both differences between those who have and have not had the experience of founding a firm as an indicator of cross-functional experience. Those who have worked in established companies are much more likely to have worked in a single functional domain at a time (unless they were CEO), whereas we know that those who were founders almost surely had work experience that crossed functional boundaries while founding the firm. We also take advantage of differences between those with multiple episodes of cross-functional work experience (multiple firm foundings) as compared with those who have only had one experience. Those individuals with more cross-functional experience compared to those with less offer another identification strategy. If an episode of cross-functional experience is thought of as the treatment effect, then we look both at differences between the treated and untreated as well as difference between those individuals with more episodes of the treatment effect compared to those with fewer. Finally, we use the panel structure of data on firm foundings over time to rule out several alternative explanations that remain plausible after the initial analyses. In particular, a strong advantage of our setting will be that we can provide

[11] We expect that those who have been CEOs would similarly build more balanced cognitive maps as a result of their multi-functional experience. However, they also have much higher opportunity costs relative to most employees so that would simultaneously influence the performance of the projects they select to pursue.

evidence that we are not seeing a selection effect rather than the treatment effect. The panel structure of the founder data where we have entire founding histories allows the use of individual fixed effects for those who have founded more than one firm so that we can control out the possibility that more persistent or higher ability individuals choose to found more firms.[12]

We use a novel survey administered in 2001 to all 105,928 alumni from a prestigious research- and technology-based university in the United States to generate a sample of firms where we have detailed information on founders as well as on firm performance. This survey generated 43,668 responses. Out of 7,798 alumni who had indicated that they had founded a company, 2,111 founders completed more detailed surveys in 2003, representing a response rate of 25.6%.[13] Examining the firm names and founding years, we identified and dropped 44 duplicate observations where multiple cofounders reported on the same firm. Industries covered include aerospace, architecture, biomedical, chemicals, consumer products, consulting, electronics, energy, finance, law, machine tools, publishing, software, telecommunications, other services, as well as other manufacturing. Each founder reported information on up to five firms which he or she had founded up to the date of the survey, yielding a total of 3,698 firm observations. On average, 1.79 firms were founded per individual, or 3.85 firms per individual who founded more than 1 firm. The founders were also asked for the total number of firms they had attempted to found over the course of their career and 80 indicated having founded

[12] The individual fixed effects allow us to rule out the selection effect (time-invariant individual characteristics) in going from fewer episodes of treatment to more, but not in going from no treatment to treatment (no cross-functional experience to one prior founding). A Heckman selection model might help with the latter concern, however we lack the requisite exclusion restriction (something correlated with entrepreneurship but not with performance) required for this identification approach.

[13] Appendix A of this chapter shows *t*-tests of the null hypothesis that the average (observed) characteristics of the responders and non-responders are the same statistically, for both the 2001 and 2003 surveys.

more than 5 firms (up to 11). The average number of firms per individual by this measure is 2.13 so we appear to have captured data on the vast majority of firms. To provide still more information about these companies including current sales, employment, industry category and location, this new database was further updated to 2006 data from the records of Compustat (for public companies) and Dun & Bradstreet (private companies).[14] For consistency in the country and institutional context, the 1,121 firms that were founded outside of the U.S. were dropped from the analyses reported in this paper. Information on sales was adjusted for inflation to constant dollars.

Although teams of multiple co-founders are more likely to start a new firm, as well as be more successful in their firms (Roberts, 1991), we only have complete founder information on prior startup experience for one entrepreneur from each team. Previous findings of strong homophily among founding teams indicate that the prior founding experience of one entrepreneur may be a good proxy for that of the team (Ruef, Aldrich and Carter, 2003) and the results are robust to using only the single-founder teams and to using all co-founded teams. To eliminate concerns of biases in the Dun & Bradstreet data, the analyses are also run on only the subset of firms for which the founders provided more detailed revenues and employee data (each multi-company founder chose only one firm to provide more detailed data). Although we lose the panel structure, this sub-sample also provides us with more detailed information on control variables and increases the confidence in our results. Due to skipped survey items and missing data we allow the final number of observations to vary by the analysis in order to utilize all available data. Meaningful numbers of foundings begin in the 1950s, therefore we

[14] Successful matches were found for 80% of the company names in the D&B database. A firm is included in the Dun & Bradstreet database when it needs to obtain a credit rating. An analysis of Dun & Bradstreet's coverage compared to other sampling sources for small businesses concluded that there was not a bias towards larger firms (Aldrich, et al., 1989).

restrict our analysis here to firms founded from 1950-2001. A key feature of this dataset is its long time horizon allowing us to analyze almost entire careers.

Dependent Variables. Because our focus is on measuring the performance effects of variation in the cognitive representations that come from work experience, we use revenues, acquisition, IPO, employees, and lag between foundings as the dependent variables. No single outcome measure is ideal.[15] Using acquisitions has the drawback of not observing the valuation of the acquisition as compared to the valuation at the time of funding. Similarly, using IPOs does not identify the valuation of the firm at the time of the IPO, or the post-IPO performance of the stock, or the personal financial benefits to the founders or the initial investors. Both IPOs and acquisitions apply only to a subset of foundings, not to all of them, whereas revenues are a common goal of all companies. Many studies use the fact of an IPO as a measure of success (Gompers, et al., 2006, Shane and Stuart, 2002). But far more firms experience acquisitions rather than exit via IPOs. It is important to recognize that performance is multidimensional in nature (Chakravarthy, 1986). The limitation of using the fact of IPO or acquisition is that both of these are sensitive to the industry, the economic environment, and the founders' desire to retain control. It is best to consider multiple performance measures, which is why we look for (and find) robustness with various measures. The variable Log Revenues is the revenue for the most recent fiscal year in operation as reported by the entrepreneur. We adjust for inflation (2001 $) and take the natural log of this measure for our dependent

[15] Profit might be a better indicator, but we lack adequate profit data to use that measure. The pair-wise correlation between employee size and log revenues was -0.024, so we do not believe revenue is picking up only size effects. Organizational performance of firms is likely to be a noisy proxy for a more accurate cognitive map. Nonetheless, because the prior work experience of the founders is a major input for a new venture, organizational performance is a relevant and appropriate objective measure. Performance can be seen as a very conservative test. For it to be detected, cognitive maps must be more accurate in such a way as to impact performance in a large sample of organizations.

variable.[16] Out of 2,111 firms, 1,370 survey respondents reported revenues for their firms ranging from $0 to $2.56 billion (mean = $34.6 million, median = $1.12 million).[17] Lag Between Subsequent Firms is the number of years from founding one firm to founding the next firm. We use acquisition in event-history models as well.

Independent Variables. We use independent variables related to the characteristics of the founder and the nature of the prior experience, as well as a number of controls. The key independent variable is our proxy for the number of diverse (simultaneous) functional experiences and a greater span of functional decision rights, the number of start-ups previously founded, which is coded as the ranking of the current firm in terms of whether it is the first firm, second, third, and so on (mean = 1.61), founded by a given entrepreneur.[18,19]

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[16] Adjusting for inflation is not entirely necessary since year dummies are used; however they were already calculated for use in descriptive statistics.

[17] To alleviate concerns of response bias where defunct firms might be non-responders, we examine the proportions of firms "in operation", "acquired", and "out of operation" in the group reporting revenues (1,424 observations) and the group of non-responders (687 observations) to this question. Our concerns are alleviated in finding that the proportions are roughly equivalent with 68.5% of those reporting revenues still in operation and 62.3% of the non-responders still in operation. 10.9% of the reporting firms were out of operation whereas that number is 18.8% for the non-responders. 19.7% of the reporting firms had been acquired, whereas 18.8% of the non-responders had been acquired.

[18] A total of 3,156 alumni indicated that they had started multiple companies, of whom 960 completed the survey for a multi-founder response rate of 30.4%. A total of 1,107 single-firm founders responded to the survey giving a 21.8% response rate out of the 5,086 single-firm alumni founders. Some of these 1,107 single-firm founders may later become multiple entrepreneurs. However, as we are looking at the effects of prior founding experience on current firm performance, this is not a problem for our current research.

[19] If the majority of learning relevant to founding occurs in work experience or life experience outside of prior foundings, then we should find that the number of prior firms lacks explanatory power. Because firms develop at different paces in different industries and the wisdom of early decisions is often not known until the founders have experienced some sort of exit event (if ever), we propose that the number of new ventures, rather than years with a single venture, is a more suitable proxy for the amount of prior experience. Another problem with using the number of years of experience is that it implicitly penalizes an entrepreneur who quickly took a firm successfully to acquisition or IPO. Similarly, with focus on the repetitive task, pilots might be expected to learn from the number of flights or take-offs and landings, not from the number of miles flown. Firemen should be expected to learn from the number of fires put out and police officers from the number of arrests made, not the amount of time on a particular fire or with a particular suspect. Managers cannot truly gauge the ultimate success of their actions until the final outcome is known.

Individuals also differ in their starting human capital and in particular in the number of years of education they have received. Advanced education may result in better information processing capacity as well as in other acquired knowledge and capabilities. An alternative that is consistent with our account is the signaling argument where an advanced degree signals the individual as a "high type" who is a quicker learner with lower costs of educational attainment (Spence, 1973).[20] While using educational attainment as a measure of cognitive ability is problematic, disentangling the two is extremely challenging as other authors have noted (Cawley, Heckman and Vytlacil, 2001). Cognitive ability and years of education have been found in numerous studies to be highly correlated, so using education as a proxy for cognitive ability is reasonable (Heckman and Vytlacil, 2001). We include dummy variables indicating whether the individual's highest degree was a Bachelor's degree , Master's degree or Doctorate. As a measure of success experience, we use Prior IPOs, the number of previous IPOs for an entrepreneur's previous firms. The variable Prior Acquisitions is a count of the number of a founder's prior firms which have been acquired. Although survival is often used as a performance measure, survival exists among underperforming firms (Gimeno, et al., 1997). Capturing the similarity of the industrial context, Same 2-digit SIC code is a count of the number of prior startups that have the same 2-digit SIC code as the current firm. Different 2-digit SIC code is a count of the number of prior startups with a different 2-digit SIC code as the current firm. SIC and VEIC codes were matched from the Dun & Bradstreet Million Dollar database and from VentureXpert. VEIC codes were converted to SIC codes with a previously used matching scheme (Dushnitsky and Lenox, 2005).

[20] Previous work has also shown a link between education as human capital and the performance of young firms (Bates, 1990, Fairlie and Robb, 2008, Baumol, 2004, Murphy, Shleifer and Vishny, 1991; Fairlie, Woodruff 2007, Dunn, Holtz-Eakin 2000; Roberts, 1991). Roberts (1991) shows a curvilinear relationship between education level of high-tech entrepreneurs and their firms' overall performance, with Master's degree recipients doing best.

Control Variables. Some of our analyses use a set of industry dummies as controls for the coarse industry segment within which the firm competes (such as biotech, software, and electronics). The variable Age at Founding is the entrepreneur's age when the firm was founded. We control for the age of the startup, as measured by Operating Years from founding to the year for which revenues are reported. A set of year dummies, one for each year from 1950-2001, captures temporal changes in the economy. Initial Capital is the natural log of the amount of initial capital raised (adjusted to 2001 dollars, roughly defined as capital raised within the first year after founding).[21] VC Funded is equal to 1 if the individual reported raising funds from venture capital firms.

Insert Tables 1 and 2 about here

Descriptive statistics are presented in Table 1. The number of observations varies due to missing observations on the survey items. Table 2 shows median inflation-adjusted revenues and Panel B shows the lag between founding firms. The trend from median revenues of $836,000 for first firms to $7.27 million for 5th (or more) firms lends support the general thesis that firms created by those with more start-up experience are more successful. The table also reassures us that we are not simply capturing differences between any prior experience and no prior experience. Although Table 2 suggests a decrease in the lag between firms across subsequent ventures, the differences are not statistically significant.

[21] There is some uncertainty around the way that respondents interpreted the time frame and some may have waited for a funding event to found the firm. Although the measure is admittedly not ideal, it is the best proxy available, particularly for non-venture capital backed private firms, which are most of the firms surveyed.

Results

Multivariate Regressions on Firm Performance

We use multivariate regressions beginning with a baseline model followed by results controlling for factors that may be confounding the results including: 1) time-invariant individual fixed effects and 2) specific firm characteristics, social networks, and fundraising. We then further reinforce the results by testing whether better representations may function as dynamic capabilities and speed the timing of events as suggested in previous work (Zott, 2003).

Baseline regressions

To test the influence on firm performance of different types of prior experience we use a variant of a production function modified to better fit the case of younger firms. Traditionally we would write an equation of the form:

$$Y=F(K, L, X) \qquad (1)$$

where Y is the current period performance, K and L are capital stock and quantity of labor, respectively, and X is a measure of experience. The Cobb-Douglas production function is widely used, but in the case of private firms, output and capital in particular are extremely difficult to measure for a number of reasons.[22] Cognitive representations of the industry resulting from varied prior experience of the founders are considered an "input" into the firm formation process in the sense that a more accurate cognitive representation increases performance (controlling for the level of labor and capital) by acting as a dynamic capability. First we use the baseline multivariate regressions shown in Table 3. The specification of the regression model is as follows:

[22] For a start-up firm, having raised external capital at all has been viewed by prior literature as a signal of performance and thus can be criticized as endogenous to the performance that we are interested in measuring.

$$y_{it} = \Phi(\beta' x_{it}) \quad (2)$$

where y_{it} is a measure of firm performance, and the vector x_{it} includes our demographic and firm level variables including the number of prior foundings. Subscripts indicate a founding year and 2-digit SIC code. Individual fixed effects are not included in this baseline set of models. Each column uses a different performance measure as the dependent variable including revenues (3-1), acquisition (3-2), initial public offering (3-3), employees (3-4), and operating years (3-5).

Insert Table 3 about here

In Model 3-1, the prior founding experience variables are not significantly associated with higher revenues. The number of employees and firm age are included as controls, so this is an analysis of firm productivity. Male gender and advanced degrees are significant. Model 3-2 shows that the number of prior start-ups that had been acquired is positively and significantly related to the likelihood that the current firm is acquired. However, starting a new firm in the same 2-digit SIC code is negatively associated with the likelihood of acquisition. Having a male founder, greater numbers of employees, older firms, and being located in Massachusetts or California are also correlated with higher likelihood for an acquisition. In Model 3-3, none of the key independent variables are associated with the likelihood of an IPO. But again, greater numbers of employees, older firms, and being located in Massachusetts or California are correlated with higher likelihood of an IPO. Looking at the number of employees as the dependent variable, Model 3-4 shows that the number of prior firms in the same industry is associated with a larger firm size. Finally, Model 3-5 shows that with more prior founding experience, individuals appear to close subsequent firms more quickly. This is consistent with

more accurate cognitive maps revealing to the founders more quickly that the opportunity can no longer be successfully executed (or increasing opportunity costs of running an underperforming firm with higher levels of start-up experience).

Controls for Individual Effects

Although intriguing, these results are not conclusive, mainly due to the lack of controls for time-invariant individual level differences which may be correlated both with the likelihood of founding additional firms and with performance. An alternative explanation for why performance might appear to improve with prior founding experience is that those who choose to start a second firm have higher skill levels than those who choose to start only a single firm (Gompers, et al., 2006). If on average those who start multiple firms are also more persistent or more talented than those who start only one firm, then we would also observe average performance improvements as lower skill individuals return to wage employment. We exploit the panel structure of the data, which includes observations of multiple firm foundings for many individuals, to implement a regression including individual fixed effects to control for time-invariant factors from the individual influencing performance.[23] Also, conditioning on one firm founding, the results should not show performance improvements with prior founding experience if underlying skill or persistence is the only component. If there is an improvement in the accuracy of cognitive maps leading to competitive advantages (in addition to differential skill levels), then conditioning on high persistence (more than one firm founding) we expect to continue to observe higher performance with prior foundings.

[23] These may include individual-level factors such as ability or persistence which without individual fixed effects would exert an upward bias on estimates of learning-by-doing and also factors such as a preference for variety or for multiple "lifestyle" businesses or the inability to hold down wage employment which would exert a downward bias in studies lacking observations on multiple firm foundings.

The results in Table 4 drop the unchanging individual characteristics for education, location, and gender and instead exploit the multiple observations on individuals to include individual fixed effects that capture time-invariant differences in individuals which may include higher underlying skill, persistence, family wealth, or preferences for variety, all of which are likely confounding the earlier estimates. Again, Model 4-1 finds that the prior start-up experience is not associated with higher revenues. Model 4-2 shows that once individual fixed effects are included, higher levels of start-up experience are strongly associated with a higher likelihood for acquisition. However, the coefficient on the number of prior start-ups which were acquired is strongly negative and significant, indicating that having a prior start-up decreases the likelihood that the current firm will be acquired (perhaps because these founders have either started lifestyle businesses or they are aiming for an IPO). In Model 4-3, the number of prior acquisitions is statistically significant and shows a higher likelihood of an initial public offering for the current firm. None of the prior experience measures in Model 4-4 are associated with a greater number of employees. Model 4-5 looks at survival and finds that whereas those with more prior foundings survive longer, but those with more prior firms that were acquired have lower survival. Again this is consistent with a story that prior experience improves survival with a moderating effect of prior success that causes individuals to be quicker in shutting down bad firms.

Insert Table 4 about here

Controls for Detailed Firm Characteristics

The analysis thus far is supportive of hypothesis 1a. However, using the panel data we lack information on certain control variables which may be important as resource differences such as the amount of capital raised, the number of co-founders and whether the firm received

venture capital funding. It may be that those with prior founding experience are better able to raise capital or to attract more co-founders. Controlling for the amount of initial capital also partially alleviates concerns that personal wealth may be driving the results. Survey respondents chose one firm to answer more detailed questions regarding the number of co-founders, initial capital, and other aspects of the firm. The following regressions take advantage of these controls and the fact that we know where this firm is located in the ordering of firms founded for each individual (first firm, second, and so on).

Insert Tables 5 and 6 about here

We condition on having founded at least one prior start-up and run the regressions shown in Table 5. Model 5-1 shows that controlling for founder age, education, the number of cofounders and initial capital raised, the number of prior firms which went through an acquisition is positively and significantly associated with higher revenues. The result is also robust to using just the total number of firms founded. The same result holds in Model 5-2 for the likelihood of acquisition and in 5-3 when a hazard rate model is used rather than a probit. Model 5-4 uses the fact of IPO as the dependent variable and finds that the number of prior IPOs is related to the likelihood of IPO for the current firm. In addition, teams with more cofounders are more likely to have an IPO. Teams with more cofounders also have more diverse sources of information and potentially more diverse cognitive representations on which to triangulate. The amount of initial capital is also correlated with performance, though a reasonable interpretation is that the more promising start-ups were able to raise more money.

While an account based on social networks is not counter to our theoretical arguments, one alternative explanation we attempt to control is the possibility that individuals are gaining a

larger social network as they found successive firms. If larger networks are enabling individuals to gather diverse signals and build more accurate mental models of the environment, then this account would be largely consistent with our main argument, only via an alternative mechanism for work experience.[24] The same results held when we constructed the sample to include only sole founders (not founding teams), eliminating one potential avenue through which a larger social network could improve subsequent firm performance. Individuals starting a firm in the same geographical location where they started a firm previously are likely to enjoy greater networking benefits. Prior work has shown that most communication is with those in closer physical proximity (Allen, 1977). Testing the impact of prior experience from startups formed in the same location as compared to those formed in a different location should allow us to a certain extent to disentangle this social network effect. Number Same State is the number of prior startups by the entrepreneur in the same U.S. state as the current startup. Number Different State is the number of prior startups in a different U.S. state from the current startup. If the benefit from prior experience disappears for foundings in different locations then this supports the idea that we are observing primarily a social network effect (or that there are performance-influencing differences in the characteristics of those entrepreneurs who change locations). In Table 6, we start with a baseline model (6-1) which tests the effect of the number of startups founded on the revenues of the current firm with age at founding, Bachelor's degree, Master's degree, as well as the controls included. The effect of prior founding experience on revenues is positive and significant.

[24] Networks can also grow with traditional wage employment, so a truly alternative story would need to build in theory explaining why the type of network that develops after a firm founding differs in ways that are relevant from networks that large company employees may develop. In terms of funding Wang (2008) shows that networks do not significantly affect investor decisions at the evaluation stage.

In Model 6-2, the coefficient on number in the same state is significant and shows that these prior firms each contribute positively to the current firm's revenues. Prior startups in different states lack a significant impact on the current firm's revenues. This effect may support the social network benefits explanation as opposed to the one we are advancing; however, it may be due to the smaller sample size of founders changing states. The total number of founders shifting states between the current startup and the prior founding is 172 and the number that we know remained in the same state is 382. Model 6-3 shows that the number of prior startups in the same 2-digit SIC code is associated with higher performance and the coefficient is significant. In Model 6-4 we find that the number of prior acquisitions has a positive coefficient and is significant but the coefficient on prior IPOs is not significant (there were only 84 prior IPOs linked to 72 different founders). Since there is a moderate degree of pair-wise correlation between these various counts of prior experience, we ran these as separate models. Model 6-5 includes an interaction term showing that those with Master's degrees benefit more from each multi-functional experience. Model 6-6 show that the results on the number of multi-functional (start-up) experience hold even when the number of functions (marketing, engineering, etc.) on the founding team are controlled.

Cox Hazard and Multivariate Regressions Controlling for Timing

Table 7 begins to explore the idea suggested in the literature that firms with dynamic capabilities (founders with better cognitive maps in this case) may be able more quickly to execute on opportunities.[25] The specification of the Cox (1972) model is as follows:

[25] A finding of more quickly executing the start-up process is consistent with either finding a higher quality idea or with learning how to design a company (or to filter ideas) for a more rapid exit. The analysis here is robust to using both the Breslow method for ties and the exact marginal-likelihood method.

$$\lambda(t \mid X) = \lambda_o(t)\exp(X\beta) \tag{3}$$

where the vector X includes our founder and first firm experience characteristics. $\lambda(t \mid X)$ is the rate at which firms will be acquired at any particular date, given that they have not been acquired up until that point in time. Equation (3) specifies the hazard rate as the product of two components: a function of the spell length (i.e. delay time since founding the firm), $\lambda_o(t)$ or baseline hazard, and a function of the observable individual and firm characteristics, denoted by the vector X. The model estimates the probability of an acquisition in a given year conditional on not having been acquired up until that time period. This model is appropriate for data like ours where right-side censoring is a problem because the timing of events is taken into account. Subjects start being at risk at the year of founding and the dependent variable is the event of an acquisition. Values above 1.0 represent increases in the hazard of acquisition and values below 1.0 represent decreases. Results indicate that number of prior startups (Model 7-1), prior acquisitions (Model 7-2), prior startups in the same 2-digit SIC (Model 7-4) all significantly increase the likelihood of an acquisition. Both the coefficients on the number of prior foundings in the same state and in a different state (Model 7-3) increase the likelihood of acquisition and are significant at the 10% level.

Insert Table 7 and 8 about here

Table 8 uses multivariate regression to test systematically the relative speed of going through the startup process. This model should be interpreted carefully due to right-hand censoring, though year fixed effects address this concern. Attention should be focused upon relative differences in lag length from founding to founding rather than on the fact of a shorter lag. The models use the lag from founding to founding as the dependent variable, but the

results are also robust to the use of the lag from closing one firm (whether by closing, bankruptcy, acquisition, or IPO) to founding the next one. The specification is that the lag is generated as follows:

$$E[y_{it} \mid x] = \lambda_{it} = \exp(\beta' x_{it}) \qquad (4)$$

where y_{it} is a measure of lag, and the vector x_{it} includes our demographic and firm level variables including the number of prior firms. Thus, each of our models predicts the lag between subsequent firms given a founding year and industry category. Because the lag is measured in years and is a count variable that is always positive, we use Poisson-based econometric estimation methods. The expected lag is an exponential function of a vector of the founder's prior founding experience and other characteristics x. We note that by construction this analysis limits the sample to those with more than one startup.

Model 8-1 shows that prior acquisitions and prior IPOs are associated with shorter lags. Shorter lags indicate that there has been less time (a quicker process). Those with Master's degrees have a shorter lag than those with just a Bachelor's. Model 8-2 adds a term interacting age and prior experience. Both variables remain significant and the interaction term is significant and negative. This indicates that older entrepreneurs show a greater reduction in lag as a result of prior experience. In Model 8-2 the number in the same state has a large significant impact on reducing lag, and the number in a different state significantly increases the lag. In Model 8-4 we find that the number of prior startups in the same 2-digit SIC code is associated with a greater decrease in lag than the number in a different 2-digit SIC code (both coefficients are significant).

Robustness and Limitations

Starting a firm in a recessionary market can reasonably be expected to be a different context than starting a firm during a boom time. As a further robustness check, Table 9 shows regression results matching the founding year of the first start-up attempt with various measures of the economic environment. The results are consistent with the idea that representations of the industry built during unusual economic conditions may be less helpful when the environment shifts to a more stable condition. The results show that the subsequent firms have lower revenues if the first firm was started during a recession (as measured by the National Bureau of Economic Research recession index).

There are a few alternative accounts worth noting. There is a possible alternative mechanism that founders who have a heightened salience that comes from having a larger stake to lose in the firm build more accurate cognitive models. There is also a large literature on learning-by-doing including Spence (1981), Fudenberg and Tirole (1983), Jovanovic and Lach (1989), Rosen (1972) and Cabral and Riordan (1994) among many others. Increases in productivity with cumulative production experience have been demonstrated in numerous manufacturing settings where activity is highly repetitive (Rapping, 1965, Irwin and Klenow, 1994, Gruber, 1994, Thornton and Thompson, 2001). The learning curve slope has been found to have a high degree of variance across organizations (Pisano, Bohmer and Edmondson, 2001, Edmondson, Bohmer and Pisano, 2001). If learning has an impact on competitive outcomes, then the question arises about the specific mechanisms of this effect – skill development or improved representations. Another stream of literature has examined the extent to which learning-by-doing may spillover outside of the firm (Dasgupta and Stiglitz, 1980, Levin and Reiss, 1988, Geroski, Machin and Van Reenen, 1993 (Ingram and Baum, 1997). Most of the literature treats knowledge as a kind of firm-specific good (Hatch and Dyer, 2004, Huckman

and Pisano, 2006), but there can also be task-specific rather than firm specific human capital which may then be transferred outside of the firm (Gibbons and Waldman, 2004) as well as internally (Thornton and Thompson, 2001). Empirical work outside of economics has begun to explore learning from rare events with intriguing, yet mixed results (Denrell, 2003, Kim and Miner, 2007, Zollo and Singh, 2004; Baum and Dahlin, 2007). Some have suggested that learning rates may be higher in slightly heterogeneous settings (Haunschild and Sullivan, 2002, Schilling, et al., 2003). However, it seems unlikely that the results are explained entirely by individuals learning the generic set of skills required for founding a firm. If this were the case, then we would expect those skills to transfer to different industries and across states.[26] We would also expect that conditioning on one founding experience, individuals would have picked up most of these entrepreneurship-specific skills and would benefit less from subsequent experiences. Nonetheless, future work should more directly test the idea that functional work experience leads to differences in biases and cognitive maps relative to multi-functional experience.

Conditioning on at least one prior firm founding addresses the problem that some of the entrepreneurs with a single founding may be lifestyle entrepreneurs who are starting a firm with

[26] The entrepreneurship literature is beginning to focus on the process of learning among entrepreneurs. Politis (2005) has an extensive review and synthesis of the research on entrepreneurial learning. Analyses of the impact on performance of founding experience have varied, with some showing no effect (Alsos, 1998, Westhead and Wright, 1998) while others show performance advantages for multiple entrepreneurs (Gimeno, et al., 1997, Stuart and Abetti, 1990). Although they argue against a learning interpretation, the work most closely related to this article is that by Gompers, Kovner, Lerner, and Scharfstein (2006). The authors argue that a large component of success in entrepreneurship and venture capital can be attributed to skill rather than luck and show that entrepreneurs with a track record of success are more likely to succeed than first time entrepreneurs. However, the Gompers et al. sample is limited to founders who received venture capital financing. Thus the authors lack data on the much larger proportion of prior foundings that were not VC funded. Furthermore, many more successful start-ups undergo acquisition rather than IPO as opportunities to go public vary with the economic environment and by industry even more than do the opportunities to be acquired. Therefore, the Gompers et al. analysis may be missing many actual prior successes which would tend to bias their estimates. If, and to what extent, small samples of experience result in learning that can be applied successfully in later comparable situations remains to be established.

little intention to grow or sell it. The current data also may suffer from a self-report bias as both the dependent and some of the independent variables were reported by the entrepreneur. Although we observe a wide range of outcomes and firm sizes, it is likely that we do not observe every startup firm attempted by the entrepreneurs. Individuals who have founded more than one firm showed a slightly higher response rate than one-time only founders and this may have influenced our results. We also cannot ascertain their reasons for deciding to start a new firm or where to locate it. Perhaps current firm performance is lower for individuals changing states because expectations or a reputation for success or failure alter the decision to move locations.

The lowest quality entrepreneurs may be dropping out of the sample. The concern is partially addressed by research in process that examines the determinants of starting a subsequent firm.[27] Gompers et al. (2006) also find higher performance for those with prior entrepreneurial experience but critique a learning explanation based on findings that founders with prior success (defined as an IPO) are more likely to be successful (IPO) than first time entrepreneurs. Our estimates in Table 4 control for individual fixed effects and should control for individual differences in time-invariant underlying ability or persistence. A skill vs. luck story where skill is constant over time requires explanation for why revenues appear to continue to increase (and variation decrease) with the number of prior start-ups (successful or not) even when conditioning on at least one prior start-up. Our data do not come from a random sample from the entire population. Nonetheless, the fact that all the respondents are alumni of a prestigious research- and technology-based university reduces the concern that there are large differences in wealth, skill, or initial human capital.

[27] The middle range of performers (in terms of revenues) are most likely to start a subsequent firm, whereas both low and very high levels of revenue are associated with a lower likelihood of a subsequent firm (Authors, working paper).

Conclusion: Do firms gain a competitive advantage through dynamic capabilities in the form of improved cognitive representations?

Do firms gain a competitive advantage through dynamic capabilities in the form of improved cognitive representations which the founders acquired via prior work experience? The results support the main thesis of the paper that the answer is yes, they do. Our primary proposition, Hypothesis 1a, that individuals with more diverse experiences and a greater span of functional decision rights will build more accurate cognitive representations, resulting in assembling more valuable combinations of resources/capabilities was supported. Hypothesis 1b was that those with higher information processing capacity will build more accurate cognitive representations. The results in Table 6, Model 6-5, show that those with Master's degrees benefit more from each founding experience, appearing to develop more accurate cognitive maps via less constraint from bounded rationality. The results appear to support Hypothesis 2a, that individuals remaining in similar contexts (SIC code, economic environment and geographic location) benefit more from multi-functional experience. The most relevant results here are the relative differences where the reduction in lag for each prior founding experience is reversed for those starting a firm in a different state and there is a greater lag for those changing industrial contexts. Hypothesis 2b was that founders would build more accurate cognitive representations from prior experiences of success. The data tend to support this hypothesis.[28] Model 4-3 indicates that the number of prior acquisitions has a significant positive impact on the likelihood of an IPO. However, we cannot eliminate the possibility that more accurate representations result from failure, yet other mechanisms such as a tarnished reputation affect performance via impact upon potential recruits, financiers and even suppliers

[28] Prior IPOs or acquisitions may be viewed as successes, and are by many other authors, though this largely depends on the valuations achieved.

and customers. The regression results in Table 7 and Table 2 show that prior experience in start-up settings improves the ability to more quickly to go through the entire process of finding an opportunity, assembling the resources and capabilities to develop it and executing on it.[29] The overall pattern of results, under a number of different specifications and measures, appears to provide robust evidence consistent with an account where experience with a broader set of responsibilities and functional decision rights leads to more balanced representations to guide strategic decisions.

However, what explains the lack of significant results in Tables 3 and 4 on the revenues (and employees) measures? One explanation may be that many high-tech firms do not achieve revenues (or ramp up hiring) for the first several years while their focus is on R&D.[30] This interpretation is supported by the significant results for acquisitions and by the results in Table 5 where we find that the number of prior acquisitions is significantly associated with higher revenues once we include controls for the amount of initial capital and venture capital funding.

Differences in the accuracy of cognitive representations, particularly concerning trends and shifts in the competitive landscape may also be a reason why individuals voluntarily leave firms. Individuals may choose to move to other firms or start their own new ventures when disagreements arise, when they see opportunities others do not, or when the existing firm seems incapable of exploiting quickly due to inertia or loss of plasticity (Klepper and Sleeper, 2005; Klepper, 2007). Prior work has suggested that the original founders of the firm may leave, having learned either something about the process of founding a firm, or about their own ability or efficiency which then affects strategic choices in the subsequent firm (Jovanovic, 1982).

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[29] Prior work shows that founding experience aids in raising capital quicker (Hsu, 2007).

[30] For many firms undertaking an innovation strategy, significant sales do not occur until after they have been acquired and a larger firm then deploys its complementary assets to drive production and sales operations.

The current paper makes its contribution in examining a different cognitive spillover mechanism: Where individuals appear to transfer to a subsequent firm more accurate representations as a result of the prior founding experience. Our account also provides a complementary theory of why managers and entrepreneurs may leave and go outside of their firms to work for others or to start their own ventures. Most organizations tend to become more rigid over time. If individuals within the same firm can develop substantially different cognitive representations of the competitive landscape due to differences in types of experience and the accumulation of psychological heuristics/biases, then individuals can begin to have fundamental disagreements with the organization. Furthermore, due to the inertia and rigidity of the existing bundles of capabilities, it becomes increasingly difficult to move the organization to a new set of resources and capabilities that individuals perceive will provide competitive advantage according to their representations of the competitive landscape. Some individuals leave for new organizations due to increased rigidity in bundles combined with cognitive maps drifting away from the increasingly small set of recombinations possible within the firm or from an inability to convince others to select their bundles of capabilities.

In conclusion, we have developed and tested a model that links psychological theory to dynamic capabilities and heterogeneity in firm performance. Variation in career experiences leads to variation in the extent of known psychological biases such as availability and partitioning dependence, and then variation in the extent of these biases results in differences in cognitive representations that function as a dynamic capability providing a map to future bundles of resources that will provide a performance advantage.

Figures and Tables

FIGURE 1

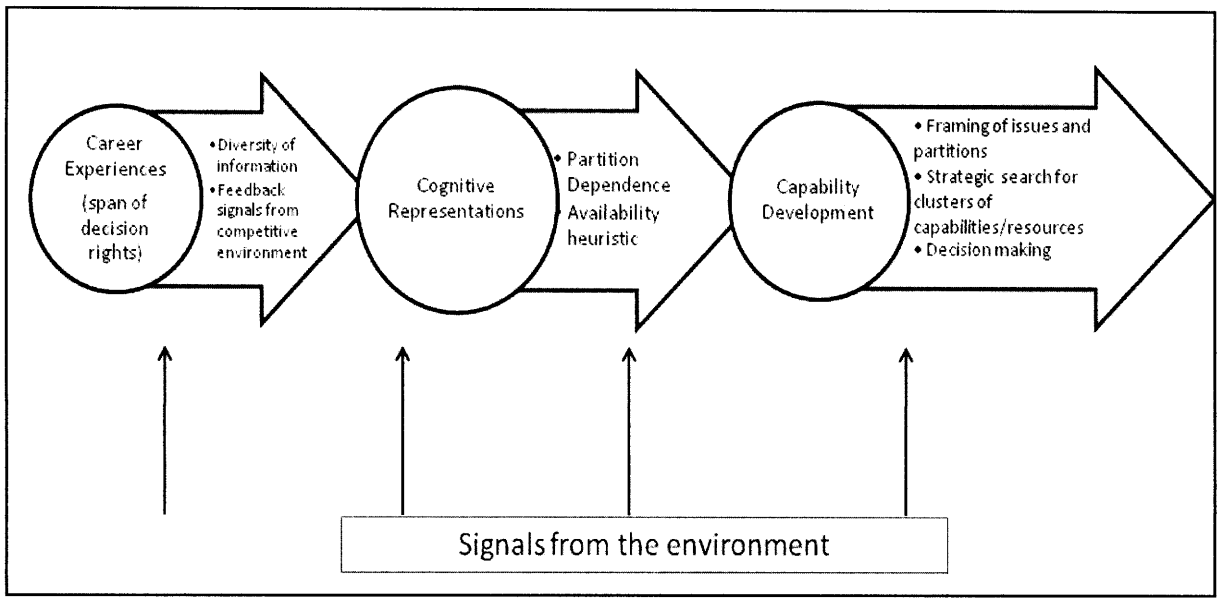

TABLE 1 Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Log revenues	1264	14.05	3.08	0.03	21.66
Acquired	1840	0.19	0.39	0	1
IPO	1790	0.11	0.32	0	1
Lag between	1502	12.11	9.41	0	50
Number of Firms	2058	1.61	1.30	1	11
Prior Acquisitions	2067	0.13	0.42	0	3
Prior IPOs	2067	0.04	0.23	0	3
Prior Same SIC	1473	0.02	0.14	0	2
Prior Different SIC	1473	0.02	0.18	0	3
Prior Foundings in the Same State	2067	0.38	0.90	0	8
Prior Foundings in a Different State	2067	0.23	0.79	0	7
Age Founded	1807	39.65	10.59	18	83
Age Founded Squared	1807	1684.19	920.07	324	6889
Bachelor's degree	2000	0.43	0.49	0	1
Master's Degree	2000	0.41	0.49	0	1
Operating Years	1837	14.34	11.30	0	74
Industry	1600	9.77	4.34	1	16
Number of Cofounders	2056	1.05	1.22	0	4
VC funded	1691	0.13	0.34	0	1
Log initial capital	1264	11.91	2.72	0.28	21.02
Functional Diversity of Team	1964	1.23	0.48	1	3

TABLE 2 Revenues and lag across ventures

Panel A – Likelihood of Exit Events and Revenues (in 2001 dollars)					
Firm Rank	1st firms (N=556)	2nd firms (N=182)	3rd firms (N=84)	4th firms (N=21)	5th firms and higher (N=36)
Median Revenues ('000s)	836	1,784	924	1,181	7,274
Standard Dev. ('000s)	153,000	117,000	130,000	10,800	21,200
Panel B – Lag (from graduation and from the prior firm founding)					
Firm Rank	1st firms (N=761)	2nd firms (N=241)	3rd firms (N=150)	4th firms (N=71)	5th firms and higher (N=31)
Lag Between Subsequent Firms (years)	14.02	7.95	7.38	6.99	6.71
Lag St. Dev.	9.78	6.90	6.73	5.42	6.37

TABLE 3 Productivity regressions

Independent Variables	LN(REVENUES) (3-1)		PR(ACQUIRED) (3-2)		PR(IPO) (3-3)		LN(EMPL) (3-4)		LN(SURVIVAL) (3-5)	
Num. of start-ups founded	-0.269	(0.206)	0.040	(0.051)	0.002	(0.069)	0.066	(0.057)	-0.028*	(0.016)
Num. prior acquired	0.121	(0.328)	0.396***	(0.087)	0.084	(0.116)	0.160	(0.103)	0.058	(0.024)
Num. same 2 digit SIC	0.396	(0.456)	-0.239*	(0.125)	-0.014	(0.161)	0.442***	(0.143)	0.014	(0.034)
Age at founding year	0.025	(0.013)	-0.012***	(0.004)	0.001	(0.005)	-0.012***	(0.004)	0.006	(0.001)
Gender (1=male)	1.179***	(0.648)	0.404**	(0.202)	0.372	(0.289)	0.582***	(0.153)	0.059	(0.052)
Masters	-0.237***	(0.287)	-0.016	(0.076)	0.170*	(0.103)	0.305***	(0.086)	0.040	(0.028)
Doctorate	-0.183*	(0.409)	-0.192*	(0.102)	0.117	(0.130)	0.181	(0.121)	0.111	(0.036)
ln(emp)	1.752	(0.292)	0.055***	(0.019)	0.188***	(0.025)				
ln(firm age)	0.539	(0.076)	0.173***	(0.057)	0.358***	(0.097)	0.532***	(0.074)		
MA	-0.546*	(0.332)	0.330***	(0.081)	0.260***	(0.104)	0.214**	(0.098)	-0.021	(0.030)
CA	-0.177	(0.346)	0.389***	(0.092)	0.440***	(0.123)	-0.030	(0.102)	0.010	(0.033)
Constant	-13.826	(3.467)	-1.422	(1.347)	-2.543***	(0.994)	-3.290***	(0.626)	1.412***	(0.198)
Year F.E.	YES		YES		YES		YES		YES	
SIC F.E.	YES		YES		YES		YES		YES	
Individual F.E.	NO		NO		NO		NO		NO	
R-squared	0.2164		0.160		0.228		0.150		0.622	
Num. of obs.	1294		1997		1760		2092		2217	

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors in parentheses.

TABLE 4 Productivity analysis including individual fixed effects

Independent Variables	LN(REVENUES) (4-1)		PR(ACQUIRED) (4-2)		PR(IPO) (4-3)		LN(EMPLOYEES) (4-4)		LN(SURVIVAL) (4-5)	
Num. of start-ups founded	0.597	(0.551)	2.326***	(0.181)	-0.099	(0.074)	0.029	(0.129)	0.161***	(0.043)
Num. prior acquired	-0.028	(0.747)	-5.105***	(0.221)	0.331***	(0.114)	0.078	(0.186)	-0.119***	(0.060)
Num. same 2 digit SIC	-0.573	(0.799)	-0.298	(0.248)	0.090	(0.154)	-0.034	(0.208)	0.010	(0.064)
Age at founding year	0.363***	(0.160)	-0.103***	(0.010)	0.000	(0.005)	-0.016	(0.011)	0.013	(0.013)
ln(emp)	1.208***	(0.598)	-0.099***	(0.045)	0.158***	(0.025)				
ln(firm age)	1.730***	(0.482)	0.359***	(0.157)	0.394***	(0.093)	0.322**	(0.145)		
Constant	-29.591***	(9.765)	-0.126***	(0.066)	-2.105***	(0.959)	-0.643	(1.137)	3.683***	(0.496)
Year F.E.	YES		YES		YES		YES		YES	
SIC F.E.	YES		YES		YES		YES		YES	
Individual F.E.	YES		YES		YES		YES		YES	
R-squared	0.740		0.750		0.206		0.750		0.884	
Num. of obs.	1528		463		1771		2135		2231	

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors in parentheses.

TABLE 5 Effects of prior founding experience (Conditioned on having founded at least one prior startup)

Dependent variables	LN REVENUES	PR (ACQUISITION)	PR (ACQUISITION)	PR(IPO)
Independent variables	Model 5-1 OLS	Model 5-2 Probit	Model 5-3 Cox Hazard	Model 5-4 Probit
Founder char.				
Age at founding	0.002	-0.001	0.999	0.009
	(0.014)	(0.011)	(0.012)	(0.014)
Number of	0.056	0.024	2.057***	0.192***
Cofounders	(0.118)	(0.079)	(0.784)	(0.096)
Prior Exper.	0.417**	0.389***	1.987*	0.099
Char.	(0.212)	(0.145)	(0.775)	(0.195)
Prior	0.132	0.350	1.003	0.427*
acquisitions	(0.361)	(0.252)	(0.089)	(0.244)
Prior IPOs	-0.078	0.548*	1.529**	0.046
	(0.438)	(0.309)	(0.227)	(0.428)
Controls	0.433	0.478	1.117	0.087
Bachelor's	(0.430)	(0.312)	(0.268)	(0.429)
degree only	0.067*	-0.043*	0.859***	0.048
	(0.039)	(0.025)	(0.016)	(0.042)
Master's degree	0.411***	0.111*	1.209***	0.115*
	(0.070)	(0.049)	(0.069)	(0.063)
Operating Years	-0.089	0.519*	1.653*	-0.140
	(0.462)	(0.304)	(0.518)	(0.366)
Initial Capital	YES	YES	YES	YES
	YES	YES	YES	YES
VC funded	13.642***	-1.281	--	dropped
	(3.446)	(1.655)		
Industry	--	-124.3	-371.78	-78.9
segments	0.432	125.1	138.18	65.9
Year dummies	0.000	0.000	0.000	0.008
Constant	347	345	439	222
Log-likelihood				
χ^2-Statistic (or R-sq.)				
p-value (or Prob>F)				
Number of obs.				

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 6 Revenues OLS regressions

Independent variables	Model 6-1 (N=964)	Model 6-2 (N=964)	Model 6-3 (N=648)	Model 6-4 (N=964)	Model 6-5 (N=964)	Model 6-6 (N=997)
Founder characteristics						
Age at founding	-0.015*	-0.013	-0.019	-0.012	-0.016*	-0.001
	(0.009)	(0.009)	(0.012)	(0.009)	(0.009)	(0.005)
# of startups founded	0.296***	--	--	--	0.195**	0.119***
	(0.066)				(0.087)	(0.033)
Bachelor's deg.	0.298	0.298	0.586+	0.346	0.361	-0.027
	(0.254)	(0.256	(0.335)	(0.255)	(0.253)	(0.132)
Master's degree	0.402	0.402	0.508	0.434+	0.036	0.054
	(0.252)	(0.255)	(0.334)	(0.254)	(0.330)	(0.132)
Master's X # of startups founded interaction					0.242** (0.126)	
Characteristics of the Prior Exper.						
# Same State		0.238* (0.096)				
# Different State		0.125 (0.104)				
Same 2 digit SIC			1.675** (0.614)			
Different 2 digit SIC			0.153 (0.623)			
Prior acquisitions				0.445** (0.189)		
Prior IPOs				0.408 (0.341)		
Controls						
Functional Diversity of Founders						-0.011 (0.094)
Operating Years	0.059***	0.062***	0.073***	0.061***	0.063***	0.041***
	(0.017)	(0.017)	(0.022)	(0.017)	(0.017)	(0.009)
Initial Capital	0.395***	0.402***	0.368***	0.393***	0.370***	0.181***
	(0.035)	(0.036)	(0.047)	(0.036)	(0.040)	(0.021)
Used VC	--	--	--	--	0.479*	0.343**
					(0.283)	(0.146)
Number of Cofounders	0.245***	0.249***	0.357***	0.256***	0.260***	0.127***
	(0.073)	(0.073)	(0.097)	(0.073)	(0.073)	(0.042)
Industry segments	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Constant	12.247***	12.430** *	8.989**	12.331	12.256** *	0.856
	(2.692)	(2.715)	(3.013)	(2.710)	(2.747)	(1.466)
R-squared	0.353	0.291	0.362	0.346	0.311	0.330

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 7 Cox hazard rate regressions

	Dep. Variable = Acquisition year (subjects start being at risk at year of founding) Note: reported coefficients are hazard ratios			
Independent variables	Model 7-1	Model 7-2	Model 7-3	Model 7-4
Founder char.				
Age at founding	0.989	0.955**	0.969	0.965
	(0.034)	(0.021)	(0.020)	(0.029)
# of start-ups founded	2.224**	--	--	--
	(1.444)			
Number of Cofounders	1.551	1.563	1.489	1.578
	(0.492)	(0.527)	(0.470)	(0.928)
Prior Experience Char.				
Prior acquisitions	--	2.011***	--	--
		(0.370)		
Prior IPOs	--	1.777	--	--
		(0.759)		
# Same State	--	--	1.255**	--
			(0.171)	
# Different State	--	--	1.333**	--
			(0.234)	
Same 2 digit SIC	--	--	--	37.621**
				(56.90)
Different 2 digit SIC	--	--	--	3.675
				(3.015)
Controls				
Bachelor's degree only	0.968	0.959	0.827	0.491
	(0.423)	(0.425)	(0.374)	(0.308)
Master's degree	0.720	0.702	0.673	1.508
	(0.316)	(0.315)	(0.298)	(0.667)
Operating Years	0.901***	0.884***	0.902***	0.856***
	(0.018)	(0.019)	(0.018)	(0.029)
Initial Capital	1.151**	1.116	1.141**	1.209
	(0.093)	(0.091)	(0.092)	(0.153)
VC funded	3.116**	2.988**	3.048**	3.428**
	(1.633)	(1.553)	(1.597)	(2.637)
Industry segments	YES	YES	YES	YES
Prob > chi2	0.000	0.000	0.000	0.000
LR chi2	77.95	88.85	77.85	76.07
(df)	21	22	22	22

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively; hazard ratio and standard errors reported; 374 firms, 53 events and 6,167 obs.

TABLE 8
Poisson regression using lag to next founding

Dep. Variable	Lag from founding to founding (N=587)			
Independent variables	Model 8-1	Model 8-2	Model 8-3	Model 8-4
Founder char.				
Age at founding	0.201***	0.067***	0.082***	0.197***
	(0.012)	(0.002)	(0.003)	(0.014)
Age Interaction w/ exp.		-0.010***	-0.022***	
		(0.001)	(0.002)	-0.002***
Age at founding2	-0.002***			(0.0001)
	(0.001)			
Number of startups founded			-0.511***	
			(0.086)	
Prior Experience Char.				
Prior acquisitions				
Prior IPOs	-0.334***			
	(0.036)			
# Same State	-0.484***	-0.084**		
	(0.070)	(0.032)		
# Different State		0.060**		
		(0.022)		-1.039***
Same 2-digit SIC code				(0.159)
Different 2-digit SIC code				-0.706***
				(0.108)
Controls				
Initial Capital				-0.002
		0.009*		(0.006)
Bachelor's degree only		(0.006)	0.011**	0.349***
	-0.012**	0.288***	(0.006)	(0.047)
Master's degree	(0.006)	(0.041)	0.287***	0.147**
	0.243***	0.137***	(0.041)	(0.047)
Industry segments	(0.041)	(0.042)	0.121***	YES
Year dummies	0.109***	YES	(0.042)	YES
Constant	(0.041)	YES	YES	-3.011***
	YES	-0.268	YES	(0.474)
Prob > chi2	YES	(0.382)	-0.904**	0.000
Pseudo R-squared	-	0.000	(0.397)	0.502
	2.555***	0.464	0.000	
	(0.453)		0.466	
	0.000			
	0.353			

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Negative coefficients represent a shorter lag.

TABLE 9 Impact of economic environment during the first founding

Independent variables	Dep. Var.=Ln(Revenues)	
NYSE at first founding year	4.61E-10**	(0.000)
NBER Recession Index at first founding year	-3.384*	(1.883)
VC disbursements at first founding year	-0.033	(0.028)
Num. of prior startups founded	0.831***	(0.306)
Same SIC	2.543***	(0.893)
Held Patents	1.352***	(0.349)
Age at Founding	-0.022*	(0.012)
Number of cofounders	0.283***	(0.095)
Operating Years	0.067***	(0.023)
Ln(initial capital)	0.349***	(0.051)
VC funded	0.452	(0.360)
Mass. Located	-0.108	(0.271)
California Located	-0.042	(0.307)
Industry segments	YES	
Year dummies	YES	
Observations	629	
Adj. R-squared	0.392	

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Appendix A

Comparison of Key Demographic Characteristics by Survey

Variable	Responded to 2001 survey (N=43,668)	Did not respond to 2001 survey (N=62,260)	t-stat for equal means
Male	0.83	0.86	10.11
Engineering major	0.48	0.47	-4.49
Management major	0.16	0.15	-5.75
Science major	0.23	0.23	0.37
Social sciences major	0.05	0.06	4.07
Architecture major	0.06	0.08	11.82
Non-US citizen	0.81	0.82	3.77
North American (not US) citizen	0.13	0.11	-4.14
Latin American citizen	0.13	0.12	-1.44
Asian citizen	0.33	0.34	1.45
European citizen	0.30	0.26	-5.08
Middle Eastern citizen	0.05	0.08	6.32
African citizen	0.03	0.05	6.25

Variable	Responded to 2003 survey (N=2,111)	Did not respond to 2003 survey (N=6,131)	t-stat for equal means
Male	0.92	0.92	0.12
Engineering major	0.52	0.47	-3.63
Management major	0.17	0.21	4.17
Science major	0.17	0.18	1.09
Social sciences major	0.06	0.05	1.18
Architecture major	0.09	0.09	1.06
Non-US citizen	0.82	0.81	-1.36
North American (not US) citizen	0.17	0.14	-1.34
Latin American citizen	0.19	0.19	0.13
Asian citizen	0.22	0.24	0.73
European citizen	0.31	0.32	0.38
Middle Eastern citizen	0.08	0.07	-0.59
African citizen	0.04	0.04	0.17

Note: bolded numbers indicate statistical significance at the 1% level.

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Chapter Four:

Entrepreneurship and China: History of Policy Reforms and Institutional Development

"The storm center of the world has shifted . . . to China, whoever understands that mighty Empire . . . has a key to world politics for the next five hundred years."
--U.S. Secretary of State John Hay, 1899

China is like a sleeping giant. And when she awakes, she shall astonish the world.
--Napoleon Bonaparte, 1803

One of the greatest untold secrets of history is that the 'modern world' in which we live is a unique synthesis of Chinese and Western ingredients. Possibly more than half of the basic inventions and discoveries upon which the 'modern world' rests come from China. And yet few people know this. Why?
--Robert Temple - *The Genius of China: 3,000 Years of Science, Discovery and Invention*, 1986

Four thousand years ago, when we couldn't even read, the Chinese knew all the absolutely useful things we boast about today.
--Voltaire: The Philosophical Dictionary, 1764

Introduction

Why is it that we see one country create numerous R&D intensive companies and start-ups while another remains full of farmers, and a third is full of small proprietors, cottage industries, and retail firms? Why do countries follow such divergent development paths and how do individuals' occupational choices interact with government policies and institutional reform? These are large questions which will likely occupy sociologists, economists, political scientists, and politicians for decades to come. This paper has a more modest goal of tracing the evolution of China's transition from planned to market economy by examining the institutional and policy reforms believed to have had an impact on private business over the

years. Rather than the traditional route of first discussing theories and then the empirical results attempting to adjudicate among them, I first lay out the history and more recent changes in China related to innovation and entrepreneurship in particular. Then I focus more on theoretical frameworks which can help guide our thinking about explaining the forces in the environment impacting Chinese private entrepreneurship over time. At this point there is relatively little empirical work in China, but where I can locate empirical tests of the theories, I incorporate them into this section.

Historical Policy Changes and the Impact on Entrepreneurship

Entrepreneurship was all but eliminated after Mao Zedong and the Chinese Communist Party won the Chinese Civil War and founded the People's Republic of China in 1949 (Whyte and Parish, 1984). New opportunities have opened up as China has undertaken the (quickly progressing, but as yet incomplete) shift from redistributive bureaucracy to open markets (Nee, 1996). Entrepreneurs have played a strong role, beyond what reformers may have initially expected, in building the market economy, from breaking state monopolies to supplying new jobs (McMillan & Woodruff, 2002). From 1989 to 2004 the compound annual growth in the number of newly registered private sector businesses in China has been 29% vs. 1% in the United States (State Statistics Bureau). From 1978 to 2004 the number of people employed in private business went up by 300 times in China.

Insert Figure 1 here

Clearly, policies and institutions have been changing rapidly, but relatively little analysis has been done on the impact on entrepreneurship and firm strategy in China to

determine whether China is likely to upgrade to more R&D intensive entrepreneurial activity (Cull & Xu, 2006; Nee, 1998; 1992; 1996; Peng & Heath, 1996; Steinfeld, 2007).

Two general features of China's reform have been gradual, local and sectoral experimentation along with partial reforms or what has been referred to as a dual-track approach (Gregory, Tenev, & Wagle, 2000). The Chinese economy was organized regionally (as opposed to centrally like the Soviet Union) since about 1958. Due to the regional nature of China's political system and reforms, institutional change and economic development has not been uniform across China (Nee, 1996). Since 1980, promotions and tax revenue were tied to local economic development ("eating from separate kitchens", or *fenzao chifan*), government officials at the local level had strong incentives to bend the rules and become creative with local policy towards private firms. Thus, a reform may be tried out in one province and years later be copied in other provinces or adopted centrally. Certain geographic areas, such as Zhejiang and Jiangsu provinces have a long history of private enterprise and as discussed below, certain areas were targeted for early experiments in market reforms. The details varied by province, but one example of a revenue sharing agreement with the central government that provided incentives for experimentation in local policy was that after Guangdong province paid a fixed amount (perhaps 1 billion yuan) to the central government, it could keep the rest, making local governments residual claimants on any local economic development. Contracts of this form became widespread after 1988 and were expanded to sub-provincial governments as well (Qian, 1999). While this set-up led to incentives for local government officials to experiment and to bend the rules, it also fragmented the Chinese market for firms by largely preventing trade and economic ties between regions. Local governments had apparent incentives to keep all business and suppliers local rather than cooperating with other regions.

The dual-track approach began in 1979 in the rural areas with two-tier pricing. It has since been extended to other sectors through various forms as a reflection of the early belief that private business served as a complement to state-ownership as a way to deal with unemployment. The dual-track policies also satisfied the central government's concern that development proceed in a way so that protests would not endanger its political survival. The view of politicians was to develop in a way that would "leave no one worse off than before" (Shirk 1993, pp. 130, 137, 334; Laffont and Qian 1999; Lau, Qian, and Roland 1997). However, this approach may have also stunted the growth and development of the private sector by continuing to protect the interests of state-owned enterprises. Thus, the transition from a planned economy to a more open market economy has been gradual with certain punctuated periods of significant progress.

Deng Xiaoping issued a reform report in 1975. In 1978, Deng launched the 'Four Modernizations' reform program to deal with the economic crisis after the Cultural Revolution by stimulating economic growth.[31] Market oriented reforms in China began in earnest in December of 1978 with the Third Plenum of the Chinese Communist Party's 11th Central Committee (Gregory, Tenev, & Wagle, 2000). In July of 1979, commune and brigade enterprises were allowed to enter non-agricultural industries. The State Council permitted these activities under the "Regulation on Some Questions Concerning the Development of Enterprises Run by People's Communes and Production Brigades," which also granted provinces the right to give 2-3 year tax holidays for new commune and brigade enterprises. As a result, light industry grew extremely rapidly from 1979 up through 1984 (Wong, 1988). Private entrepreneurship began to re-emerge in China with the legitimation of township and

[31] See Young (Young, 1995) for a comprehensive background on private business and economic reform in China from 1978 to the mid-1990s.

village enterprises (TVEs) to de-collectivize agriculture. The vast majority of TVEs were completely private.[32] These enterprises were sometimes collectively owned by local governments but primarily had entrepreneurial incentives for their managers who were free to react to prices and choose product lines. Commune and brigade enterprises had long existed prior to this time period in the rural areas and were renamed in March of 1984 as TVEs. By 1988, total rural enterprise output had increased by five times compared to 1983. By 1990, TVEs accounted for 20 percent of China's gross output (Liao and Sohman, 2001).

From 1978 to 1988, the Chinese government began to allow the entry of foreign invested firms along with opening to foreign trade and investment. One stream of literature has examined the institutional drivers of FDI and some of its unintended economic consequences within China (Huang, 2003; Huang, 2004a; Huang, 2004b; Huang, 2006). Some scholars argue that financial integration and particularly foreign direct investment (FDI) is another mechanism that contributes to economic growth in developing countries (Alfaro & Charlton, 2007). Investment by "co-ethnic networks" appear to have been particularly large over the years, with 59% of the entire stock of FDI between 1978 and 1999 being supplied by three ethnically Chinese economies – Hong Kong, Macao, and Taiwan (Huang, Jin, Qian, 2008). Besides providing capital, these ethnic ties can also perform institutional functions which would otherwise be performed by a government in a more developed country, but are typically lacking in developing economies. These institutional functions include contract enforcement and dispute resolution (Huang, 2008; Tong, 2005).

Despite this opening of the economy to foreign trade and investment, domestic private enterprises were still subject to ideological biases which largely limited them to rural areas only

[32] Confusion has arisen since the Chinese definition of TVEs is as rural firms, whereas Western academics assume the term refers to ownership (Huang, 2008).

(Qian, 2000). For many years that focus on FDI led to a consequent discrimination against domestic private firms, which increasingly were allowed to exist, but whose growth was stifled by various practices. Initially, the private sector in China almost solely consisted of individual businesses, employing seven people or fewer (the same as in the European Communist countries), referred to in Chinese as *getihu*, which were unregulated. On April 12, 1988, entrepreneurship became legal again in China. The First Plenary of the Seventh People's Congress approved Article 11 of the 1988 amendment to the Constitution of the People's Republic of China, which "permits the private sector of the economy to exist and develop within the limits prescribed by law." Three additional regulations were issued by the State Council providing protection for the private sector and specifying rights and obligations (Zhang and Ming, 2000). In June of 1988, the government issued the Tentative Stipulations on Private Enterprise (TSPE) stating that a unit with privately owned assets that hired more than eight employees was regarded as a private enterprise (*saying qiye*). This document officially permitted entrepreneurs to hire more than eight employees. The cutoff of eight employees is said to have come from Marx who theorized that a business at that size could support an owner who can begin to exploit labor (Whiting, 2001 Power and Wealth in Rural China). Large private firms had existed as early as 1981, however it was impossible for the party leadership to officially recognize them at that time (Young, 1995). After June of 1988, firms could either register as *getihu*, and be given permission to employ more than eight people, or they could pay an administration fee and obtain a collective license to a state or collective unit. The latter category were called "red hat" firms since to avoid harassment, they put on a hat of collective ownership, even though they were essentially privately owned (Gregory, Tenev, & Wagle, 2000). Red hat firms continue to exist to this day in China, making interpretation of

government issued statistics difficult. Using a sample of 300 villages surveyed, it's estimated that there were 500,000 *getihu*, or private firms at the end of 1988 (Zhang & Liu, 1995).

Economic reform was put on hold in 1989, however. Inflation and corruption as well as the political uproar from the Tiananmen Square incident allowed conservatives to gain more power and to implement from 1989-1990 an "austerity program" throughout much of the country. Credit was sharply cut to rural enterprises and total employment in TVEs fell by 3 million between 1988 and 1990 (People's Daily, March 23, 1990). There was relicensing of private operators and a major tax collection drive among private enterprises. There was even discussion of recollectivizing agriculture and recentralizing financial power and investment away from the provinces and local governments. Debate within the country grew as jealousy and outrage emerged over the high incomes of business owners and the exploitation of workers (Young, 1995). The new boom period of private sector development in China began after Deng Xiaoping's "South Touring Talk" in early 1992. Motivated by the economic slowdown (4.4% and 3.9% GDP growth in 1989 and 1990) and the gridlock within the central government, Deng Xiaoping made stops in several special economic zones, which would be sympathetic to his views in the Southern part of the country, to give speeches about further economic reforms. It worked and economic reforms were re-started beginning with the removal of price caps on the Shanghai Stock Exchange in May of 1992. Interviews suggested that many were inspired after these talks that as Deng reportedly said, "it is glorious to be rich" and decided to try to get rich quick through entrepreneurship. Other sources deny that the "glorious to be rich" part of the speech was ever actually made. Up to this time, economic activity between businesses and with the government was done primarily by "particularistic contracting" on a one-off fashion.

The government had largely failed to establish a rule-based market system, and up to now had not addressed ownership and property rights issues (Qian, 1999).

After Deng Xiaoping's speeches, the Fourteenth Party Congress in September of 1992 indicated that the goal of economic reforms in China was a socialist market economy. While to Westerners, this may sound insignificant, for China it was a bold statement about the relationship between the state and private sectors. Next, the Third Plenum of the Fourteenth Central Committee issued the "Decision of Issues Concerning the Establishment of a Socialist Market Economic Structure" in November of 1993. The decision moved the country towards a reduction in ownership discrimination between state and privately owned businesses. It also showed the intention to turn large state enterprises into more independently run companies and to sell off the smaller ones, known as grasping the large and releasing the small (zhuada fangxiao) (Young, 1995). Finally, this decision emphasized the importance of coordination among reforms to create more of a rule-based system and less particularistic contracting (Qian, 1999). Following this important decision, a series of reforms were passed covering foreign exchange, taxes, the monetary system, the financial system more broadly, and a streamlining of government bureaucracy (Qian, 1999).

While the intention was announced much earlier, the privatization of state-owned enterprises began on a large scale in 1995.[33] By the end of 1996, 11.5 million workers were laid off and 50-70 percent of SOEs had been privatized (Qian, 1999). In September of 1997, the Fifteenth Party Congress made a large rhetoric shift in referring to private ownership as an important component of the economy and state ownership as a pillar of the economy. They also indicated that public ownership could be realized through joint stock corporations with

[33] Transformation of ownership (*zhuanzhi*) or "restructuring of ownership" (*suoyouzhi gaizao*) are used in China in place of the term "privatization" (Qian, 1999)

many owners investing. Through a twist of careful wording, they were essentially condoning the private ownership of corporations.

The Chinese Academy of Sciences (CAS), like the U.S. National Academy of Science, is the country's most prestigious research institution. The objective of the Knowledge Innovation Program (KIP) program was to re-create the CAS by redirecting resources towards creating 30 internationally recognized research institutes by 2010. The long term goal was to have five of those research institutes become recognized as world leaders. The Knowledge Innovation Program was passed in 1998 and in order to re-direct resources to create a handful of world-class institutes, between 1998 and 2005 the number of Chinese Academy of Sciences research institutes was scaled back from 120 to 89 (Ma, Dali 2006). While the research institutes were being reformed, changes were also occurring to build venture capital as a financial intermediary. Much of this occurred due to the influential role of Deng Nan, the daughter of Deng Xiaoping, who was the number two official in the CAS. Her visits to the U.S. and to MIT in particular, exposed her to high levels of institutionally encouraged technological entrepreneurship, which she hoped to emulate in China (Roberts, 2009).

The development of venture capital in China is discussed in further detail in the section on reforms in the financial system. Without repeating that section, it is worth noting that also in 1998 reforms were passed promoting venture capital and private equity investment. The State Council approved a government document, *Several Opinions on Establishing a Venture Investment Mechanism*, released November 16, 1999 jointly by the Ministry of Science and Technology and the State Development and Planning Commission. The document offers guidelines for venture capital regulation in China and states that: "A healthy venture capital investment system is important to propel the establishment of a country's technology

innovation system, promote national economy and comprehensive national capacity, and realize leapfrog development for China."

Since 1998, the Chinese government has invested more than $16 billion of its funds in state-owned venture capital funds. The local governments in Shenzhen and Guangzhou, have passed regulations granting favorable conditions for venture capital. The Ministry of Foreign Trade and Economic Cooperation has also eased the entry of international venture capital firms.[34]

Building on the statements issued in 1997 redefining the relationship between the state sector and the private sector, on March 15, 1999, the Second Plenary of the Ninth People's Congress approved an amendment to the Constitution. The Amendment put the private sector on the same legal footing as the public sector for the first time. It was reported that immediately after the amendment, local governments started to relax restrictions on private enterprises (People's Daily, April 9, 1999). The Innovation Fund for Technology Small and Medium Enterprises (SMEs) was passed in 1999 to provide a new mechanism of funding to encourage the development of technology-based entrepreneurship. A significant landmark occurred when China joined the World Trade Organization (WTO) in 2001. It is not clear, however, the impact that this particular event may have had for entrepreneurship in the country. Most likely, the most direct effect may have been a signal of improved intellectual property protection in the coming years. The broader economic impacts were more diverse since many reforms led up to the admission into the WTO and many reforms followed that on the whole

[34] In February of 1996, Sohu.com launched the first internet search company in China. It is also reported to have been the first internet company funded by venture capital (http://en.wikipedia.org/wiki/Charles_Zhang accessed 4/17/2009). The rise of Sohu and its listing on the NASDAQ along with the U.S. dotcom boom was noted in several of my interviews with entrepreneurs as a source of inspiration for their own ventures.

appear to have boosted trade and economic growth. This increased economic activity would indirectly aid entrepreneurs.

The pre-1999 time period can be characterized by an institutional environment that begins to support entrepreneurship via legitimization, less stringent discrimination against private ownership, economic zones with lower tax rates and foreign investment reform[35] and privatization of SOEs. One exception to the claim that the earlier period focused on providing legitimation is that it was only in 2002 that the 16th National Congress of Communist Party of China allowed private entrepreneurs to join the Communist party.

During the more recent (post-2000) period, the institutional environment can be characterized as one that more directly supports the growth of start-ups, particularly those that have the potential to be high growth and are technology-based. The changes in the institutional environment in this period are distinguished by the proliferation of science parks and technology business incubators as well as associated tax incentives for R&D and licensing activities. Overall, there is an emphasis on reforms in the tertiary education system with the stated long-range goal of an economy driven by advances in science and technology.

For example, in 2006, the government adopted the Medium and Long Term Science and Technology Strategic Plan to plot the course of science and technology policy in the coming years (OECD Review, 2007). Overall, there is a dearth of scholarly work (in the English language journals) on the more recent reforms related to entrepreneurship in China since 2001. In many ways this is a shame since many diverse programs and changes appear to be occurring. For a review of 68 English language articles published on entrepreneurship in China, see work by Yang and Li (2008). Rather than continuing with the details of the most recent reforms, I

[35] Foreign investment would have gone mainly to state-owned enterprises (SOEs) rather than to start-ups.

next turn to several more specific, but important topics: regional differences, science policy, higher education and the financial system, before discussing relevant theoretical lenses.

Regional Differences: Coast/Inland, Special Economic Zones and Science Parks

Scholars have produced a large literature on the economic geography of China, particularly the coast-inland regional disparities. Much of this work portrays China as being a highly fragmented regional market (Young, 2000). More recently, Naughton (2003) has used interprovincial commodity trade data to show that the regions are more economically integrated than expected and rapidly growing more so. It is true that Guangdong and Fujian have enjoyed special treatment due to their geographical location dating back to 1979 when they were permitted to open up and reform ahead of other regions within China. The central government established Xiamen in Fujian Province, Shenzhen, Zhuhai, and Shantou in Guangdong Province (near Hong Kong) as special economic zones in 1980 (Qian, 2000). Essentially, these zones were allowed to become market economies while the rest of China maintained central planning. The special economic zones had a special policy (*teshu zhengce*) and institutional environment more conducive to free markets, such as the authority to approve foreign investment projects up to $30 million, lower tax rates, and the encouragement of private entrepreneurship. In 1992, special privileges were extended to most cities along the Yangtze River. Even inland cities that did not have special economic zones created "development zones" and granted them tax benefits (sometimes without central government approval).

In his book on IT enterprises in China, Segal (2002) studies the four cities: Beijing, Shanghai, Xi'an, and Guangzhou. He notes that differences in the relationship between the local governments and the private or hybrid quasi-private enterprises were the drivers of growth in the IT sectors. In the cities where state-owned and foreign companies successfully won the attention of the local government, the private firms and thus the overall IT industry in

those cities suffered. On the other hand, when local policies were favorable for indigenous private firms, conditional on past institutional arrangements (to be discussed further below) they tended to prosper.

To encourage the entry of high-tech firms and spur innovation, local and national governments in China have developed an extensive number of science and industrial parks. China currently has six thousand industrial parks and 58 national-level science parks (Cai, Todo, and Li-An Zhou, 2007). Established in the geographic area of Zhongguancun in the northwestern section of the Haidan District in Beijing, the Zhongguancun Science Park (the Z-Park) was the first of many science parks now set up throughout China. The Z-Park was established in 1988 and is today the largest national science park in China. It is affectionately known as China's "Silicon Valley," and in 2003 contained over 12,000 firms, and a total employment of 480,000. Many high-tech multinational enterprises (MNEs) such as Google, Panasonic, Motorola, IBM, Microsoft and Nokia have offices in the Z-Park and MNEs accounted for 12 percent of the firms in the park in 2003 (Cai, Todo, and Li-An Zhou, 2007). The majority of construction was finished on the Tsinghua Science Park (affiliated with Tsinghua University) by 1999 and it was one of the first national university science parks in China.

As an example of the type of benefits and incentives to locating in these science parks, the government offers Z-Park firms several advantages. One is that corporate income is taxed at 15 percent instead of the normal rate of 33 percent (but now only for a limited time period). For the first three years new entrants are exempt from corporate income tax altogether. In addition, traditionally in China a system of household registration (*hu kou*) has been enforced for regulating the mobility of people across locations. School and housing subsidies are not

available for a person who does not have *hu kou* in a locality. However, to attract talent from other parts of China and back from overseas, the government allows employees in the Z-Park to obtain Beijing residence. Even more preferential policies were granted in 1999 by the government. These included reduction of sales taxes on technology transfer, R&D expenditures, services, and consulting activities.

One should not get the idea that all of the regional policies in China have been conducive to entrepreneurship of course. A strong industrial policy adopted in Shanghai in the mid-1980s appears to have largely suppressed the long history of entrepreneurship in that coastal city and economic hub (Huang, 2008). Shanghai illustrates the complexity of entrepreneurship as it had many aspects going for it, including a highly developed legal system (Guthrie, 1999). However, under mayors Jiang Zemin (who became Premier of China) and Zhu Rongji, (who was Minister of Industry) from 1985 to 1991, the city embraced a development plan starting in 1987 which put restrictions on private businesses and directed investment towards foreign-invested and state-owned firms. The result of this policy is one of the lowest rates of entrepreneurship and smallest levels of household business income across China (Huang, 2008 Working paper).

History of China's Science Policy

After the founding of the PRC in 1949, China adopted a Soviet style public research institute-centered innovation system where firms concentrate on production and public research institutes (PRI) focus on science and technological innovation with transfers between the two coordinated by government bureaucrats at various levels (Law, 1995; Xin & Normile, 2008). The Chinese Academies of Science, local governments, and various industrial ministries oversaw research in China via the state research institutes (Liu & White, 2001). In general terms the OECD has claimed that roughly four eras of Science and Technology policy reform

have elapsed since the "open door policy" began in 1978. Overall, China's science and technology reforms can be viewed as moving away from a PRI-centered system to more of a firm-centered innovation system (OECD Review, 2007). Scientific research was dramatically affected by the Cultural Revolution, however, and order was not restored until 1978 when the national science congress in Beijing announced a development guideline for science and technology (Hong, 2008). In 1984, the Chinese patent law was enacted and the Chinese Intellectual Property Press began keeping a dataset of patent information since 1985. 1985 was a key year for Chinese science and technology reform. The Central Committee of the Communist Party passed a resolution on structural reform of the science and technology system and indicated the move away from the former Soviet system (Motohashi & Yun, 2007). After this reform, in the mid-1980s in order to push research units and universities toward serving the market and economic results, government research funding was significantly cut. Cutting the budget continued from 1986 to 1993, when there was an annual decrease of 5% per year in government research funding (Zhou, Li, Zhao, & Cai, 2003), p. 24). As a result of this decline in funding, some universities started their own enterprises as a source of funding. In 1991, the central government made this practice official, even though university-owned start-ups generated 1.8 billion RMB in sales that year. That number increased to 37.0 billion RMB by 1999 (Zhou, Li, Zhao, & Cai, 2003).

Other significant reforms in the mid-1980s were the passing of the National Key Technology R&D program in 1984, and the creation of the National Natural Science Foundation in 1986. In 1986, a group of scientists convinced the state that China was missing out on scientific and technological commercialization opportunities and the central government passed the 863 Program to encourage entrepreneurship through technology development zones

(Zhang, Li, & Schoonhoven, 2008). During the 1990s the special privileges associated with these zones spread to most cities along the Yangtze River and beyond to the coastal provinces. Essentially, these zones were allowed to become market economies while the rest of China maintained central planning. The special economic zones had an environment more conducive to free markets, such as the authority to approve foreign investment projects up to $30 million, lower tax rates, and the encouragement of private entrepreneurship.

Higher Education

China differs from other low wage countries in focusing on tertiary educational development rather than primary or secondary education as a development strategy. Initially, Chinese universities were set up Soviet-style, such that different universities specialized in different areas (e.g. life sciences, engineering), rather than the system we are accustomed to in the West where each university has almost every academic department (Law, 1995; Xin & Normile, 2008). In the 1960s, the Cultural Revolution shut down higher education altogether and universities only opened again in the late 1970s. In June of 1981, to develop and increase enrollment of science and engineering students at 26 leading universities, the World Bank approved a $100 million loan to China and the University Development Project (part of the International Development Association) made another $100 million credit available (NY Times, June 25, 1981).

While the details of history are often more complicated than the narratives which get retold, it may be helpful in this case to paint a finer-grained picture of what China's universities and science policy environment were like leading up to 1999 and in the period since then. The 1990-1999 period can be characterized by an institutional environment that supports entrepreneurship via lowering barriers to entry including legitimization, economic zones with lower tax rates and reform and privatization of SOEs.

Over the past ten years, the major trends in higher education in China have been merging universities and expansion of enrollment, decentralization, diversification and moves to establish world class universities, privatization, and internationalization. University enrollment (broadly defined by the Ministry of Education Statistics) has ballooned from under three million in 1995 to over 18 million students enrolled in 2007 (Figure 2). According to the National Bureau of Statistics of China, restricting the definition to four year colleges and universities, the total number of graduates has gone from 830,000 in 1998 to just over three million in 2005. Since 1999, the number of undergraduate and graduate students has grown at nearly 30% per year. However, evidence indicates that quantity has been expanded at the expense of the quality of the graduates (Gereffi, Wadhwa, Rissing, & Ong, 2008).

Insert Figure 2 here

Ministry of Education of China; National Bureau of Statistics

The Chinese government appears to be using education policies as a mechanism to maintain high economic growth via skill upgrading (Li, Whalley, Zhang, & Zhao, March 2008). A national forum decision to encourage the consolidation of institutions and decentralization in December of 1994 caused another wave of change in the universities. The percentage of national universities went from 51% to 9% between 1995 and 2002 as decentralization moved centrally controlled universities to the jurisdiction of local governments (Zhou, Li, Zhao, & Cai, 2003). Consolidation was particularly rapid between 1999 and 2006 when 60% of the 431 consolidations between 1990 and May of 2006 occurred (Li, Whalley, Zhang, & Zhao, March 2008). For example, in major cities, four or five smaller universities could move to improve their ranking by consolidating into a single university. Beijing Medical University was

incorporated into Peking University in 2000 and the Central Arts and Design College was incorporated into Tsinghua University. The State Education Commission (SEdC) launched the "Reform Plan of Teaching Contents and Curriculum of Higher Education Facing the 21st Century" in 1994, establishing 211 large projects and nearly a thousand sub-projects to improve teaching and curriculum in higher education institutions. In 1995, Phase I of "Project 211" was initiated and since then $2.3 billion has been spent on Project 211 mainly for infrastructure and curriculum development with the goal of identifying 100 top educational institutions in China for improvement. The plan covers infrastructure and teaching ideology, content, curriculum structure and methodology. In 2000, Phase II of Project 211 was launched, and Phase III is planned for 2008.

Another active year for new science and technology programs was 1998. This was the year when the ministry of education devised Project 985. The plan was originally targeted at Peking (Beida) University and Tsinghua University in order to strengthen existing research and to catalyze new areas for research. Phase I of Project 985 began in 1999 (with funding grants to Peking, Tsinghua, Fudan, Zhejiang, and Nanjing Universities) and was expanded to over 30 universities. Tsinghua University and Beida University each received $225 million and Beida used these funds to establish its Institute of Molecular Medicine (Xin & Normile, 2008). Phase II of the project was approved to run from 2004-2007 and Phase III begins in 2008. As mentioned earlier, the Knowledge Innovation Program was passed in 1998. In the following years, this reform resulted in over 14,000 new academic appointments as the Chinese Academy of Sciences was reformed and established as the backbone of the innovation system with the goal of 30 internationally recognized institutes. Also in 1998, the 100 Talents Program was also established to provide incentives for young, talented scientists who were educated abroad

to return to China and also for those in China to remain with the CAS. The last major change was in August of 1999 when a National Innovation Congress, organized by the central government, announced an act promoting high-tech industries and promoting the commercialization of innovation. Local governments also incorporated the promotion of technology commercialization in their local science policies after this act was passed as well (Liu & White, 2001).

During this time period, from 1985 to 2004, analysis of Chinese patent data and co-patenting trends between universities and firms shows evidence of decentralizing of knowledge flows and some localizing trends in the sense of local firms and universities patenting more with each other than only with universities in Bejing (Hong, 2008). Hong (2008) interprets this finding as resulting from decreased central planning and coordination across regions by the central ministries as greater levels of control were released from central ministries to local governments and their universities. Li and coauthors claim that pre-1999 there was a focus on increasing the quantity of enrolled students, whereas post-1999 there has been an increased emphasis on quality of research and teaching (Li, Whalley, Zhang, & Zhao, March 2008). Since 1999, there have been changes not only in the enrollment and funding levels for universities but also in the academic contracts. New academic contracts tend to use annual publication quotas and not to offer tenure (Li, Whalley, Zhang, & Zhao, March 2008). Often faculty members are required to publish three articles in international journals each year and their employment can be terminated if this goal is not met. Citations to articles as well as international rankings and cooperative projects are also tracked and these are sometimes tied to funding at the university or department level.

Government funding for higher education is program based and heavily skewed towards the top ten universities. Since 2001, tuition and fee payments (not government funding) have provided over 50% of total education expenditures.[36] In absolute levels, the amount of funding for education has increased significantly over the past 10 years (from RMB 226 billion in 1996 to RMB 981 billion in 2006). The top 11 universities that were funded in the first phase of Project 985 received over 17 billion RMB in government funding in 2004 (Li, Whalley, Zhang, & Zhao, March 2008). However, when scaled as a percentage of GDP, it has remained constant at just under 3% and when normalized for the large increases in enrollment, it has actually declined to $672 per student in 2005 (from $847 per student in 1998) (Xin & Normile, 2008). The result is that universities have been forced to borrow large amounts of money from the banks. A report in 2007 indicated that 72 top national universities have $4.5 billion in outstanding loans. Exacerbating the situation, many local governments have reportedly failed to match central-government funding as they are required to do. Another source of funding for higher education in China has been commercial activities organized by the universities themselves. While the total number of these university-owned firms has decreased, their profits have increased and the amount of funding flowing back to the universities has increased slightly from 1.5 billion RMB in 1998 to 1.75 billion RMB in 2004 (Li, Whalley, Zhang, & Zhao, March 2008). In an effort to remedy what is seen as a short-term problem of funding shortfalls, the ministry of education has limited growth in admissions to 5% each year. In order to address the problem, the government has returned to the prior approach of sending graduate students overseas. The China Scholarship Council was established in 2007 and funded with $1.3 billion to pay for 5,000 scholarships to Western universities a year for Chinese students, with the requirement that they return to teach in China.

[36] National Bureau of Statistics of China (2005)

In 2006, the 11th 5-year plan set goals to improve the quality assurance system, improve the national college entrance exam and recruitment, stabilize admissions and make the funding system sustainable, as well as to strengthen Projects 211 and 985 (Whalley & Zhou, 2007). On Sept. 11, 2006, China adopted Project 111, which aims to recruit 1,000 prominent academics from overseas to help create 100 "subject innovation centers" in China.[37] As further targeting of the development of a select group of world-class universities, only those universities which were included in Project 985 and 211 may participate.

In general, much has been made of the amount of money being spent and the goals to create world-class universities in China. Since 2000 there has been a strong increase in academic hiring efforts, wages and an overall upgrading of equipment and facilities in the top Chinese universities. However, pinning down exact numbers and digging deeper, one can see that there are still large financial hurdles to be overcome.

Intellectual Property

It has been estimated that in the late 1980s and early 1990s, the United States lost $2 billion of revenues due to intellectual property violations in China.[38] In 2006 alone copyright piracy in China resulted in $2.2 billion of US trade losses (International Intellectual Property Alliance, 2007, p96). Thus, intellectual property protection disputes and negotiations between the U.S. and China have been contentious and spirited (Yu, 2006).

As mentioned earlier, the Chinese patent law was enacted in 1984 and the Chinese Intellectual Property Press began keeping a dataset of patents since 1985. Figure 3 shows the growth in domestic patent grants up to 2007 (National Bureau of Statistics, China). In 1993,

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[37] http://english.hanban.edu.cn/english/China/181075.htm
[38] Seth Faison, China Turns Blind Eye to Pirated Disks, N.Y. TIMES, Mar. 28, 1998

China passed a patent law bringing it into compliance with the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), however, enforcement has been up to local officials and has been a different matter. By the late 1990s, the Chinese central government had realized the positive effects of the U.S. Bayh-Dole Act (Mowery, Nelson, & Sampat, 2001), and was under pressure to improve intellectual property rights in order to join the World Trade Organization (WTO). The Ministry of Education announced in April of 1999 a Chinese version of the Bayh-Dole Act, allowing universities to own patents on inventions resulting from government funding (Ministry of Education, 1999; Hong, 2008). Nonetheless, intellectual property rights enforcement has been singled out by the American Chamber of Commerce in China as an exception to the otherwise strong implementation of World Trade Organization (WTO) obligations in China (Branstetter & Lardy, 2006).

Figure 3 here

Effects of Multinationals

One concern about the large amount of FDI in China is that multinationals and foreign-invested firms might be crowding out domestic entrepreneurial firms (Backer & Sleuwaegen, 2003; Huang, 2003). Cai, Todo, and Li-An Zhou (2007) suggest that the R&D done by multinational firms in China has stimulated the entry of domestic firms. The authors interpret their findings to show that potential indigenous entrepreneurs benefit from the diffusion of multinationals' advanced knowledge and technology by providing evidence that domestic firms do more R&D as a result of knowledge spillovers. Increases in domestic entrepreneurship in their dataset do not appear to be tied to multinationals' production activities or domestic firms' R&D activities. The authors are careful to correct for endogeneity concerns through use of system generalized method of moments (GMM) estimation. However, their estimation relies

on the assumption that the lagged regressors can be used as instruments since they are predetermined and should not be correlated with the contemporaneous error term. This assumption is tenuous if there is autocorrelation between the lagged and contemporaneous regressors. While the data have the advantage of the detailed records of the Zhongguancun Science Park (the Z-Park), this is the largest and oldest science park and may not be representative. Nonetheless, the results do concur with prior studies (Backer & Sleuwaegen, 2003; Gorg & Strobl, 2002). In particular, the results also are supported by the case studies of Taiwan, Israel, and Ireland reported in Breznitz (2007) that countries can effectively pressure MNCs to locate R&D activities within the country.

China's Technical and Entrepreneurial Labor Market

Despite the fact that the U.S. share of the world's science and engineering graduates is rapidly declining (the U.S. share is expected to drop to 15% of the world share by 2010) and the greatest growth is in China, the vast majority of the related literature on entrepreneurship and innovation focuses on the U.S. and Europe (Freeman, 2005).[39] Further, it is clear from work in institutional economics and cross-cultural psychology that the levels and modes of entrepreneurial activity should be affected by the surrounding institutions, norms, and legal systems (Busenitz, Gomez, & Spencer, 2000; Licht & Siegel, 2006). High-tech entrepreneurship and innovation in transitional and developing countries are rarely part of the scholarly dialogue of the field (Lu 1997, Lu, 2000 are notable exceptions). Puga and Trefler (2005) in the course of their discussion on the rise of incremental innovation in low-wage countries point out that much of our current thinking is influenced by Vernon's (1966) product-cycle model where products are developed in rich countries and moved off-shore to low-wage

[39] In 1966, 71% of science and engineering PhD graduates were U.S.-born males, 6% were U.S.-born females, and 23% were foreign born (Freeman & Shen, 2004).

countries. However, massive changes are under-way in international trade and development. China went from almost no science and engineering doctorates in 1975 to over 9,000 science and engineering PhDs in 2003 (Freeman, 2005). However, once the quality of the engineering graduates is taken into account, these numbers may be much lower or less comparable to U.S. numbers (Gereffi, Wadhwa, Rissing, & Ong, 2008). Nonetheless, at that rate of growth, by 2010 China will produce more technically-trained doctorates than the U.S. So while the current state of scientific research in emerging disciplines such as stem-cell research may be marginal, China is an up-and-coming player with a burgeoning pool of talent even in areas that are cutting-edge in the U.S. (Murray & Spar, 2006). Nonetheless, in the short term, the massive expansion of university graduates, especially since 1999 has led to a sharp increase in individuals with high educational levels relative to the number of job positions (Li, Whalley, Zhang, & Zhao, March 2008). This has created problems in absorption and unemployment which some speculate has led to the efforts to expand graduate education enrollment to prevent protests over high unemployment levels.

In the 1980s many SOEs fired or let go significant numbers of employees to privatize or create new firms since they could no longer financially support them (Steinfeld, 1998; Young, 1995). Many of these employees were in sales and marketing functions. In addition, reforms in the 1980s aimed to develop mechanisms to link managerial careers in SOEs to firm performance and to enhance the authority of SOE managers (Groves, Hong, McMillan, & Naughton, 1995; Naughton, 1995). These reforms created a managerial labor market where managers in poorly performing firms were more likely to be replaced and auctions were used to find new managers whose pay was linked to sales and profits (Groves, Hong, McMillan, & Naughton, 1995). A bankruptcy law for SOEs was passed in 1986 to provide, for the first time,

a path for SOEs to declare bankruptcy and a path through which they could go out of business rather than being continually supported by the state.

Such changes are happening rapidly especially in China's policies regarding property rights and institutions with important and as yet rarely documented implications for firm strategies, innovation and entrepreneurship (Cull & Xu, 2006; Nee, 1998; Nee, 1992; Nee, 1996; Peng & Heath, 1996; Steinfeld, 2007). Interestingly, China's new private entrepreneurs appear to have different values (Holt, 1997) and some influence on the political process and debate within the country (Roberts, Unpublished doctoral dissertation, 1997). Greater property rights protection and greater fairness (less corruption) in 33 emerging markets in Europe has been found to increase new firm founding and firm growth rates (Desai, Gompers, & Lerner, 2003). However, their analysis shows that the institutional effects appear to be of second order in more developed economies. In post-Soviet and formerly-Communist countries, insecure property rights have been argued to be more inhibiting to entrepreneurship than capital constraints (Frye & Shleifer, 1997; Johnson, McMillan, & Woodruff, 1999; Johnson, McMillan, & Woodruff, 2000; Johnson, McMillan, & Woodruff, 2002; Shleifer, 1997). Chinese entrepreneurs have been shown to use specific strategies such as political participation and philanthropy to overcome limited property rights protection and constrained access to bank loans (Bai, Lu, & Tao, 2006). Obukhova (2007) finds that depending on their training and overseas work and educational experiences, Chinese entrepreneurs engaged in two different entrepreneurial strategies which she terms technological entrepreneurship and network entrepreneurship. These strategies for firm formation which hinge on whether innovation or the individual's business network is driving performance, she argues, resulted in important implications for the performance of these firms over time.

As in the U.S., there are various routes to entrepreneurship in China and these have likely changed over the years as changing institutions signal the appropriate ways of getting ahead (Baumol, 1990). Particularly in more recent years there has been a government path to entrepreneurship where higher ranking government officials have opted to either formally or informally leave their posts and found private firms or reconstitute cooperative companies as limited liability corporations (Wank, 1999). The connections built up through prior government service provide these entrepreneurs with advantageous access to both information and resources. Also, within China where education is highly valued, academic jobs have been prestigious positions and we should expect that those who have worked in academia may have access to opportunities that are less available to others. Our interviews indicated that traditionally, as with the graduates of the French Ecole Polytechnique, the most talented Tsinghua University alumni often took prestigious positions within the Chinese central government. Some Chinese took opportunities to study overseas and gain stable work with large and multinational corporations. Until the most recent generation, these large firm and government opportunities were seen as the reward for persevering through years of competitive schooling to attend a prestigious university.

However, as noted above, innovation and high-tech entrepreneurship are rarely part of the discourse in relationship to China (for exceptions, see Tan, 1996; Tan, 2001; Tan, 2007). Widespread entrepreneurial activity began with the economic reforms that started in the late 1970s and high-tech entrepreneurship blossomed in the mid-1980s in the IT field. To the extent that resources and institutional infrastructure for entrepreneurship has been lacking in China, work experience and the accumulation of social and financial resources may be relatively more important for entrepreneurs. Our interviews suggest that investors in China see

fewer experienced entrepreneurs and must rely more on pre-founding work experience outside of an entrepreneurial context to judge the quality of entrepreneurs.

Financial System

Many authors argue that the state-dominated financial system in China retards efficient allocation of capital (Boyreau-Debray & Wei, 2005; Chow & Fund, 2000; Steinfeld, 1998). Bank loans are most often reserved only for state-owned enterprises and so private entrepreneurs are often denied loans (McMillan, 1997; Nee, 1992). For decades, the central government controlled all capital allocation by keeping all banks as state-owned and then directing bank loans towards state-owned enterprises, which were then taxed and received loans again in a closed-loop system, distorting incentives for all involved. Private capital may be acting to undo some of the inefficiency; however to know the true extent of the inefficiency result from state intervention in the financial system would require systematic data on private capital (business angels, or venture capital) invested. In March 1998, the PRC implemented a number of policies to promote venture investments (Batjargal & Liu, 2004). The initial venture capital funds within China were backed by the government, however, and had both policy as well as financial objectives. These initial government-venture capitalists often lacked the business experience necessary to pick good investments and these funds are widely seen as having had very poor performance. A handful of non-government backed private equity firms began entering the China market in the 1980s. It was not until after 1992 that economic reforms began to encourage significant numbers of private equity firms to enter the market (Bruton & Ahlstrom, 2003). Total venture capital investments in China grew from virtually nothing in 1990 to $858 million in 2000. In the early 1990s, 90% of VC-backed firms were SOEs. In contrast, fewer than 10% of the VC-backed firms were SOEs in the late 1990s (Zeng, 2004). By 2001 there were 180 venture capital firms in China, many of them with overseas ties,

some of these as joint ventures with Chinese government organizations, and $1.87 billion under management (Batjargal & Liu, 2004). In 2007, $2.49 billion was invested in 241 deals, according to the China Quarterly Venture Capital Report released by Dow Jones VentureSource) China's business/consumer/retail industry saw a record $1.25 billion invested in 94 deals in 2007, up 83% over the $682 million invested in 2006. The most popular segment within this industry was consumer/business services, which accounted for 48 deals and $761 million in 2007—61% of the industry's investment total. Elsewhere, 110 information technology (IT) companies in China received $992 million in venture funding in 2007. Healthcare had 21 deals and $175 million invested. Six deals were completed in clean energy and some $31 million invested in 2007, a big drop-off from the $421 million invested in 14 deals in 2006.

Theoretical Frameworks

Having finished a high-level overview of the historical perspective on the re-birth of widespread entrepreneurial activity in China, it is worthwhile to pause for a moment's reflection before diving into the various theoretical frameworks which may guide more analytical and generalized thinking about entrepreneurial development and market reform. It would be a mistake to simplify the past three decades as a story of the rise of private entrepreneurship and venture capital only. Indeed, the state-owned sector grew as well and may have even supported reform efforts (Naughton, 1994b). A complex array of policy reform, macroeconomic conditions, institutional entrepreneurship and individual behavior intertwined to produce the outcomes. Yet the international literature has characterized the process as 1) economic reform without political reform, 2) incremental, 3) beginning with agriculture, and 4) as regionally differentiated (Naughton, 1994b).

Most scholarly studies of the transition from command economy to markets and entrepreneurship have debated mainly issues of the optimal pace of reform or financial liberalization, institution building, and property rights arrangements. The authors have drawn largely on various sociological and economic theories, but made the assumption that transition from the starting point of a socialist, planned economy to a capitalist system is a unique and singular phenomenon (Steinfeld, 2002). However, a different viewpoint and set of theoretical lenses becomes available when one views the economic problems of countries like Korea or China as similar to the typical economic challenges of capitalist economies (e.g., corporate governance, soft-budget constraints, information asymmetries), rather than as totally different phenomena. So, expanding beyond the particulars of China's market reforms, what are the theoretical frameworks which should guide deeper exploration of the emergence of entrepreneurship? In my view, we are not trying to perfect our knowledge of "how to transition from socialism to capitalism" as (unless some alien socialist planet is discovered, which seems unlikely) there are no large centrally planned economies left to transition (Steinfeld, 2002). Instead, I believe the goal is, or should be, to use the special conditions of economic transition as a laboratory for testing theories and learning things about the economic and sociological underpinnings of management, entrepreneurship, and strategy for which these settings provide a unique perspective not available to scholars examining developed economies or while keeping the set of institutions and corporate governance structures relatively constant. Some scholars argue that Western conceptions can only take us so far in analyzing the emerging economic order in non-Western countries (Boisot & Child, 1996). The next generation of organizational scholars should step up to this challenge of testing theories and addressing

global differences, not only in marketing, strategy, or manufacturing, but also in entrepreneurship.

Four Levels of Social Analysis

When naively thinking about the various factors that may lead to international differences in the entrepreneurial process and outcomes or performance of start-up foundings, a host of variables come to mind (Begley & Tan, 2001). One could think about the culture, religion, risk tendencies, or about the governance and property rights institutions, policies, or even about the material costs and labor market conditions. Without a general conceptual framework, it is easy to get mired and confused in the myriad possible drivers and mediating factors. Williamson (2000) attempts to provide a conceptual framework of four levels of social analysis to begin to classify the various perspectives on why different countries wind up with different economic outcomes and industrial structures. Of course this is only one view, but it provides a nice starting point for taking a broad perspective.

Williamson refers to the first level as the *social embeddedness* level. It is at this level that culture and religion have their impact and this is the field in which a few economic historians, many anthropologists and some sociologists work. Factors at this level can be thought of as relatively stable and slow to change.

Second is the *institutional environment*. These are the "rules of the game" such as constitutions, how the judiciary process works, the organization of the political system. Political scientists and institutional economists or sociologists work on analyses of this level of society. The third level is that of *governance*. The governance level is concerned with contracts (Baker, Gibbons, & Murphy, 2002; Grossman & Hart, 1986; Hart, 1995; Hart & Moore, 1988; Hart & Tirole, 1988; Williamson, 2002 Holmstrom, Hart, Moore), information economics (Bolton & Dewatripont, 2005), transaction cost economics (Holmstrom & Roberts,

1998; Teece, 2000; Williamson, 1981), and the theory of the firm (Coase, 1937). In recent years and looking forward, this is a high growth area in terms of economics research. Sociologists and management theorists have also provided alternative frameworks at this level. Linking this area with the institutional environment, Lerner and Schoar forthcoming) analyze 210 developing country private equity investments and find that transactions vary with the legal enforcement in the country. They find that private equity groups in low enforcement nations rely more heavily on ownership rather than contractual provisions resulting in lower valuations and returns.

Finally the fourth level is referred to as the *resource allocation* level. This is the domain of neoclassical economists who concern themselves with incentive alignment (Grossman & Hart, 1983), production functions, quantities, and prices. Having set the stage with an image of these four levels of analysis of a society, Williamson goes on to argue that clearly these four levels interact with one another, but primarily in the order in which they have been laid out. The culture and religion in a country largely constrain the choices as to the form of the constitution and the institutions that are set up to guide behavior. Similarly, the institutional environment serves to enable in some directions and constrain in others the governance structures and types of contracts that can be written or enforced in the economy. In the same way, the governance level and the choices available there will constrain actors as they solve the pricing, quantity and incentive alignment problems at the level of resource allocation within and between firms as well as individuals.

The remainder of the paper will have more to say about the institutional level in particular as well as the governance level since justifiably, these are a major focus of recent work in understanding the international differences in economic growth and in

entrepreneurship. Yet, first I should note that one can easily quibble with this framework, particularly concerning directions of causality and co-evolution or feedback between different levels. Along these lines, it could be that it is economic development which provides the wealth necessary to build better institutions. The framework also lacks emphasis on psychological and some sociological factors. Nonetheless, it provides a good overview of relevant factors, and it is difficult to come up with a comprehensive alternative framework.

Some scholars have argued that certain components in the above framework are not appropriate for the conditions of developing economies. Theoretical work shows that occupational structure can be shown to depend on the wealth distribution. Only with a certain level of inequality in wealth does one start to see employment contracts used by employers (Banerjee & Newman, 1993).

In a reaction against the transaction cost economics framework of corporate governance mechanisms, Boisot and Child (Boisot & Child, 1988) propose an information based theory. In their theory, the twin factors of information codification and information diffusion determine the organizational structures that will dominate in a society. According to their argument, only in societies with high information diffusion and high information codification do we see market-based capitalism because only there is the information environment such that it will support such a system of large firms and mass-produced goods. They develop a matrix of other alternative arrangements including fiefs and clan structures which result from lower levels of diffusion or codification.

National Innovation Systems

The literature on national innovation systems also highlights the role of governments and institutions in enhancing innovation and research activities by coordinating local knowledge transfers and spillovers between universities and firms (Freeman, 1987; Nelson,

1993). While the term refers to an overall system, which could encompass government policies, large firms, start-ups, universities, and public research institutes, mostly, U.S. authors in this stream have placed weight on spillovers of commercially relevant knowledge from universities to firms. European authors have tended to emphasize the role of sophisticated users in the innovation system and the information flows from producers back to suppliers (Breznitz, 2007). More recent work has applied the innovation systems framework both more at the regional level and also to countries outside of the U.S. and Europe but similarly stressing university/industry interfaces (Motohashi, 2005). As discussed earlier, work tracing joint patent applications between firms and universities in China appears to show a decentralizing and at the same time localizing trend in knowledge flows from university to industry from 1985 to 2004 (Hong, 2008). Other authors have used a national survey of 22,000 large and medium sized manufacturers to track science and technology activities and linkages from 1996 to 2002 (Motohashi & Yun, 2007). The national innovation systems literature can be seen in many ways as a variant or subset of the varieties of capitalism idea that different institutional maps or structures can lead to different economic outcomes (Breznitz, 2007).

Building on the work on national innovation systems and on macroeconomic growth, Furman and colleagues (Furman, Porter, & Stern, 2002; Furman & Hayes, 2004) have developed a conceptual framework for a country's national innovation capacity, which is a combination of policies supporting innovation and investments in innovation through R&D expenditure and personnel. Their empirical work suggests that while many countries have adopted policies and institutions supporting innovation, those that have had greater growth in innovative performance have managed to make much greater investments in R&D in addition to adopting supporting policies.

Institutional Perspectives

Such alternative conceptions provide contrasting views, rich detail, and ways to think outside of more traditional frameworks, but have yet to be built upon or empirically tested extensively. On the other hand, neoclassical economics is built largely on a foundation which has abstracted away from institutions and the political, legal, and financial rules and structures within which pricing and quantity decisions are embedded. However, these institutions have not been neglected by sociologists and political economists and increasingly economists are paying heed to institutional frameworks as well. In institutional economics, the social institutions are defined as the laws, norms, and beliefs which form the written and unwritten "rules of the game" (North, 1990; Williamson, 2000). Institutions can help alter the constraints and structure of incentives in a society to direct self-interested behavior towards either more or less economically productive activities (Baumol, 1990; Nee, 1996). One complaint against the early institutional work done by many has been that institutions seem at once to be the heroes of economic development, doing countless jobs, yet the definition bundles together many seemingly disparate organizations, laws, and traditions. Yet over two decades ago a contract theory and a "predatory theory" of the state were distinguished (North, 1981). More recent work distinguished property rights institutions and contracting institutions. The former can be thought of as vertical, that is, protecting citizens from expropriation from government elites, while the latter can be thought of as horizontal in nature, protecting citizens and economic organizations with enforcement when they write contracts between each other. Empirical work appears to provide evidence that various measures of property rights appear to be more important for long-run economic development than contracting institutions (Acemoglu & Johnson, 2005). The explanation given is that it is easier to find informal and alternative mechanisms or second-best solutions to limited contracting institutions than it is to find

informal mechanisms to protect citizens from weak property rights institutions. Yet, other work has shown that informal property rights protection mechanisms do exist and can work (Bai, Lu, & Tao, 2006).

In recent years, there has been a fascinating, growing debate regarding the role of state intervention in developing economies. One view, which some have called the "Washington Consensus" for its widespread acceptance has advocated market liberalization including property rights, financial liberalization, and in general giving greater autonomy and control over prices and residual rights to private firms to allow markets to form (Johnson, McMillan, & Woodruff, 2000; Johnson, McMillan, & Woodruff, 2002). This view argues that there is very little role for the state in development and demonizes the state and government intervention while arguing for the great power of free markets and the "invisible hand" to allocate resources to their most productive uses. On the other hand, some sociologists and economic historians have argued for the important influence of what has been termed the "developmental state," which calls for government intervention to generate economic growth. The pioneers in this field saw economic development as part of the national building project and that government attention to the development of the economy was needed to preserve independence (Gerschenkron, 1962). Gershenkron (1962) argues that certain characteristics of less developed countries actually allow for more rapid economic development since existing investments do not act as barriers and a certain map of technological development has been shown by the more developed economies. In more recent years, scholars have taken the examples of the success of Japan, Korea, and Taiwan to argue for aggressive state intervention in developing economies (Amsden, 2007). At times, these scholars raise the state to a heroic level, arguing that in developing economies, only governments have the resources, talent, patience, and long-term

vision to build the core industries that will drive the growth of the economy. The perspective often builds on the ideal of a Weberian bureaucracy with career bureaucrats trained from within for their positions. They argue that relative failure has occurred in many economies in South America and Russia that have tried aggressive privatization and free market, lassie-faire approaches. Instead, developmental state proponents advocate government support to select a few key industries, generously support several large, nationally-owned firms, and protect these "seedlings" with trade tariffs, tax credits, and government subsidies until they grow to a point where they are strong enough to conduct their own R&D and support suppliers and related industries (Amsden, 1989). Theories in this vein talk about the challenges of import-substitution and upgrading from manufacturing and low-value added activities to do more innovation and higher margin activities (Amsden, 2003). They tend to ask how latecomers compete and how can developmental governments intervene in the markets to support them.

A typical successful example given of the effectiveness of the developmental state is that of Taiwan's semiconductor industry which was dominated by foreign firms in 1975. One company, Tatung managed to grow larger in size which enabled it to enjoy economies of scale and more optimal-sized plants (Amsden, 2003). The growth also allowed the company to develop managerial skills such as large project management among employees. This virtuous cycle then allowed for the capabilities for outsourcing manufacturing to lower-cost facilities in China. The Taiwan government had policies to support such large, national firms and gave subsidies for R&D and facilitated networking between Tatung and those who could help continue its growth. Stories like this and the case of Japan's rapid development via government-led efforts have had a strong impact on leaders in China's central government. On the other hand, the critique of this viewpoint, often from proponents of liberalization policies, is

that it is precisely too much government intervention and skewed market incentives which were the problem for planned economies in the first place. The argument here is that we want firms to be investing more in R&D, operations, and marketing rather than in building political connections and currying favor from government bureaucrats.

Instead of taking sides in this debate of aggressive market liberalization vs. aggressive state intervention, other scholars have questioned whether there is not more of a middle road and if the historical examples cited have relevance for today's world economy. This more recent area of literature has become known by various names include the neo-developmental state or the networked developmental state. Other authors have merged in observations related to globalization and global production network theories. Steinfeld (2004) makes the argument that what is different today is that because of technological progress and the ability to transfer codified knowledge via information technology, firms have more networked production and manufacturing, marketing, and design can be spread across geographic locations. Industries are spread across locations rather than the entire production chain existing in single location (Sturgeon 2000, 2002, 2003). This argument is closely related to the work on global production networks and the global commodity chains perspective (Gereffi, 1999). The global commodity chains perspective has examined patterns of international trade and industrial upgrading and looks at mechanisms of organizational learning within trade networks, organizational conditions facilitating upgrading, and the trajectory from assembly to higher value activities such as original equipment manufacturer (OEM) and original brand name manufacturing. In the past, it was more appropriate to promote certain industries, but these changing in networked production have caused China to become very integrated into the world economy, but only in terms of low margin manufacturing activities. Instead of market

liberalization and decentralizing authority and property rights to firms, Steinfeld argues, what is needed is a clamping down and constraints-based approach to make the basic selection mechanisms of the market work in a developing economy. Ownership doesn't matter until the basics of markets are put in place and soft-budget constraint problems are solved (Steinfeld, 1998).

Dating back for many years, some scholars have advocated that the highest economic growth can be achieved by balancing the trade-offs between state planning and the efficiency of market competition. Of course, Japan experienced a wave of tremendous economic growth and with that a flurry of scholars wrote about various mechanisms through which the "Japanese Miracle" occurred. A similar flurry of writing can be said to be occurring with China's rapid growth, however, with the benefit of history, one can plot the economic growth of China's GDP against that of South Korea, Japan, and Taiwan and see that in comparison it is exemplary perhaps in terms of entrepreneurship, but not necessarily in terms of overall economic growth when comparable starting points are used. Johnson's (1982) detailed review of Japanese industrial policy argues that it was a highly trained and experienced bureaucratic leadership at the Ministry of International Trade and Industry (MITI) coupled with a national priority of economic growth and skillful implementation of a cooperative industrial policy which effectively balanced state planning and competition to achieve high growth.

As discussed above, the example of the IT industry in Beijing, Shanghai, Xi'an, and Guangzhou has been used to argue similarly for the positive impact of local government policies and help directed at indigenous private or quasi-private enterprises (Segal, 2002). In Segal's study, many of the top IT firms were spin-offs from government agencies and academic institutions. He does not argue that the contribution of the state is always positive, but rather

that it is conditional on past institutional structures. The other areas appear to lag behind since Beijing offered support for smaller private enterprises but did not have a history of having large government resources available to distort incentives away from market-based competition.

The latest version of the developmental state (or networked state or neo-developmental state) combines the perspectives of national innovation systems, global networked production, and the neo-developmental state framework (Breznitz, 2007). Breznitz (2007) argues that we need a more realistic story that views the state not as a single monolith, but rather as separate departments that bring in political choices, allowing for a cohesive story about why in a single country, one innovation-based industry can fail while a different one succeeds. He builds a framework where there are choices for the politicians to make in the character and direction of development. For Breznitz, the state's role is to initiate and encourage a set of actors to enter into innovation-based industries and then to step back and act more as facilitator and network broker both internally among the firms and between the firms and multinational corporations or international financial systems. He emphasizes that in a world of fragmented production, it is not the state's role to dictate and determine industries to focus on, but rather to allow participants to sort out where to link into global production chains and to become networked with the industry enough to be able to respond to needs quickly and in a targeted manner. His work argues that the route that the state takes to becoming embedded with industry is as important as the state's structure and that there is no one optimal choice.

As an empirical test of the idea that supporting institutions impact the innovation strategy and performance of entrepreneurial firms in China, Li and Atuahene-Gima (2001) examine 184 firms located in the Beijing Experimental Zone science park. They use resource dependency theory and argue that their results show that there are contingent effects of

institutional support and environmental turbulence for product innovation strategy and performance of technology ventures in China. Their findings indicate that product innovation strategies are more effective in high turbulence environments and when the CEOs perceive institutional support to be higher. However, their study design has clear problems with endogeneity in the effects of performance on the perception of institutional support, and since the only variance among the firms in the environment they actually faced would be the industry, their results are also confounded with industry effects.

Another view which steps outside of this debate to take an even broader view of the relationship between non-market institutions and market forces argues against the idea that there is a single optimum institutional "blueprint" for economic development. A common element among the more recent, neo-developmental state writing has been a move away from the idea that economic development and the emergence of rapid innovation-based industries follows a linear trajectory with a single optimal set of institutions for growth (Breznitz, 2007). Some have argued that democracy is a type of meta-institution which allows for the aggregation of local knowledge and the development of the particular ecosystem of non-market institutions best suited for growth in a particular country (Rodrik, 2000). This argument alludes to literature on varieties of capitalism which argues that while some capitalist economies are organized for radical innovation and high growth (U.S.), others are better at other outcomes such as equality or incremental innovation (such as the EU, Japan) (Hall & Soskice, 2001). There is some support for this theory in the literature on China's development in the sense that some practices, unexpectedly, worked in China due to its particular history and environment. For example, Naughton (1994a) argues that the collective ownership form common for China's township and village enterprises (TVEs) leads to uncertainty about ultimate property rights.

Proponents of the role of property rights institutions in economic development might argue that this should have dulled incentives to invest and thus entry and growth. However, as indicated above, TVEs were remarkably successful and appear to have grown rapidly. This may have been because TVEs were an effective adaptation to the particular economic environment in China at the time (Naughton, 1994a). Product markets and demand for consumer goods was high, but markets for factors of production or assets and financing were not well-developed. TVEs may have been an organizational form that was flexible enough to be effective in that environment. While it's very hard to imagine that "local knowledge" anticipated that this would work well, it does lend credence to the idea that perhaps no single blueprint can foresee all the important environmental contingencies and adaptations.

Still another view is that whatever the government may do, legal systems and institutions are difficult to change or strengthen in the short to medium term, and so the main challenge for entrepreneurs in emerging economies is in finding informal and clever ways to overcome weak institutions and limited resources. Overseas Chinese networks have been shown to help in this regard, both with providing financing and also contract enforcement (Huang, 2008; Tong, 2005). The preceding line of work has led many authors to question whether in emerging economies, during liberalization, if it is better for resource-constrained entrepreneurs to invest in political networking or in R&D, operations and marketing (Guthrie, 1999; Rona-Tas, 1994). Political investment confers status and reputation, access to timely market information, and politicians still control critical aspects such as tax policy and banking regulation. However, with liberalization, one may no longer needs officials to bring resources or remove bottlenecks. Plus, using connections may be more dangerous as law enforcement is strengthened. Siegal (2007) uses a natural experiment in Korea to examine political

connectedness after liberalization and finds that, controlling for R&D and marketing, investments in political connections is one of the strongest determinants of cross-border alliance formation. The results suggest that the effect of liberalization policies is not to decrease the importance of political network investments, but rather to allow entrepreneurs to access new outside resources and partners. The study referred to previously of Beijing science park firms from the late 1990s found no effects for amount of effort spent on political networking on innovation strategy or performance (Li & Atuahene-Gima, 2001). However, the nature of the location and technology focus of these firms indicates that they were likely the focus of political officials regardless of their efforts to network.

Network theory has been a growing area of inquiry for a long time (Burt, 1992), but particularly in recent years it has been applied in an innovation or entrepreneurial context (Freeman, 1991; Shane & Cable, 2002). Previous work has indicated that while networking is vital in U.S. entrepreneurship, in China *guanxi* or a particular sense of "social connections" (Farh, Tsui, Xin, & Cheng, 1998; Park & Luo, 2001) is particularly important and appears to be a mechanism used to improve firm performance and overcome some of the underdeveloped legal and financial infrastructure in the country (Batjargal & Liu, 2004; Licht & Siegel, 2006; Peng & Luo, 2000; Xin & Pearce, 1996; Zhao & Aram, 1995). Political connections, as measured by affiliation with the ruling Communist Party, have been found to be particularly helpful for firm performance in regions with weak market institutions and legal protection (Li, Meng, Wang, & Zhou). Using a nationwide survey of 2,324 privately owned enterprises conducted by the Chinese Academy of Social Sciences and several other groups (including the United Front Work Department of the Central Committee of the Communist Party of China), Li et al. (2009) find that party-member entrepreneurs are more likely to obtain loans, have more

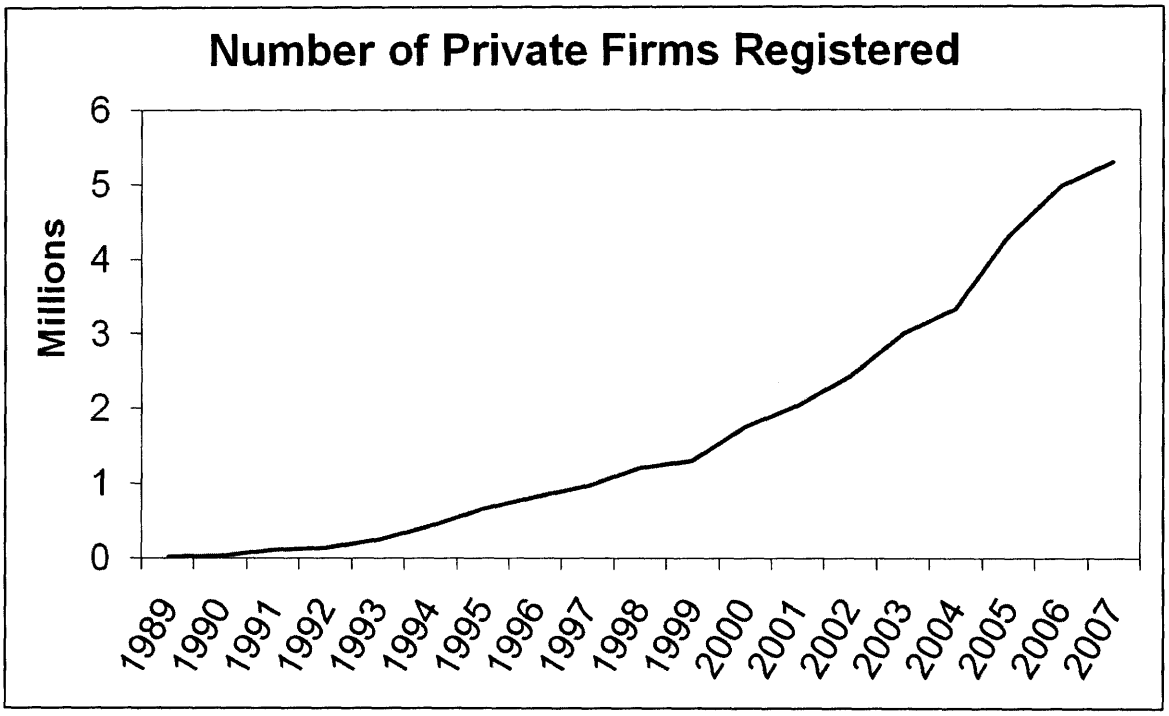
confidence in the legal system, and have higher firm profitability (assuming no systematic differences in reporting), even controlling for human capital. However, party-member entrepreneurs may have been more significant achievers even before becoming party members. There is an on-going debate, however, about the extent to which elites in transitional economies have been able to translate their power into economic benefits and the mechanisms that allow such a transfer (Walder 2002, 2003, Nee 1996).

Conclusion

In conclusion, the laboratory of China's recent economic liberalization and the growth in private entrepreneurial firms offer a unique window on the effects of shifting institutional and political factors on the entrepreneurial process and strategic issues for entrepreneurs and managers. For researchers, it offers an opportunity to examine the effects of aspects of the economic and social structure which are changing rapidly in China, but tend to remain relatively stable in the developed country contexts where entrepreneurship previously has been empirically and theoretically examined. Institutional frameworks have received increasing attention from scholars in recent years for their roles in supporting R&D along with entrepreneurial activity. The application of these frameworks in the context of technology-based entrepreneurship in developing countries should yield exciting results and new challenges for both empiricists and theoreticians interested in innovation and new business formation.

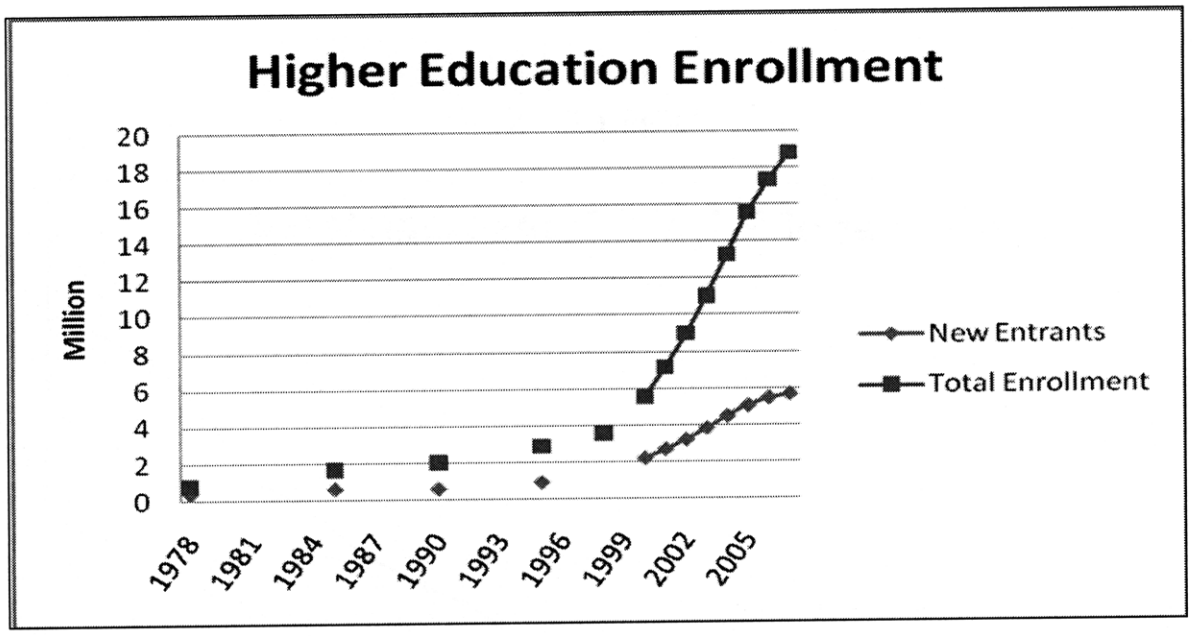
Figures

Figure 1



(Chinese State Statistics Bureau)

Figure 2


Higher Education Enrollment
Million
20
18
16
14
12
10
8
6
4
2
0
1978
1981
1984
1987
1990
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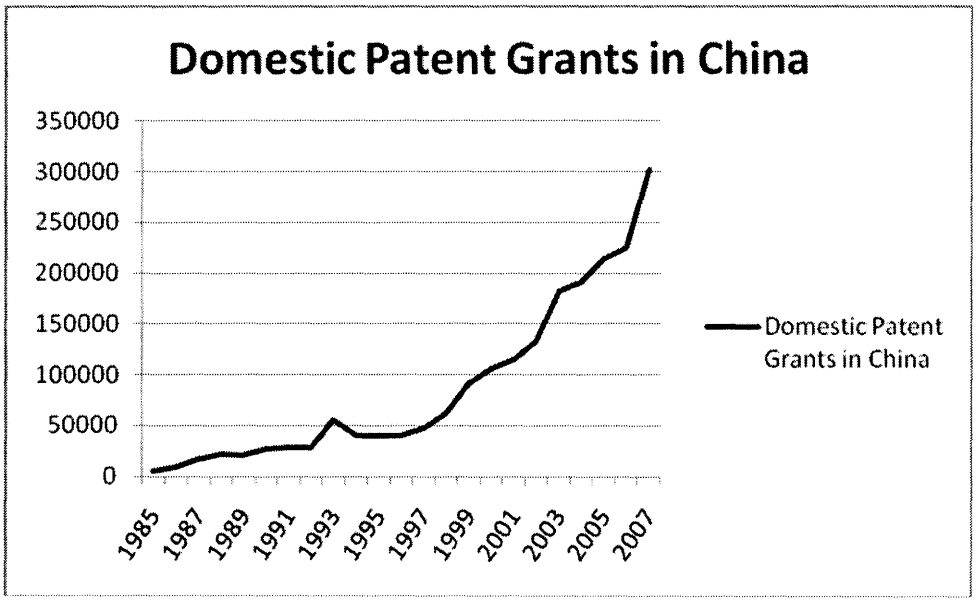
1996
1999
2002
2005
New Entrants
Total Enrollment

Figure 3



(Source: China Statistical Yearbook)

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Chapter Five:

Who has 'the right stuff'? Human Capital, Entrepreneurship and Institutional Change in China

Introduction

Nations, regions, even cities typically encourage entrepreneurship in the expectation that it drives economic growth as well as competition (Schumpeter 1934, Schumpeter 1942, Simeon Djankov, Porta, Lopez-de-Silanes, Shleifer 2002). The institutional arrangements to enhance entrepreneurship are framed in terms of easing constraints to allow those who previously could not overcome certain obstacles (yet who had entrepreneurial ability) to become entrepreneurs (Acemoglu, Johnson, Robinson 2002, Evans, Jovanovic 1989, Holtz-Eakin, Joulfaian, Rosen 1994).[40] Yet, this view is contradicted by evidence of high levels of entrepreneurship in some of the poorest, least developed countries that have high constraints to entry (Gollin 2002). One explanation for this puzzle is that economic development is associated with better wage employment opportunities and higher opportunity costs to striking out as an entrepreneur.[41] Consistent with this scenario, the current paper proposes and tests the idea that institutional reform is less about lowering barriers for entry and more about lowering barriers to new firm growth to tempt talented individuals to take the risk by providing higher returns to entrepreneurship.

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[40] In institutional economics, institutions are defined as the laws, norms, or beliefs which form the 'rules of the game' (North 1990, Williamson 2000). There are also traditions of sociological institutionalism and historical institutionalism developed within sociology and political science.

[41] Iyigun and Owen (1998) propose that risk-averse individuals will choose the wage sector over entrepreneurship in a developed economy.

An important gap exists in our understanding of the mechanisms by which institutional change affects entrepreneurship. This paper asks how a particular institutional change draws in individuals to entrepreneurship and where those individuals are located on a talent distribution. We question which institutional arrangements, those that lower barriers to entry or those that lower barriers to growth, are more effective in enhancing entrepreneurial behavior. Specifically, does a reform lowering barriers to growth draw more talented individuals to become entrepreneurs by increasing the expected returns?

One role of institutions may be to shape the costs and incentives guiding entrepreneurial endeavors (Baumol 1990). Previous literature has presented the idea that some are "pushed" into entrepreneurship, where the individual cannot get a traditional employment job (Amit & Muller 1995). If the individual can gather the necessary resources to start a firm, then self-employment becomes a last resort. Alternatively, "pull" entrepreneurship has been distinguished, where an individual is drawn into entrepreneurship because of the attractiveness of an opportunity that is too good to pass up (Amit, Muller 1995). Understanding how the institutional environment affects which individuals leave traditional employment to become entrepreneurs is not just a theoretical curiosity. It has important implications for the performance of start-up firms in the economy. It is also important for policymakers interested in how firm productivity, strategy, and competition via new entrants are affected by government interventions.

The challenge to answering this question is finding an empirical setting with sufficient variation in the institutional environment for entrepreneurship and also detailed human capital or work history data on a comparable set of individuals at risk for entrepreneurship. An ideal empirical setting would be where individuals of known ability levels are randomly assigned to

different institutional environments and then tracked over time. Lacking this, a context is needed where there was an exogenous shift in the institutional environment (ideally in the direction of increasing the expected returns to entrepreneurship) and where we have measures of human capital levels. One setting in which the first requirement is fulfilled is in China where a 1999 Chinese Constitutional amendment aimed to end discriminatory practices against domestic private firms. This shift is exploited and data developed to satisfy the second requirement by collecting a unique, detailed survey.

The key finding of this paper is that a stronger increase occurred in the propensity for entrepreneurship among those with higher human capital levels (as measured by graduate degrees, promotion, GPA, salary, work experience, or parents' education) when expected returns to entrepreneurship increased. In addition, these higher human capital individuals were more likely to found firms which became more profitable, larger, and more innovative. The rest of the paper proceeds as follows: First, the literatures on institutions and on work history as they relate to entrepreneurship are each briefly reviewed followed by the hypotheses. Then I describe the empirical setting. The next section describes in detail the data and the variables used followed by the analysis and results. Finally in the discussion and conclusion sections I describe the robustness checks, address alternative explanations and mechanisms, and discuss the theoretical implications of the findings.

Theory and hypotheses

Institutions and Entrepreneurship

Institutions are defined as the laws, norms, or beliefs that form the 'rules of the game' (North 1990, Williamson 2000). By altering the constraints and structure of incentives in an economy, institutions direct self-interested behavior towards either more or less economically

productive activity (Baumol 1990, Nee 1996). While lively debate surrounds the quest to determine the best institutions for economic development and entrepreneurship, consensus is growing that institutions, particularly property rights and financial liberalization, play an important role in shaping incentives for economically productive entrepreneurial behavior (Acemoglu, Johnson, Robinson 2002, Acemoglu, Johnson 2005, Klapper, Amit, Guillen, Quesada 2007, Porta, Lopez-de-Silanes, Shleifer, Vishny 1998). Theory and evidence linking institutions to entrepreneurial decisions have lagged behind (Klapper, Amit, Guillen, Quesada 2007).

In contrast, a rapidly growing literature examines the link between career experience, human capital and entry into entrepreneurship (Beckman, Burton 2007, Boeker 1989, Haveman 1993, Haveman, Cohen 1994, Phillips 2002). This literature yields mixed results. On one hand, Evans and Leighton (1989) use the National Longitudinal Survey of Young Men and find that those who transitioned to self-employment had relatively lower wages. Similarly, Amit and colleagues find that individuals who became entrepreneurs had lower salaries in their previous job (Amit, Glosten, Muller 1990, Amit, Muller, Cockburn 1995).[42] In contrast, Hamilton (2000) examines the returns to self-employment and finds little evidence for wage differences between would-be entrepreneurs and non-entrepreneurs. Groysberg and coauthors (2007) find that high performance research analysts in investment banks are more likely than non-star analysts to become entrepreneurs. Of course, those "stars" may be more visible to and attractive to outside investors and prospective clients who would lower the difficulties of starting a new firm. Lazear (2004) uses a database of Stanford Graduate School of Business alumni and suggests that entrepreneurs tend to be generalists and have more varied work experiences. The evidence

[42] However, the authors acknowledge the difficulty in using such a correlation to identify the impact of opportunity costs on the transition to entrepreneurship, including unobserved ability and lower wages due to effort being expended on the new startup rather than in the current job.

on opportunity costs (as measured by previous salaries) and whether low or high human capital individuals have higher propensities for entrepreneurship appears mixed. It is important to note that these studies (with the possible exception of Lazear (2004) do not include high proportions of technology entrepreneurs. No previous literature that we are aware of has examined these issues in the context of high tech entrepreneurs.

Beyond salary and performance, some literature has begun to examine the contexts that are more conducive to producing or selecting for potential entrepreneurs (Thornton 1999). Scholars have theorized about the employment conditions under which employees choose to commercialize their ideas in external spin-offs rather than within the firm (Anton, Yao 1995, Klepper, Sleeper 2002, Klepper 2001, Hellmann, 2006, Klepper, Thompson 2006).[43] The literature has emphasized both the characteristics of the individuals (Evans, Leighton 1989, Roberts, 1991, Shane, Khurana 2003, Zucker, Darby, Brewer 1998, Stuart, Ding 2005) as well as parent firms (Burton, Sørensen, Beckman 2002, Gompers, Lerner, Scharfstein 2005, Sørensen 2007) or job roles and context (Dobrev, Barnett 2005) as important determinants of the likelihood to spin off new ventures.

Almost no work has made the connection between the broader contexts which influence people of particular characteristics and not others to found firms. Some signs exist that the institutional environment also matters (Nanda, 2008). Human capital is clearly an important determinant of the likelihood of entrepreneurship, yet the relationship between human capital, institutional environments, and entrepreneurship is unclear. It may be that only through linking macro-level, institutional effects together with micro-level, individual effects that the

[43] Hellmann (2006) develops a model for why employees leave their employers to become entrepreneurs and also captures the idea that the external entrepreneurial environment may encourage spin-offs. Holmes and Schmitz (1990, 1995) develop models of occupational choice consistent with those holding higher entrepreneurial ability (or with good matches with their business) becoming entrepreneurs. Similarly, the Lucas (1978) model unambiguously predicts the most able will become entrepreneurs.

previously conflicting patterns may become clearer. Evidence from less-developed countries (LDCs) is useful for three reasons. First, LDCs more frequently see larger variations in the institutional environment in the direction of lowering barriers to entry and in terms of lowering barriers to growth, allowing opportunities for identification. Second, typically LDCs have not yet developed well-organized industry associations to lobby for reforms, reducing concerns of reverse causation. Third, more variation exists in the human capital distribution in less-developed countries where some families are able to send their children overseas for a high quality education yet overall enrollment in tertiary education is lower.

Very little prior work has examined the link between human capital and institutional change. Existing work either explicitly or implicitly takes ability for commercial/market productivity as being largely of a different type than ability that allows individuals to overcome the barriers to entrepreneurship in less-developed institutional environments.[44] While this view might be correct, what if a large component to ability is common or transferable across the two activities?[45] The Roy (1951) model is relevant for theories of occupational choice and has been widely used and extended (Borjas 1987, Roy 1951, Heckman, Honore 1990, Jovanovic 1994). The basic model assumes that individuals form predictions of their earnings in two sectors under consideration and choose the one that provides higher utility. The model examines sorting into wage employment and entrepreneurship on the basis of known heterogeneous abilities. The institutional environment may be modeled as altering the relative payoff to skills in entrepreneurship and changing the resulting self-selection. A relatively simple formal model based on a Roy Model linking talent, institutional change and entrepreneurial decisions can be

[44] Or ability is viewed as uncorrelated with the endowments (such as government connections, family wealth, or the ability to navigate bureaucratic hurdles) that allow one to overcome barriers to entry.
[45] Stuart and Ding (2005) show that scientific advisory board membership is highly correlated with academic quality and patenting.

found in Appendix A of this chapter, but the main insights are conveyed via the more conceptual model below.[46]

Insert Figure 1 here

First, consider two simple alternative formulations of the relationship between human capital and institutional change. Figure 1 shows the hypothesized relationships between shifts in the institutional environment for entrepreneurship and increased entrepreneurial behavior. The top graph of Figure 1 (1A) shows human capital levels on the x-axis and the costs of starting a business on the y-axis. One curve is shown which represents the income that can be earned via wage employment that increases at a decreasing rate with talent. The horizontal lines represent the average costs of starting a business under different institutional environments. The new institutional environment lowers the average costs (or effort costs) of starting a firm. If this is true, then if the change in the institutional environment reduces the barriers to entrepreneurship, the increase in entrepreneurship comes primarily from those who are relatively lower on the talent distribution.

An alternative mechanism for increased entrepreneurship is higher returns to entrepreneurship leading to relatively more talented entrepreneurs. This view sees institutions for entrepreneurship as raising the expected returns conditional on entrepreneurial entry rather than lowering the bar to enter in the first place. According to this idea, overcoming fixed start-up costs is relatively easy, but the difficulty is in growing the firm to a significant size or in

[46] Changes in the institutional environment for entrepreneurship will raise (or lower), the returns to talent in entrepreneurship which will impact the payoff to entrepreneurship differentially according to human capital. Institutional reforms may have the effect of broadening the number of individuals engaged in entrepreneurship either among the same types of people who were already becoming entrepreneurs or they may induce those of different ability levels to become entrepreneurs.

appropriating the returns that the firm generates. In this situation, institutional reform has the effect of increasing expected returns for entrepreneurs and higher outcomes then encourage more individuals of higher human capital and with better wage employment options to become entrepreneurs.[47] The level of expected returns (rather than the fixed start-up costs) may be more important for more talented potential entrepreneurs.[48]

In the bottom (1B) section of Figure 1, the x-axis is again the talent distribution, but this time the y-axis represents the expected returns to entrepreneurship. The upper line represents an institutional change that raises the net mean returns to entrepreneurship. Examples of this type of institutional change are those that lower barriers to firm growth such as policies awarding government contracts to small or young businesses, industrial policies aimed at growing businesses and institutions conducive to merger and acquisition or initial public offerings, or decreased tax rates targeted at high growth entrepreneurial firms.[49] Figure 1B represents the expected returns to entrepreneurship as a flat line for simplicity.[50] If the mechanism in Figure 1B is correct then certain institutions affect the level of entrepreneurship through improving returns to entrepreneurship relative to traditional employment. An

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[47] This effect may be attenuated over time however, if an increase in high quality firms translates into more wage employment opportunities or if more competition drives back down the expected returns.

[48] This is also true if the prospective entrepreneur is motivated by "need to achieve" (McClelland, 1961) in which significant tangible accomplishments are made, not merely financial returns. Or if the reward to the entrepreneur is in overcoming a major challenge, where lesser, easier to attain, goals are not especially stimulating. Under all these circumstance, making significant growth a realistic possibility would increase the entry of more aspiring entrepreneurs.

[49] By barriers to growth, what is meant more precisely are barriers which depress the entrepreneur's financial returns relative to wage employment. While start-ups could grow (in terms of employees or revenue) without providing higher payoffs to the entrepreneurs, *in general* barriers preventing entrepreneurial firms from reaching their efficient size (or helping state-owned firms to maintain market share) will tend to alter returns to talent for the entrepreneur as well.

[50] This line may possibly be more accurately represented as an upward sloping curve. A large number of variations in the shape or height of the curve are possible. A bi-model distribution is possible as well with high ability entrepreneurs making very high returns in a poor institutional environment. The simplest case is chosen here to make the point that an increase in the returns to ability in entrepreneurship should draw in higher ability entrepreneurs.

environment where we increase the returns to entrepreneurship relative to wage work should draw more entrepreneurs from relatively higher in the talent distribution.

Hypothesis 1: An institutional change that reduces barriers to growth (or to the returns from growth) will increase entrepreneurship among individuals located relatively higher in the talent distribution.

A difference may exist in the types of firms created by those who are induced to enter entrepreneurship by a different institutional environment. The effects of selection processes in entrepreneurship on competition and strategy can be quite strong. Banerjee and Munshi (2004) find differences in the level of capital stock, productivity and the capital intensity of production between two communities of garment knitters in India, arguing that they are driven by selection processes of higher ability individuals in one community and lower opportunity cost of capital in the other community. Certain institutional environments may be required for more talented individuals to be able to start high performance firms. High human capital individuals will be more likely to start firms if they can attain higher performance in entrepreneurship, which is more likely when barriers to growth are lowered. If more talented individuals are increasingly entering entrepreneurship due to increasing expected returns, then the start-ups they create should have higher performance levels on average. The idea that higher human capital should result in higher entrepreneurial productivity seems straightforward, but could be attenuated for a number of reasons.[51] On the other hand, if talent as demonstrated in prior wage work has no bearing on entrepreneurial performance, then this result would call into question whether the expectation of higher performance is driving the increased entry.

If there is no component of human capital that is transferrable from the wage sector to the act of entrepreneurship, then this would make both finding empirical results and policy

[51] An association may not be found if competition increases which drives down survival or profit margins, or if higher ability individuals are attempting riskier start-ups.

prescriptions more difficult. Thus, the type of human capital or talent that is of interest is a component that is transferrable from wage work to entrepreneurship. If the marginal individual being drawn into entrepreneurship is shifting higher in the talent distribution, then one should also expect that talent or human capital measures should be associated with higher firm performance levels.

Hypothesis 2: Individuals of higher talent, as evidenced in their wage employment careers, will experience higher returns in entrepreneurship after an institutional change that lowers barriers to growth.

The traditional mechanism focused on in the literature lowers barriers to entry (i.e., decreased costs to entrepreneurship). For example, individuals may want to become entrepreneurs but cannot overcome credit constraints or hurdles to registering a new business (Acemoglu, Johnson, Robinson 2002, Evans, Jovanovic 1989, Holtz-Eakin, Joulfaian, Rosen 1994). Institutional reform then acts to lower the barriers, in which case we would find an increase in relatively less talented individuals becoming entrepreneurs. If there is sufficient correlation in the skills rewarded by wage work and those rewarded by entrepreneurship, then lowering entry barriers has the effect of driving more low ability individuals to entrepreneurship. The less talented individuals would expect lower returns to entrepreneurship (compared to more talented individuals) and have less incentive to save and accumulate the resources needed for entry so they are impacted more by a reduction in fixed start-up costs. Recent work shows that in response to an increased cost of external financing, the greatest decrease in entrepreneurial behavior came from those of lowest ability (Nanda 2008). This result indicates that decreasing the cost of start-up capital has its greatest impact among lower ability entrepreneurs.

Hypothesis 3: An institutional change that reduces barriers to entry will increase the

propensity for entrepreneurship among individuals located relatively lower in the talent distribution.

China's Institutional Reform

The Chinese context provides a particularly interesting and appropriate empirical context to study given the high degree of institutional variation (relative to well-developed economies), and its importance in the world economy.[52] As a case for looking at human capital and institutional constraints on entrepreneurship, China offers a natural experiment in the 1999 amendment to the Constitution that lowered barriers to growth and altered the history of discrimination against the growth of domestic private firms. The Chinese context also offers an earlier 1988 policy shift reducing high barriers to entry.

China's reforms in the late 1980s and early 1990s eliminated restrictions on entrepreneurship and provided legitimacy to private business. Most significantly, in 1988 the state officially recognized the growing number of private businesses (known in Mandarin as '*saying qiye*') with eight or more employees (Xu and Zhao, 2008).[53] Significant increases in entrepreneurship occurred in the years that followed. Yet the years before 1999 had been characterized by direct discrimination in favor of foreign-invested and state-owned firms (Huang 2003). In the spring of 1999, the Second Plenary of the Ninth People's Congress

[52] The vast majority of the related literature on market entry/entrepreneurship and innovation focuses on well-developed economies. High-tech entrepreneurship and innovation in transitional and developing countries are rarely part of the scholarly dialogue which still largely thinks of new products as being developed in rich countries and moved to low-wage countries (Lu 2000, Puga, Trefler August 2005, Vernon 1966).

[53] Prior to the reform private businesses with fewer than eight employees were permitted. It is widely recognized that even before 1988 many private businesses had more than 8 employees, but the risk of being discovered was removed in 1988. Township and village enterprises spread during this time and many firms registered as publicly owned (known as "wearing the red hat") to avoid discrimination. Wang (2008) uses a reform in the mid-1990s which allowed employees to purchase their state-owned rental housing at subsidized prices to examine the impact of credit constraints and mobility costs on entry into entrepreneurship.

approved an amendment to the Constitution that put the private sector on the same legal footing as the public sector (*People's Daily*, April 9, 1999, Liu, 2008). The amendment essentially did three things: 1) officially ended discriminatory practices against domestic owned private firms; 2) provided some assurance that private property would be defended; and 3) signaled to local governments the importance of entrepreneurship. The original clause in the Constitution was changed from "the private economy is a supplement to public ownership" to "the non-public sector, including individual and private businesses, is an important component of the socialist market economy" (*China Daily*, March 16, 1999, Qian 2000). Local governments responded and incorporated the promotion of technology commercialization in their local science policies after this act was passed (Liu, White 2001). Immediately after the amendment, local governments were reported to start to relax restrictions on private enterprises (*People's Daily*, April 9, 1999).[54]

Yingqiu Liu, Professor of Economics at the Chinese Academy of Social Sciences (CASS), notes that the amendment created a more level playing field for businesses for the first time since the Communist revolution (Liu 2008). A large number of provincial governments issued documents promoting the rapid growth and development of private enterprises. In 2000, Zeng Peiyan, minister at the State Development Planning Commission, issued a statement saying "[We will] eliminate all restrictive and discriminatory regulations that are not friendly towards private investment and private economic development. In the area of stock listings,

[54] For instance, the Jiangsu Provincial Government adopted a new policy to give private enterprises equal treatment as state-owned and collective enterprises in the areas of granting business scopes and credit access (*People's Daily*, April 9, 1999). A proliferation of science parks and technology business incubators occurred following the Constitutional change, as well as associated tax incentives for R&D and licensing activities all of which supported the growth of entrepreneurial firms. Local governments had freedom and their own incentives to experiment and the programs seen as more successful such as tax breaks and industrial science parks spread rapidly to encourage private entrepreneurship (Segal 2002).

private enterprise should enjoy equal opportunity which was enjoyed by the state-owned enterprises."

Overall, the institutional environment shifted to encourage the growth of entrepreneurial firms through office space, R&D tax incentives, and later stage funding. In contrast changes after 1988 lowered entry barriers and legitimized entrepreneurship, broadly defined, but without as many specific institutions and policies to support growth of already established entrepreneurial firms. Also since 2000, property-rights became clarified, there was a policy push to encourage R&D and high tech firms and after 1998 private equity firms were easier to set up.

As suggested by interviews with entrepreneurs and investors in China, 1999 was widely perceived as a key year. Chinese entrepreneurs and investors suggested that there was a perception that China had moved towards an institutional environment which could support rapid growth technology start-ups like those that made individuals very rich during the dotcom boom in the U.S. The perception spread that one could now become very wealthy through the creation of technology start-ups in China, whereas that was not possible in the past (although creating smaller scale start-ups was certainly possible). The institutional environment prior to 1999 was not prohibitive for entry, but it did make growth difficult. One Chinese entrepreneur reported that she had to get each new product approved. [55]

I spent an entire year just looking for the right office space...because ...each product must be registered and approved by the government. It's an expensive and time-consuming procedure. I eventually found space for the company's first store in a children's museum which was perfect since they were selling toy bears aimed at children. This also allowed the

[55] These survey data were combined with interviews. The Tsinghua Alumni Association set up 42 interviews in Beijing, Shanghai and Xi'an. Interviews were requested with technology entrepreneurs, including some who had not been successful. The representativeness of these interviews cannot be established and primarily those who did become entrepreneurs were interviewed. Presumably any bias might be more on the basis of performance than on the basis of reasons for selection into entrepreneurship in one year and not another.

start-up to hide from government inspectors. – Beijing entrepreneur

The institutional environment post-2000 appears to have been much more attractive for high human capital individuals. One pair of founders had very high human capital with one being a lawyer and an MBA and the other having a Ph.D. They started the company in 2003 and the female co-founder said:

I spent 20 years in the [San Francisco] Bay area in life sciences companies. In the mid-1990s I came back to China to survey biotech companies in China and found that the environment was not ready yet. – Shanghai entrepreneur

The analyses will exploit both the 1988 reform lowering entry barriers and most importantly, the 1999 amendment supporting the growth of existing firms and moving away from practices that discriminated against private firms and kept them at a smaller size.[56] A discussion of the limitations of using this reform as an identification strategy and robustness checks to allay those concerns is contained in the discussion section below.

Methodology

To address these hypotheses, I use a sample from a well-defined at-risk population with detailed work history data on both non-entrepreneurs and entrepreneurs, over significant periods of time. The empirical context for the study is a sample of alumni from a prestigious university in China. As discussed more thoroughly in Chapter 2, a survey of alumni has the advantage of being a well-defined population, not biased by government collection towards classification of private firms as state-owned and not selected based on success in

[56] A more detailed discussion of the Chinese context, particularly as it pertains to entrepreneurship and science and technology policy is in Chapter 4 and has been written about elsewhere (Wang 2008, Qian 2000, Huang 2008, Steinfeld 1998).

entrepreneurship or in traditional employment. Such a survey allows us to track the work experiences after graduation of both entrepreneurs and non-entrepreneurs over long periods of time. Research universities are also important institutions for educating technologists and providing a setting for students and faculty to exchange ideas. In the U.S., alumni from leading research universities are responsible for numerous new ventures (Hsu, Roberts, Eesley 2007). The Chinese sample provides data on individuals with high enough human capital levels that many have a real choice between career paths, including entrepreneurship.

In cooperation with the Alumni Association, we undertook a survey of alumni from Tsinghua University, located in Beijing, China. The survey instrument itself was developed collaboratively by the author, a fellow Chinese Ph.D. student at our institution, an M.I.T. professor, and a professor of management at Tsinghua University. Some overlapping questions were asked from the M.I.T. alumni survey to enable future comparison (Hsu, Roberts, Eesley 2007). It was translated into Mandarin and checked by several Chinese speaking associates for accuracy and communications clarity. The Tsinghua Alumni Association has assisted with endorsing, mailing, and collecting the survey results. The survey was sent to all alumni with an address on record (a total of 30,000 according to the alumni association). Our dataset includes alumni across all university departments. The respondents could mail back the paper copy or complete the survey online. In the initial section, completed by all alumni respondents, alumni were asked if they participated in founding a company, "where founding indicates that you were present at the start of the company and other founders would consider you a co-founder." Respondents also answered questions about privatizing a state-owned enterprise since this is also considered to be "entrepreneurship" in China. Those responding positively to either question were asked to fill out the Founders Survey section. The working definition of

entrepreneurship here is more focused and narrower than a representative national sample of self-employment.[57] The survey also asked a question about whether the individual had gone overseas to work or go to school. Those who responded positively to that question were directed to fill out the "Returnee" section of the survey. The survey packet included a personalized letter from the authors, signed by the University President, the questionnaire, and a postage-paid envelope with address labels. A total of 2,966 surveys have been received online and via paper and email (including 718 entrepreneurs).[58] Of the 2,966, I eliminate (for certain analyses) the 144 alumni who responded from outside of China since changes in policies in China should have less effect on them. Our final number of observations for the main analysis is the 1,821 alumni who responded to all of the variables used. The entire survey is available in Appendix B at the end of the dissertation.

The response rate is 10%.[59] One approach to assessing non-response bias involves extrapolation. This method is useful when trying to determine the direction of bias and a survey of non-respondents or archival methods cannot be conducted (Lehman 1963, Donald 1960, Pace 1939, Rogelberg, Luong). It rests on the assumption that individuals who respond less readily resemble non-respondents, so a common method is comparing characteristics of respondents who answered quickly with those who answered following a reminder or stimulus

[57] Self-employment is interesting in itself, but typically includes professional occupations such as consultants, lawyers and physicians which do not fit as well with a model of choosing riskier entrepreneurial activities.

[58] The results include 963 alumni responses received via the online survey and 2,003 responses received via email or hardcopy.

[59] The actual response rate is likely to be much higher once incorrect addresses and deceased alumni are subtracted from the original total. While low responses rates can introduce bias, I examine specifically whether there is systematic bias in respondent characteristics (Tomaskovic-Devey, Leiter, Thompson 1994). Response rates to surveys of managers in China have tended to be in the lower range (Peng, Luo 2000, Tan, Litschert 1994). Zhejiang University officials told us that when they survey their alumni response rates of 5% are average. In the U.S. response rates for entrepreneur surveys are often lower than those for managers.

at a later time.[60]

Although one limitation of our data is that it is cross-sectional in the sense of coming from a survey given at one point in time, on the other hand, our respondents graduated from the university and founded companies over an impressive span of time. The advantages of this dataset include a panel of detailed work history and education variables, information on family background, coverage over many years of graduates, detailed data on funding and performance measures for multiple founding attempts, and less bias than government surveys where Chinese entrepreneurs are known to misreport their earnings and firm status as state-owned (*wearing the red hat*) to avoid discriminatory practices. Forty-five questions were asked about prior firm founding history and the entrepreneur's most recent start-up including: industry category, work experience, relationships among the cofounders, sources of entrepreneurial ideas, timing and sources of financing events, commercialization strategy changes, causes of failure, exit routes,

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[60] Appendix A of this chapter shows *t*-tests of the null hypothesis that the average (observed) characteristics of the responders and non-responders are roughly the same statistically. Only the variables *gpa rank, age, entrepreneur, privatized,* and *high salary* show statistically significant differences in means at below the 1% level. It appears that non-respondents were more likely to be entrepreneurs, were slightly older, had higher salaries, less likely to have been academics, and slightly more likely to have held a greater number of job positions, to have a higher GPA, and more likely to come from more wealthy families. Years of education is significant, but the means are very similar. Older founders appear to have been equally likely as younger founders to respond. The 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles of graduation years were also checked and are similar, offering some reassurance that there were not large differences over time in the response rates. Since there is evidence of some non-response bias, weights were created using logistic regression and calculated as one over the predicted probabilities of responding. Results are robust to using and also not using these weights. Finally Appendix C of this chapter shows a histogram of respondents by bachelor's graduation year. One can see the impact of the Cultural Revolution when Tsinghua was largely disrupted between 1966 and 1976 when regular admissions resumed. In comparison to a representative sample of rural and urban households from the China Health and Nutrition Survey (http://www.cpc.unc.edu/projects/china) the Tsinghua sample is 8.7 years older on average, much more likely to be male, less likely to be married, more highly educated, and slightly more likely to have founded a firm. The differences in age and education most likely contribute to differences in the entrepreneurship rates. The data were also benchmarked against a representative sample from the National Bureau of Statistics (NBS 1999 survey). In comparison the Tsinghua sample is significantly older, less likely to be self-employed, has more years of education, but similar in terms of parent's education and parental self-employment. It appears that the sample is not weighted towards more recent alumni. A non-respondent survey is also in progress.

revenues and number of employees. In addition, the data include notes from interviews with 42 people (including entrepreneurs, investors, and government officials), along with follow-up phone calls to probe more deeply. Figure 4 shows a plot of the locations of the entrepreneurial respondents with the three locations where we did interviews in red.

Measures and Data

Insert Figures 2 and 3 here

In this context the descriptive statistics alone are interesting. Figure 2 previews the main findings of the paper by showing the increase in the rate of higher human capital individuals becoming entrepreneurs in the more recent time period. The figure reinforces the story that institutional change pulled individuals from higher in the talent distribution into entrepreneurship through improved outcomes. It appears that there was some increase just prior to 1999. Interestingly, the increase in the proportion of those with graduate degrees becoming entrepreneurs follows closely the increases in founder income (these coefficients are taken from the corresponding year dummy variables of a regression on founder salary). This adds support to the idea that improved returns to entrepreneurship may be driving the increase. Figure 3 shows the increases in the proportion of 'at risk' individuals becoming entrepreneurs in each year. Table 1 shows the industry breakdown for the firms. Internet, electronics and software firms are the most common, which fits with the technical training of these graduates.[61] The average number of employees per firm as of 2007 is 628 (median=20). Approximately 34% of the firms have 10 employees or fewer. The mean annual revenues of each firm were 495,000 RMB (the median is 70,000 RMB or $20,290 at an approximate 2007 PPP exchange

[61] The industries also provide evidence that the respondents have started firms rather than reporting on primarily "sole proprietorships" and self-employment activities.

rate of 3.45 RMB/dollar). Seventeen percent of the firms claimed to hold at least 1 patent. Median profit levels were reported as 20% of gross revenues. Table 2 presents pair-wise correlations. Table 3 presents independent variable definitions and summary statistics.

Insert Tables 2 and 3 about here

Analyses and Results

To determine whether changes over time took place in the market development of the institutional environment that had a differential impact on those with higher human capital, a differences-in-differences regression analysis is performed. The differences-in-differences estimate is identified by interacting the *post-1999* variable with the various human capital measures to see in the post period how the propensity for entrepreneurship for more talented individuals changed relative to those lower in the talent distribution.[62] The dependent variable is the event of founding a firm for the first time.[63]

Since the most recent graduation classes have not had much time to gain work experience and found firms, right-side censoring is a concern. The analyses in Tables 4 and 7 employ Cox (1972) hazard regression models for two reasons. First, the model is semi-parametric, so that we can estimate the impact of independent variables on the hazard of

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[62] Identification of a panel differences-in-differences estimator requires the assumption that trends are parallel before and after the reform. A placebo regression (Appendix I) using 1997 as the reform year provides some evidence that pre-reform trends among higher human capital individuals were not significantly different. Including year interaction terms with *years of education* and *income residuals* also provide evidence that trends in these coefficients are relatively flat in the post-reform period also.

[63] Privatizing an SOE is also an entrepreneurial act in China since it often requires all the same behaviors of taking on risk, raising funding, recruiting new employees or cofounders, becoming the residual claimant, and redefining the product market strategy. Any performance analysis would need to control for higher beginning asset levels of SOEs, but conceptually this paper is interested in transitions to entrepreneurial behavior rather than performance. The results are robust to limiting the sample to only pure startups as well. A total of 47 of the firms reported on in the survey were privatized SOEs.

founding a firm while being agnostic about the baseline hazard function.[64] Second, the model explicitly takes the timing of events into account (by estimating the probability of founding a firm in a given year conditional on not having founded a firm up until that time period), and adjusts for the right-censoring of the data. In these regressions subjects start being "at risk" of founding a firm at the time of their graduation, and a "failure" event occurs the year the individual founds a first firm (otherwise, the founding year is considered censored for that individual as of the year 2008).[65] Reported coefficients are hazard ratios, with values above 1.0 representing increases in the hazard of founding a firm and vice-versa for values below 1.0. The main results are robust to using a logit as well. The Breslow method is the default for handling ties, but the results are robust to using exact marginal likelihood and exact partial likelihood.[66] The specification of the model is as follows:

$$\lambda(t \mid X) = \lambda_o(t)\exp(X'\beta) \tag{1}$$

where the vector X includes our founder and work experience characteristics. $\lambda(t \mid X)$ is the rate at which founders will start a firm at any particular date, given that they have not founded a firm up until that point in time. Equation (1) specifies the hazard rate as the product of two components: a function of the period length (i.e. delay time since graduation), $\lambda_o(t)$ or baseline hazard, and a function of the observable characteristics, denoted by the vector X. The Cox

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[64] It does assume that the hazard functions (in this case, the probability of founding a firm, conditional on time) at different levels of an independent variable are proportional to the baseline hazard function. The standard procedure to test this assumption is to examine the graphs of the natural logarithms of cumulative baseline hazard functions (Anderson 1982). The functions appeared to be approximately proportional to one another, offering reassurance that the proportionality assumption was not violated.

[65] The statistics literature (Breslow, Lubin, Marek, Langholz 1983) suggests little loss of efficiency so long as approximately 20% of a sample has experienced the event of interest (over 20% of my sample has founded a firm).

[66] Since the human capital measures were mainly run in separate regressions, multicollinearity is not a primary concern; however, future versions can orthogonalize the variables using a modified Gram-Schmidt procedure.

nonparametric estimation allows the estimation of β without needing to make a distributional assumption about $\lambda_o(t)$. Figures 5 and 6 show the results of Kaplan-Meier and Schoenfeld residual tests of the assumptions of the hazard rate model. The data appear to satisfy the requirements.

Insert Table 4 about here

Observable Human Capital Measures

Table 4 examines the impact of lowering barriers to growth and the 1999 Constitutional amendment. The table examines the impact of observable measures of human capital. In Model 4-1, looking first at the controls, individuals were less likely to transition from jobs in academia to entrepreneurship. Academic jobs are traditionally prestigious positions within Chinese society. Those able to secure such positions would be reluctant to risk their careers on entrepreneurship.[67] Individuals who had worked in a higher number of different positions and who were male, or who had worked in academic jobs in the past, had higher rates of transitioning into entrepreneurship. Having a higher number of prior job positions has also been found in the U.S. to correlate with entrepreneurship (Lazear, 2004).[68] All models include dummy variables for the Bachelor's degree academic major, graduation year, and current

[67] As is true in most U.S. universities (but not MIT), Chinese faculty have not traditionally been encouraged to start a company while retaining their academic positions. In my conversation with the Technology Licensing Office (TLO) at Tsinghua, the director indicated that because Tsinghua is so prestigious they do not have problems with faculty leaving to set up companies. However, they do demand very favorable terms for Tsinghua in any faculty licensing arrangements to start-up companies. There are strong penalties for faculty who do not go through the TLO, so many faculty are reported to allow their students to graduate and then take the technology to commercialize via a start-up.

[68] Interestingly, in Table 4, individuals with parents who were entrepreneurs are not more likely to become entrepreneurs themselves. A positive association between parental self-employment and entrepreneurship has been found repeatedly in the U.S. and Europe, but does not appear to hold in the Chinese context. One good explanation may be that during the time period when these individuals' parents could conceivably have founded companies, most entrepreneurship was illegal in China.

region. Turning to the main independent variables, those with Master's degrees were significantly less likely to become entrepreneurs.[69] Model 4-1 shows the results for the differences-in-differences estimation by including an interaction term between Master's degree and a dummy variable which equals 1 if the individual was 'at risk' of founding a first firm in 2000 to 2007 (to be at risk the individual must not have founded a firm previously and below age 65). The interaction term is greater than one and statistically significant, indicating that there was a stronger effect on those with Master's degrees for increasing the probability for entrepreneurial behavior. The coefficient on Master's degree alone is below one and significant indicating that before the institutional change, those with Master's degrees were less likely to found firms. The same interaction was included with Doctorate degree. Dummy variables equal to one for those who were at risk for entering entrepreneurship for the first time between 1991 and 1999 and between 2000 and 2007 are included (1978-1990 is the omitted category).

In Models 4-2 through 4-7, the results for the controls are largely the same, with one exception. In some of the models individuals are significantly less likely to transition from a government job to entrepreneurship. Like academic jobs, positions in government have been historically very prestigious and stable so this is expected.[70] In some models, returnees who

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[69] Human capital as measured by education (Fairlie, Woodruff 2007, Fairlie, Robb 2008, Baumol 2004, Dunn, Holtz-Eakin 2000, Murphy, Shleifer, Vishny 1991, Roberts, 1991) or work experience is clearly related to entrepreneurship. Macroeconomists also have a long tradition of examining the impact of education on growth (Bils, Klenow 2000). Recent reviews of the literature on education and entrepreneurship and on the returns to education more generally have been compiled by others (van der Sluis, J., van Praag, Vijverberg 2004, Card 1999). Murphy et al. (1991) acknowledge that the direction of causality may be reversed here, however: countries with faster growth may provide more engineering jobs and may support more engineering education. Roberts (1991) shows a curvilinear relationship between education level of high-tech entrepreneurs and their firms' overall performance, with Master's degree recipients doing best.

[70] There is an on-going debate, however, about the extent to which elites in transitional economies have been able to translate their power into economic benefits and the mechanisms that allow such a transfer (Walder 2002, 2003, Nee 1996).

were educated or worked abroad are also less likely to found firms. The returnees are also more likely to take jobs in business rather than in government or academia. Models 4-2 through 4-7 substitute a series of measures of human capital into the equation. In general, they show the robustness of the results to various observable measures of human capital including parents' education (found in the psychology literature to correlate with the child's test scores), whether the individual was promoted to general or technical manager, higher GPA, higher salary and whether the individual held one of the higher ranking student leader positions. The results are also robust to including an indicator for whether the parents' education level was above the median. The number of years of work experience is the only measure where the result does not come out as significant. In all models, the coefficient on the human capital measure (not the interaction term) is below one and significant indicating a lower likelihood of founding a firm for those with higher human capital during the *pre*-1999 period. The main results are mostly robust to the calculation of robust standard errors.

If the impact of the market development of the institutional environment was to raise returns to entrepreneurship rather than lower the barriers to entry, then the coefficient on the interaction terms between human capital and the post-period should be greater than one. This is indeed the case and the size of the effect is large. This result can be interpreted as consistent with increase in the propensity for entrepreneurship among individuals higher in the talent distribution.

Unobservable Ability

Any study of human capital and entrepreneurship must reflect concern about unobserved ability levels. At least four drawbacks exist to using the observable measures. The first is that the observable measures of human capital are not pure measures of underlying

ability and may be conflated by the influence that family background may have on both the likelihood of being able to afford and attend graduate school and having access to the resources necessary to become an entrepreneur. Similarly, being promoted, having a higher salary and even a higher GPA could potentially be influenced by the family socio-economic status and likelihood of paying for tutoring or having important family connections.[71] The second concern with the observable measures is that with the market development of the institutional environment, the salaries available in the wage sector should have been improving as well and in that case, increasingly, only those who are truly talented (or who happen upon very good entrepreneurial opportunities) would become entrepreneurs, even if the institutional environment for entrepreneurship was not improving. Third, there may be shifts in the marginal individual obtaining a graduate degree, or becoming promoted as conditions change. Fourth, it may be more convenient to have a more continuous underlying measure of talent to be able to test changes in the shape of the distribution of those becoming entrepreneurs. To address these possibilities, the next section explores the impact of other, "unobservable" measures of underlying ability.

Ordered Logit Income Regression and the residual measure of underlying ability

Finding a measure of underlying ability is challenging.[72] The method used in this paper exploits the data on salaries at the end of each job spell and uses the residuals from a wage regression. It is possible to use higher or lower than expected performance in the most recent job to generate an underlying ability measure. In the first stage, a regression is performed with

[71] It is important to note that the (self-reported) parents' wealth level is controlled for, so the estimates are consistent with a story that controlling for family background, via all other observable work history characteristics, then relatively higher ability individuals may have had better outside options yet increasingly chose entrepreneurship.

[72] Some have used cross-sectional salary levels; however, these may be more a function of contemporaneous external labor markets, macroeconomic conditions, opportunity costs, or specific career path choices than underlying ability (Elfenbein, Hamilton, Zenger 2008).

the most recent (pre-entrepreneurial) income as the dependent variable and independent variables include the year, job type (business, academia, government, etc.), tenure, graduation year, etc. The residuals from this regression can then be thought of as either positive or negative shocks to the salary level relative to what the individual might have expected given her family socio-economic status, education and career choices. General measurement error will also be present, but should reduce the likelihood of a significant finding. Many factors and components of ability or skill will still be amalgamated in this residual term including potentially social skills, social network, and any other individual capabilities which influence higher salaries in the wage sector. Nonetheless, methodologically this is a step in the right direction. Since the last (pre-entrepreneurship) salary for the entrepreneurs would be farther in the past than for the non-entrepreneurs, a 2:1 matched sample of non-entrepreneurs was created by matching on both graduation year and last job year for the entrepreneurs. This reduces the sample size, but allows for a control for the year that the salary is measured which should control for inflation and trends in the increase in wage sector salaries.

A component of the residuals indicates performance in each job which can be contributed to the individual controlling for education, year and work history.[73] The results of the income regression used to generate the residuals are shown in Appendix E. An ordered logit specification is used because the dependent variable is the pre-entrepreneurship salary for each job (six categories for salary bands earned at the end of each job spell).[74] The regression is of the form:

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[73] Independently, a very similar method is already being used to capture talent levels (Andersson, Freedman, Haltiwanger, Lane, Shaw 2006).

[74] One might attempt to estimate the unobserved ability by using the multiple employment observations over each individual using fixed effects wage regressions in the first stage. As a robustness check, this method was also implemented. The residual measure described above is positively correlated with individual fixed effects calculated in this way. However, the methodology relies on panel data on salaries

$$Y_i = \alpha + \gamma_i X_i + \varepsilon_i$$

where Y_{it} is each individual's total income (including bonuses) in job t and X_{it} is a vector of education, work experience, job type, graduation year, and regional variables. Individuals having worked in business, having higher education levels, overseas educational and work experiences, and a higher parental economic status are all associated with higher salaries.

Insert Table 5 about here

Panel A of Table 5 shows the results from a quantile regression using the income residuals as the dependent variable and dummy variables equal to 1 if the individual founded a first firm in each of three time periods (Koenker, Hallock 2001).[75] This method is largely equivalent to regressing the residuals on a dummy variable for becoming an entrepreneur in each period and allows an examination of the relationship between being located at a point on the talent distribution and founding a firm. The post-1999 time period is the one of interest and the 1990s is used as a comparison as well as the pre-1990 time period. Column 1 (10^{th} percentile) compared to Column 5 (the 90^{th} percentile) shows that those at the bottom of the

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prior to entrepreneurship and the survey is essentially a cross-section. In addition, the individual fixed effects have the drawback of being only a time-invariant component of ability and the capability to learn more quickly on the job over time may be more important for entrepreneurship. In cases where the coefficients need to be interpreted, a negative binomial can be preferable to an ordered logit. However, in the negative binomial specification, the idea that the categories are ordered from lower to higher salary categories is not captured.

[75] Quantile regression shares many of the attractive properties of ordinary least squares (OLS) or mean regression, yet has the advantage of allowing changes in the shape of the entire conditional distribution to be examined. The results are robust to using a dummy variable for residuals above or below the median and using a logit specification. Using the residuals as the dependent variable avoids possible concerns about computing standard errors if the residual is entered as an independent variable.

distribution were more likely to found firms in earlier time periods and those of highest underlying ability are significantly more likely to found firms during the post-1999 time period. Panel B uses quantile regression to show that individuals higher in the talent distribution were associated with more profitable firms. Since heteroscedasticity is one of the motivations for using quantile regression, the bootstrap method (with 100 repetitions) is used to generate standard errors (Horowitz 2001, Rogers 1992). The results support the idea that there was not less entrepreneurship among individuals lower in the distribution of talent. Also the results provide some initial evidence for *hypothesis 3,* that these individuals were more likely to found firms in the years after the 1988 reduction in barriers to entry.

Effects on Start-up Firm Productivity

To more directly show that returns to human capital in entrepreneurship increased relative to wage employment is difficult since it is hard to know the salaries of entrepreneurs had they remained in wage jobs. However, Table 6 uses differences-in-differences estimates to see whether the returns in entrepreneurship to human capital increased in the post-period. The dependent variable in Models 6-1 to 6-4 is the natural log of the average profit margin for the firm. Models 6-5 to 6-8 use the log of the income of the founder from the business as the dependent variable. Since these dependent variables take only non-negative values and can be thought of as being censored at zero, a tobit model is used (the results are robust to using a Poisson and not taking the log of the dependent variables).[76] The regressions interact the human capital measures with a dummy variable indicating whether the individual founded the firm in the post-period. The results robustly support the idea that higher human capital individuals appear to have had higher returns to entrepreneurship after the institutional reform.

[76] Respondents were asked for profits as a percentage of revenues. Those with negative profits or no revenues can be considered censored at zero.

The results become even stronger when run without using robust standard errors.

Insert Table 6 about here

Next we ask whether after the 1988 reform that reduced entry barriers (legalizing private firms with more than eight employees) entrepreneurs were drawn from lower in the human capital distribution. Table 7 shows Cox hazard rate regression results, but just including individuals at-risk for founding a firm between 1988 and 1999. The results are that those founding firms during this period were more likely to be drawn from the lower end of the talent distribution. The results, along with prior empirical work (Nanda, 2008, Xu and Zhao, 2008) are consistent with hypothesis 3.[77]

Insert Table 7 about here

To further examine how the changing macro-economic environment may affect entrepreneurial activity, yearly data on several measures of the broader economic environment in China were compiled mainly from the Chinese National Bureau of Statistics[78] and filled in with data from other sources such as the World Bank and Chinese statistical yearbooks. These variables were regressed on the number of new start-up firms established. Data on new firm formations were from the Tsinghua survey described above. To get enough observations to make the regressions meaningful, the data go back to 1959 through 2007, however, the earliest firm founding in our data was 1964. The results here should be interpreted with caution due to the small sample size and the unreliable nature of economic data in China, particularly from

[77] The interpretation that lower human capital individuals were better represented among entrepreneurs before the 1988 reform is not ruled out by this analysis but seems extremely unlikely given the conditions in China and prior findings (Xu and Zhao, 2008).

[78] http://www.stats.gov.cn/english/

earlier time periods. These results are reported in Appendix G. Since the dependent variable is a count of the number of new firms established that year, negative binomial regressions are used and the independent variables are lagged by 1 year. Dummy variables for 1988 (indicating the reform allowing eight or more employees in a private firm) and for 1999 are included. The results support the idea that the 1999 and 1988 institutional reforms led to higher levels of entrepreneurship even when controlling for other macro-economic factors. The macro-economic conditions in China impact both positive and negatively the level of entrepreneurship.[79]

The regressions in Appendix I test whether the human capital measures are transferrable and associated with higher entrepreneurial productivity. In addition to controls for whether the firm was bought, privatized and its age, industry, city, founding year, and graduation year fixed effects are included in all models. For the unobserved ability measure calculated from the wage regression residuals, these residuals are recalculated on just the sample of the founders for the performance analysis. For Model (1) this underlying ability measure has a positive and significant effect on the firm profits. Model (2) finds that none of the human capital measures have a significant effect on firm revenues (or the sample size is not large enough to detect it). In Model (3), those with more years of education or who were promoted start firms with greater numbers of employees. The human capital measures are not significantly related to firm survival (in theory there are conflicting effects since those with higher opportunity costs may be quicker to close underperforming firms). Finally, Model (5) uses a logit regression on a dependent variable that indicates whether the founder indicated that intellectual property was

[79] The results show that *higher GDP per capita* (in 0.1 billion RMB), lower *Shanghai Stock Exchange Market Capitalization*, and few *domestic patents issued*, are associated with higher levels of entrepreneurship. Results are robust to contemporaneous and two year lags, except the year dummy variables are not robust to two year lags.

important for the start-up or not as an indicator of innovation. Those who had higher education levels, higher wage regression residuals, and who had worked in R&D positions were more likely to start firms where innovation and intellectual property were considered important. In general, the results show evidence that relatively more talented individuals indeed start firms which are higher in productivity.[80]

Discussion

Overall the results support the main thesis of this paper. Reforms in the institutional environment in the period after 2000 reduced constraints to growth and returns to entrepreneurship increased relative to wage employment. The evidence for this is that post-2000 individuals with higher human capital were relatively more likely to engage in entrepreneurship and had higher economic returns.

Endogeneity and Alternative Explanations

Five possible mechanisms may be behind an observation of reforms in the institutional environment and increased entrepreneurship. Other empirical work has already used instrumental variables approaches to largely alleviate concerns one through three (Acemoglu, Johnson 2005). First, entrepreneurs may be causing the improvement in institutions (reverse causality). Work on the political economy of private entrepreneurs in China suggests that they have not coalesced into a unified political movement, reducing concerns of lobbying for institutional reforms (Tsai 2005). Second, market opportunities may be driving both changed institutions and increased entrepreneurship. Either anticipated technological opportunities or poor wage employment opportunities may be causing both an increase in entrepreneurship and

[80] A further implication of the results is that the 1999 reform may have altered the incentives for individuals to invest in (certain types) of human capital. Future work may look for this implication that with greater incentives for entrepreneurial activity, individuals may have altered their investment decisions in the direction of the types of skills relevant for entrepreneurship.

efforts to improve the institutional environment. This endogeneity concern is not easily ruled out. Several factors together alleviate the concern to some degree. Prior literature using instrumental variables techniques suggests that there is a direct causal effect of institutions on economic growth (Acemoglu, Johnson 2005). Next, removing internet and software industries (the most likely candidates for anticipated technological opportunities) only reinforces the results. Also, this story suggests that government bureaucrats saw technological opportunities arising and that they then designed institutions to reduce growth barriers. Yet, despite the 1999 amendment being intended to move China toward a market economy, accounts do not describe it as intending to encourage more talented entrepreneurs (OECD, 2007, Qian, 2000).[81] The third mechanism is that changes in the investor community or competitive environment may be causing changes in the type of entrepreneurs being selected for funding. Fourth, the set of institutions that resulted from market development in the more recent period could be lowering the barriers to entry, which may lead to more individuals of lower quality or with lower payoff ideas to become entrepreneurs. Fifth, the set of institutions in the more recent period could be leading to better outcomes for entrepreneurs and encouraging others who are higher in the talent distribution to become entrepreneurs.

Still other interesting possible alternative explanations and mechanisms merit further analysis: (a) universities and research institutes themselves became more profit oriented and sought to invest in the ventures they knew most about, those of their own students, and the university had better information on underlying ability levels; (b) the demography of the funders/lead investor community itself might have changed and its preferences perhaps leaned towards higher ability individuals or technically skilled entrepreneurs with real marketable

[81] Since 1986, the government had attempted to encourage high tech entrepreneurship so this was not new as of 1999 (Zhang, Li, Schoonhoven 2008).

research output; (c) the nature of the economic opportunities or competition changed as China liberalized and the available opportunities required those with higher ability levels; (d) increased college student enrollment led to a flood of graduate students with limited wage job opportunities; (e) payoff to skills, demand for innovation/R&D in the economy increased; (f) increased legitimacy may have led higher status individuals to become entrepreneurs and higher status also happens to be correlated with ability. The available evidence is used to address these mechanisms.

University investing. First is the idea that the universities and research institutes became more profit oriented and then invested preferentially in the spinoffs created by their own students or professors for which they had more information. A question on the survey asked whether Tsinghua played a role in either directly funding the startup or in helping to find funding. Only 13 respondents indicated "yes" to either question. Thus, it seems that university funding does not explain the results.[82]

Shifting investor community. The demography or preferences of the investor community may have changed. This explanation is harder to rule out since the question cannot be addressed head-on without data on the demography of investors and their investment preferences. Specifically, the dotcom boom in the U.S. inspired both investors and entrepreneurs to seek out internet and software opportunities in China. To test this explanation, the analyses were re-run, dropping all internet and software firms from the sample and the results hold with coefficients of slightly higher magnitude. Nonetheless, it is important to note that the venture capitalists that we talked with indicated that VCs in China primarily tended to focus on later stage private equity deals and non-technology start-ups. Certainly changes were

[82] Furthermore, during the 1990s the largest increases in university-affiliated start-ups occurred due to funding cuts and the universities' need to generate operating revenues. During the 2000s, as funding for top universities increased the number of such enterprises declined.

occurring in the investor community during this time.[83] However, the main effects should have been for later stage firms.[84]

Changing Opportunities. The nature of the entrepreneurial opportunities or the competition increased such that potential entrepreneurs located relatively lower in the talent distribution were screened out and the opportunities were only available to entrepreneurs with higher human capital levels. Other forms of this same argument are that perhaps the payoff to skills in entrepreneurship increased or the demand for innovation and R&D in the economy increased.[85] Again, the fact that the result remains and grows stronger with the elimination of software and internet firms provides some evidence inconsistent with this interpretation. The results also hold when all 193 firms indicating that intellectual property would be important for their success were dropped. The results in Panel A of Table 5 provide evidence against the idea that there was a decrease in entrepreneurship among the lower tail of the talent distribution. Finally, Appendix F shows that there were not increases in the returns to talent in the wage sector after the reform.

Labor Market. On the supply side, the number of students enrolling in tertiary education in China dramatically increased since the 1990s. According to the National Bureau of Statistics

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[83] In March 1998 China implemented a number of policies to promote venture investments (Batjargal, Liu 2004). The initial venture capital funds within China were backed by the government, however, and had both policy as well as financial objectives. Total annual venture capital investments in China grew from virtually nothing in 1990 to $858 million in 2000 (Batjargal, Liu 2004).

[84] There are actually two separate questions here. The first is whether new types of investors entered the market, who were more interested in high quality individuals rather than the merits of the idea alone or its alignment with policy objectives. The second question is whether the existing investors shifted their preferences towards high ability founders. Only twenty-five of the firms in the sample reported venture capital funding, so the relevant investor groups would mainly have been informal (angel investors). Anecdotal evidence from the interviews does not appear to support this notion since the entrepreneurs indicated that most of the informal (angel) investors in China made their money in traditional industries. While they want to diversify into technology firms, many reported that their informal investors were not knowledgeable about technology industries and thus would not be expected to have greater capacity to select based on ability.

[85] It has been argued that Chinese managers imitated some of the practices of Western managers (Guthrie 1999). Some have suggested that there was imitation of the U.S. dotcom entrepreneurs.

of China, restricting the definition to four year colleges and universities, the total number of graduates has gone from 830,000 in 1998 to just over three million in 2005. Since 1999, the number of undergraduate and graduate students has grown at nearly 30% per year.[86] If traditional job demand could not accommodate this increased supply, many of these individuals may have turned to entrepreneurship. However, while possibly true more broadly, this type of explanation does not seem likely for the individuals in this study since alumni from the top engineering school in the country should have had no problems finding employment. Second, for this account to be correct, one would expect that it is primarily the individuals from the lower end of the talent distribution who both have trouble finding acceptable wage employment and thus who opt into entrepreneurship. This implication is contradicted by the data in 5-3 on the increase coming from the higher end of the talent distribution.

Increased legitimacy. An alternative explanation is that the increase in entrepreneurship among more talented individuals is not due to changing incentives in the institutional environment, but rather to the increasing legitimacy of entrepreneurship in China during this time. Changes in legitimacy may be highly correlated with changes in the institutional environment. Xu and Zhao (2008) use a national dataset from 1978-1996 in the China Statistical Yearbook and argue that as entrepreneurship became fully legitimized by 1996, particularly at the local level, greater numbers of high-status individuals (Communist party cadres and those with more education) became entrepreneurs at a more rapid rate. However, status and education also tend to correlate with ability. Interviews seem to indicate that by the end of the 1990s, entrepreneurship was already seen as a legitimate career option. According to Xu and Zhao (2008), entrepreneurship was already fully legitimized by the mid-1990s, and

[86] However, evidence indicates that quantity has been expanded at the expense of the quality of the graduates (Gereffi, Wadhwa, Rissing, Ong 2008).

legitimate enough by 1996 (when their data end) that government officials and highly educated, high status individuals were becoming entrepreneurs at faster rates than lower status individuals. They measure legitimacy by the state's official recognition of private enterprise in 1988 when private businesses with eight or more employees were granted "organization" status. Their analysis ends in 1996, the year before the state "fully recognized private business as an important component" in the economy. It is reasonable to believe that entrepreneurial activity was seen as quite legitimate by 1997 by when most (74%) of the pre-2000 foundings occurred. Also, a control for the graduation year controls for more recent graduates viewing entrepreneurship as more desirable. Even controlling for such trends, the propensity for higher ability entrepreneurs to found firms appears to increase. Perhaps most convincing are the results in Appendix C. If the effect is due to legitimacy, then one should see higher status individuals (who had more to lose previously) becoming entrepreneurs at a higher rate (Giordano 1983, Xu, Zhao Jan. 2008). Thus, a dummy variable was added indicating whether the individual was high status (government officials, and Communist party members) and this variable is interacted with the dummy for the post-1999 time period. The coefficient is insignificant while the human capital measure remains significant indicating that a change in legitimacy does not appear to explain away the results. Furthermore, the analysis here controls for many status factors, such as level in the government, education and academic positions, so the results indicate that even after controlling for status, still individuals located higher in the talent distribution became entrepreneurs at significantly higher rates post-2000. The current paper offers support for a different explanation for the rise in entrepreneurship, one that focuses more on incentives for more talented individuals to form private businesses and less on the roles of status and legitimacy.

Robustness

Three dimensions appear important for checking robustness on for these results: different talent measures, a subset of the sample where confidence is higher, and different model specifications.

Robustness to different talent measures. For those with prior jobs in business, the data include whether they had been promoted to general manager positions. The results are robust to using many observable ability measures. An alternative measure of "pull" entrepreneurship (Klepper, 2008) is whether the Bachelor's or Masters major matches the industry of the start-up that the individual founded. This proportion goes from just under 30% before 1999 to 40% post-1999 ($p<0.05$; $t = 1.759$).

Time invariant underlying ability. The results are robust to using the data on job spells to create a panel of multiple observations on each individual and using the wage regression to generate individual fixed effects. The main results are also robust to using a logit rather than the hazard model. The underlying ability measure is robust to using a negative binomial rather than the ordered logit.

The number of responses was lower for graduates during 1947-1951 and 1970-1980. The first period is the time of the Communist revolution and the second period is the time of the Cultural Revolution during which university activities were impaired. To check whether the results were affected by response bias during these times, the analyses were repeated dropping all observations during these two time periods and the results hold.

Limitations

It is useful to keep in mind three data-related issues: representativeness, response rates and self-reporting. The first issue is the extent to which inferences made from this dataset apply

to entrepreneurship in general. The data for this study come from alumni of a very important academic institution in China. It is important to note that these are alumni and therefore the sample is not limited to those currently associated with Tsinghua or to technology coming from Tsinghua. I do not claim generalizability across the spectrum of entrepreneurial activity; however, the sample represents an interesting and important population of individuals.[87] To the extent that individuals at the bottom of the talent distribution are excluded, the exact slope estimates will be biased. A second issue is possible response bias. For example, graduates who started a company but were unsuccessful may well not have reported these failed firms, either by omitting them from their responses or by not participating in the study at all. Next is the issue of self-reporting. Older respondents, especially those who have started multiple companies, may display a memory bias in which some companies, possibly those which were relatively unsuccessful, are not reported. This may lead to the appearance that younger entrepreneurs are starting more (though less successful) firms on average. Older entrepreneurs may have been less likely to respond to a university survey if such alumni ties weaken over time.[88]

Two more conceptual issues should be considered. The first is identification and there are two main concerns. It is not unambiguous that the 1999 policy reform only lowered barriers to growth without also lowering barriers to entry. If the effect of the reform was

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[87] While those with a technical education and knowledge workers are seen as an increasingly important part of the economy, we know relatively little about what drives them to start technology based enterprises (Roberts 2004). National samples of entrepreneurship may be more representative of entrepreneurship broadly defined, but probably not of technology-based entrepreneurship. Moreover, comparing national samples of entrepreneurship is challenging, as data sampling strategies vary depending on the subject matter of study (compare, for example studies of self-employment (Blau 1987) and manufacturing (Dunne, Roberts, Samuelson 1988). With these caveats in mind, note that very few datasets exist of entrepreneurial activity in China, especially for technically trained individuals, so in this sense the present study represents a step forward.

[88] During the interviews many older alumni assured that they feel a very strong bond with Tsinghua and the Alumni Association which reassures us that there were not large biases in the age of respondents.

primarily to lower barriers to entry then the results could be interpreted as consistent with the conventional view. Five pieces of evidence help to allay concerns. First, access to a similar survey of MIT alumni enables a robustness check (Hsu, Roberts, Eesley 2007). During the dotcom boom years of 1998-2000 there was a perception of increased returns to entrepreneurship. Anecdotal reports exist of many MBA students and alumni at elite business schools founding firms. If similar results were not found in the U.S. during this time then it would cast doubt on the robustness of the results. Results for a similar differences-in-differences hazard rate analysis using the MIT alumni dataset reinforce the findings. The interaction term between years of education and a dummy variable equal to 1 if the individual was 'at-risk' of a first firm founding during 1998-2000 is greater than one and statistically significant. Results for a placebo regression using the pre-boom years (1995-1998) were insignificant. Second, in the data from Tsinghua, a set of 'placebo' regressions were run using 1997 and 1998 as the cutoff year instead of post-1999. As expected, the differences-in-differences estimates lose their statistical significance when the wrong year is chosen for the policy change. Third, the results in Tables 5 and 6 more directly test whether increased returns to entrepreneurship occurred after the reform. Fourth, results from income regressions show that there were not higher returns to talent in wage employment during this time period, alleviating concerns that the reform had broader effects (Appendix F). Fifth, qualitative evidence from interviews indicates that lower barriers to entry were not perceived as a result of the reform, but rather that it was possible to create a high growth business during the post-1999 time period. As long as the primary effect was to increase returns to talent in entrepreneurship, if entry barriers were marginally lowered then the interpretation here is still sound. If other changes were happening in China that were both highly co-linear with the changes in the

institutional environment post-1999 and acted primarily to increase the returns to human capital in entrepreneurship, they would be difficult to disentangle. It is possible that the analysis may pick up the effects of earlier reforms. If the earlier reforms primarily act in the same direction this would introduce the 'treatment' effect in the pre-2000 time period and should be making it harder to see an effect.

Next, unobserved heterogeneity is a valid concern which can never be entirely addressed.[89] The fixed effects robustness check alleviates this concern, however there may be unobservable attributes of the past work experience which drives the distinction between the measure of talent and are also correlated with entrepreneurship, such as working in a multinational corporation. One of the advantages of our dataset is the relative uniformity of Tsinghua alumni. This should provide some level of uniformity in unobservable characteristics, especially compared to other datasets of entrepreneurs. Academic department dummy variables and a well-defined sample population help alleviate concerns that various sources of unobserved heterogeneity are driving our findings.

Regional variation exists in the institutional environment in China and traditionally movement of individuals across regions was restricted. However, the coastal provinces have experienced quicker market development of the institutional environment in many ways and much higher overall economic growth. Future work will take advantage of regional variation of reforms.[90]

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[89] Propensity score matching models would better address heterogeneity concerns, yet a propensity score matching model is not possible to implement in this context since there is no suitable untreated control group of individuals (untreated here would mean that they did not live in China after 2000 or had already founded a firm prior to 2000).

[90] In recent years some policies allowed movement of technically trained employees across provinces. Therefore, the regional variation does not provide an opportunity for identification when only looking at coastal provinces versus others. Entrepreneurship does not appear to have been higher in the coastal provinces which is consistent with these areas having better wage employment opportunities.

Boundary Conditions

The results appear to open up an interesting line of research. However, given the complexity and diversity of entrepreneurs and of institutional environments, lowering barriers to entry is unlikely to draw increased entrepreneurial behavior from those lower in the talent distribution in all research samples. Similarly, lower barriers to growth may not always increase the propensity for entrepreneurship among individuals higher in the talent distribution. Considering the sample used, it is vital to outline certain boundary conditions. The theory should apply outside of the context of Tsinghua graduates so long as at least four boundary conditions hold: 1) the types of skills and talent necessary to overcome entry barriers are not largely orthogonal to those useful for firm growth; 2) feedback loops are weak: that is, increases in the number of entrepreneurial firms do not strongly increase competition or create significantly better wage employment opportunities; 3) the initial relationship between talent and returns to entrepreneurship is not one where primarily those at the top of the talent distribution become entrepreneurs; and 4) sufficient variation exists in the distribution of talent (by measures relevant for wage and entrepreneurial payoffs) in the sample at risk for entrepreneurship.

First if the skills that are useful for generating returns in entrepreneurship are unrelated to the skills (or endowments) needed to overcome entry barriers then the theory will not hold. Second, if increases in entrepreneurship by those of higher ability increase competition significantly then this feedback mechanism should act to bring expected returns to entrepreneurship back down. Similarly, if increased entrepreneurship results in significantly better wage employment opportunities then this will counterbalance the returns to entrepreneurship relative to wage work. Third, in some cases the relationship between human

capital and returns to entrepreneurship may be initially represented by a line or curve that begins below the curve for returns to wage work and only intersects at the high end of the distribution. A shift upwards in the curve for returns to ability in entrepreneurship would then increase entrepreneurship among those of relatively lower talent levels. Finally, for research settings without sufficient variation in the talent distribution it should be more difficult empirically to find results.

Our data comprise a representative sample of Tsinghua alumni not selected based on entry (or successful entry) into entrepreneurship.[91] While generalizations to all entrepreneurs are challenging, the advantages of this dataset are the systematic survey methodology, the number of years covered, the number of observations and detailed work histories as well as the ability to compare the founders' characteristics with their classmates who had largely the same educational experience but did not become entrepreneurs. The data include individuals who were very successful in their careers as well as many who had low salaries, were fired or never promoted. The Tsinghua dataset is one of the first systematic large-scale records of technology-based entrepreneurial activity in China.

Conclusions

The impact of the institutional environment on entrepreneurship has conventionally been seen at its worst as severely constraining entrepreneurial behavior via difficulty in raising start-up capital, insecure property-rights, or unreliable courts and contracts, and at its best as allowing market incentives to work. Yet the very high rate of entrepreneurship in less developed countries leaves a puzzle for this conception of the role of market institutions. The

[91] The Tsinghua data contain wide variation in firm sizes, number of operating years, and outcomes so they do not share *to the same extent* the limitation of other entrepreneur datasets in only sampling successful founders.

other side of the coin is the puzzle of why certain countries that have rapidly adopted institutions of privatization and financial liberalization have not experienced higher levels of growth from entrepreneurship (McMillan, Woodruff 2002, Frye, Shleifer 1997)? This paper takes a step towards showing the type of institutional change that can induce individuals more likely to succeed to become entrepreneurs.

To shed light on the impact that lowering barriers to growth may have for entrepreneurship among individuals of differing human capital levels, a novel survey was collected including entrepreneurs and non-entrepreneurial alumni covering multiple decades when entrepreneurship began to emerge across China. The analysis uses a differences-in-differences approach, exploiting a natural experiment with the 1999 Chinese constitutional reform and detailed data on pre-entrepreneurship work history. This paper is one of the first to combine a dynamic view of institutional change with a view on specifically who is most affected by shifting incentives for entrepreneurship. The main results come in two stages. First, a change in the institutional environment in 1999 which lowered the barriers to entrepreneurial firm growth resulted in a greater increase in talented individuals becoming entrepreneurs. Second, the results show that various measures of human capital are associated with founding firms which become larger, more profitable, and are more likely to innovate.

These results are novel, not only for documenting for the first time that a policy change results in higher quality entrepreneurship, but because they change the way we think about the mechanisms through which institutions affect entrepreneurship. The findings change previously held views in three different ways. First, the ability to overcome institutional barriers to entry (either through connections or the capability to navigate a complex bureaucracy) is not orthogonal to the aspects of ability which are important for commercial

success in the market, but rather there is much overlap. Second, individuals with stronger resumés and with better employment performance relative to their resumé do carry over those skills to the task of entrepreneurship with the implication that investors and entrepreneurs may want to look for those characteristics. Third, policy may be able to influence not just the rate, but the overall direction of innovative activity and the type of entrepreneurial firms in a society by focusing less on the fixed start-up costs of entrepreneurship and more on the barriers to growth and opportunity costs. Nevertheless, the results are not merely consistent with a standard opportunity cost explanation. Rather, even controlling for opportunity costs and rising salaries in the wage sector, the results in Table 5 show that the institutional shift had an additive effect of its own.

The results have several implications. First, they contribute to the literature on institutions and economic growth by shedding light on one mechanism by which certain institutional environments contribute to economic growth. The paper provides a unique theoretical link between institutions and the economics of entrepreneurship. Institutional reforms alter the selection into entrepreneurship, not only by reducing barriers to entry, but by shifting the directions in which talented individuals channel their energies in society (Baumol 1990). One important implication is that there may be two separate classes of institutions, one that lowers barriers and costs to entry and another which lowers barriers to entrepreneurial growth. Some have already begun to unbundle institutions, but the distinction between institutions which have different mechanisms of action may be important to consider.[92] The results have implications for developing economies, particularly those with a manufacturing

[92] Examples of the first category may include government legalization and legitimatization of entrepreneurship, property-rights institutions, and some types of financial and banking reform. Examples of the second category may include subsidies and tax incentives for R&D, science parks and incubators, licensing laws, IP protection, private equity and venture capital reforms, and changes in the regulatory systems for mergers and acquisitions or IPO.

sector that is looking to upgrade and to foster the emergence of technology-based entrepreneurship as a driver of economic growth. For policy-makers, entrepreneurs, and university officials to blindly apply theories tested in developed country contexts is not without risk. The prior literature may be incorrect in conceptualizing the characteristics which allow one to overcome institutional barriers to entry as being largely orthogonal to those important for commercial success or entrepreneurial ability. Lowering barriers to entry may increase entrepreneurship among individuals lower in the talent distribution (i.e. by reducing the costs of entrepreneurial finance) (Nanda 2008, Wang, 2008). The results may lead to rethinking even the theoretical predictions on liquidity constraints. Even the original model of Evans, Jovanovic (1989) predicts constraints impacting the top quartiles of the ability distribution most strongly, leading to the idea that liquidity constraints may actually be one of many types of constraints to growth, rather than being most binding on entry. Buera (2008) shows that a dynamic model of financial constraints yields more nuanced predictions than standard static models. Testing his model with U.S. data, he shows that welfare costs are not due to individuals with ability not starting businesses, but rather to undercapitalized entrepreneurs. The results here may allow for targeted programs to encourage entrepreneurship among those more likely to create high-impact organizations by focusing on growth of entrepreneurial firms.

The paper also provides groundwork for a talent-based theory of technology bubbles or of the direction of technological progress. For strategy researchers, the findings contribute to our understanding of who is selecting into entrepreneurial firms and also on the type of firms and competition in the market. Previous work finds that institutions which reduce the perceived risk in new sectors appear to result in greater use of novel technology by entrepreneurs (Sine, Haveman, Tolbert 2005). Similarly, the results of this study show that

individuals with higher levels of human capital were more likely to indicate that intellectual property would be important for their firms and were more likely to found firms after the reform. Prior theories of why we see waves of creative destruction have emphasized differences between large and small firms in capabilities or incentives to innovate, while this paper provides a theory of when and why human capital may flow in the direction of smaller firms. Savvy entrepreneurs may capitalize on an awareness of shifts in the institutional environment to begin recruiting more talented cofounders or to anticipate shifts in the competitive landscape. Changes in the institutional environment could alter the basis of competition, or open up new markets if it brings about entrepreneurial entry by a different group of people.[93] Particularly in fast-paced industries, there may be room for the strategic influencing of perceived payoffs in a particular market or for managers to avoid stiff competition by searching for markets and technologies with payoffs that are falsely perceived to be lower than elsewhere. A higher propensity for more talented individuals to become entrepreneurs may result in stronger competition or result in more firms needing to use an innovation strategy to avoid direct competition on price or market share. The results also show that prior conflicting results on the human capital characteristics associated with entrepreneurship may be due to differences in context. Some environments are more conducive for altering the marginal costs, encouraging entrepreneurs to be drawn from relatively lower in the talent distribution. Others alter the marginal benefits and foster entrepreneurship among those with higher levels of human capital. The findings help guide those in larger organizations

[93] Similarly, those interested in national innovation systems (Freeman 1987, Nelson 1993) or the related literature on varieties of capitalism argue that while some capitalist economies are organized for radical innovation and high growth (U.S.), others are better at other outcomes such as equality or incremental innovation (Hall, Soskice 2001).

looking to do more corporate venturing.[94] A better understanding of the incentives for entrepreneurial behavior is important for product development and corporate entrepreneurship efforts when structuring incentives to attract high ability employees towards risky new business projects. Appendix H summarizes the implications for the competitive environment and for entrepreneurs. This paper provides evidence that entrepreneurship in distinct institutional environments may have different drivers and outcomes.[95]

A key contribution of this paper is that there may be two different margins at which institutions affect entrepreneurship. Prior literature has examined one margin, where potential entrepreneurs are considering the costs and barriers to entry and are concerned primarily with whether the resources necessary to begin the business can be gathered. Yet there is another margin that has a greater impact on more talented individuals. Most of these individuals are capable enough to creatively acquire the necessary resources to start a business if they wanted to do so. Yet, they have good options in the wage sector and may be concerned more with the relative payoffs and whether the size and type of business they wish to start can be achieved.[96]

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[94] Prior work finds larger firms that select and reward managers based on performance grow faster and have higher return on capital (Bandiera, Guiso, Prat, Sadun, 2008, Bertrand, Schoar 2003).

[95] Previously, other scholars have suggested a necessary ordering to institutional reform, with macroeconomic stability coming first and then financial liberalization needing to be tied to securing property rights and market infrastructure (Johnson, McMillan, Woodruff 2000). China has certainly had macroeconomic stability at least since the Cultural Revolution; however, it appears to be a counter example in having experienced rapid growth despite ambiguous property rights. Others have suggested that the idea of one ideal blueprint may be incorrect (Segal 2002, Breznitz 2007). The confusion may reflect the literature's implicit assumption that the same market failures affect *all* potential entrepreneurs equally from creating the *same* types of firms at *all* stages in market development. In the early stages of market development, good wage employment options are not available and lower ability individuals experience a strong push towards entrepreneurship but are resource constrained. At a middle stage in market development, better wage opportunities are available and the resources to start small scale firms can be gathered. Different market failures affect different individuals and different firm types at different stages in development.

[96] This is not to imply that potential entrepreneurs care only about pecuniary benefits (Hamilton 2000). Nonetheless, it does appear that monetary outcomes are better for those higher in the ability distribution (Hamilton 2000) and even the non-pecuniary benefits may only accrue if individuals can create the type of firms they prefer to found and run.

The results show that entrepreneurs and investors can screen for higher quality co-founders and that policymakers can craft institutions to encourage more market entry by those who are more likely to create high-growth, innovative firms. I provide evidence consistent with a story that the institutional environment may be shaped to encourage a more Schumpeterian-type of creative destruction rather than to increase marginal new firm creation by less talented individuals (Schumpeter 1942).

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Figures and Tables

FIGURE 1

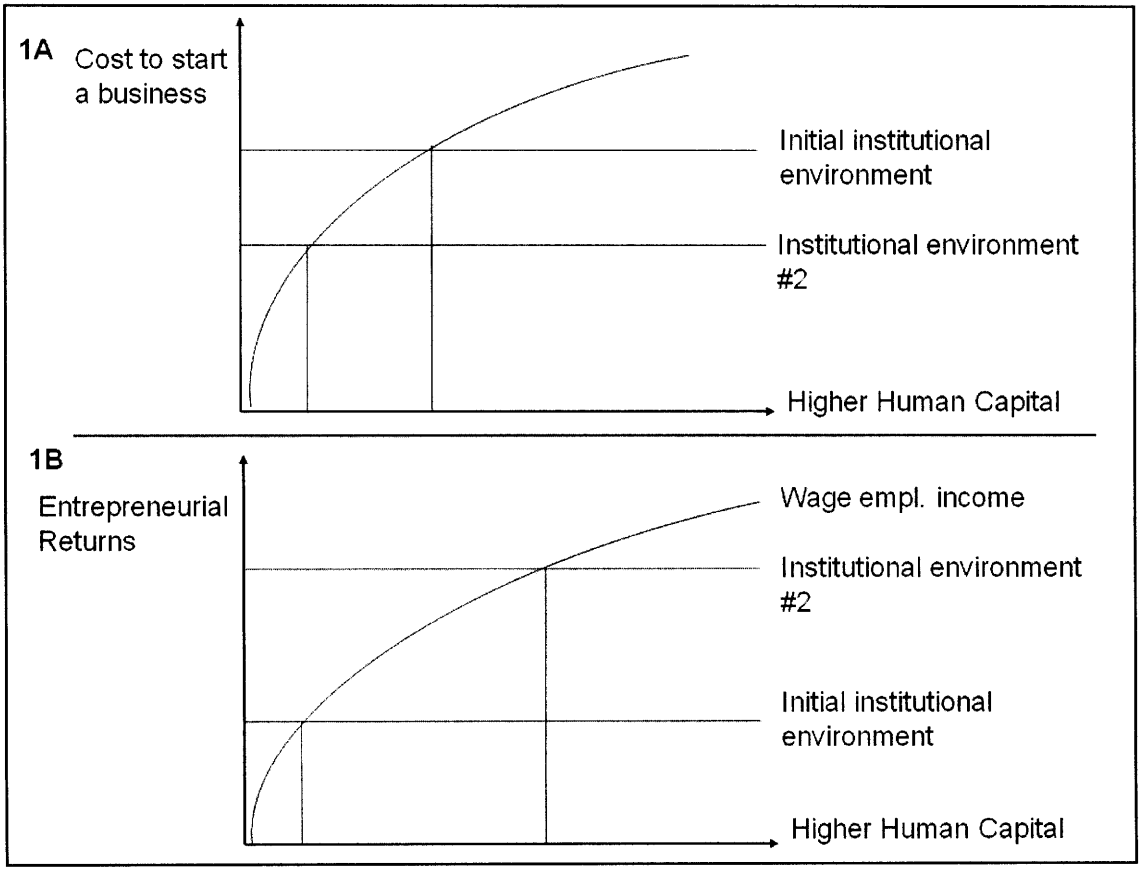


FIGURE 2

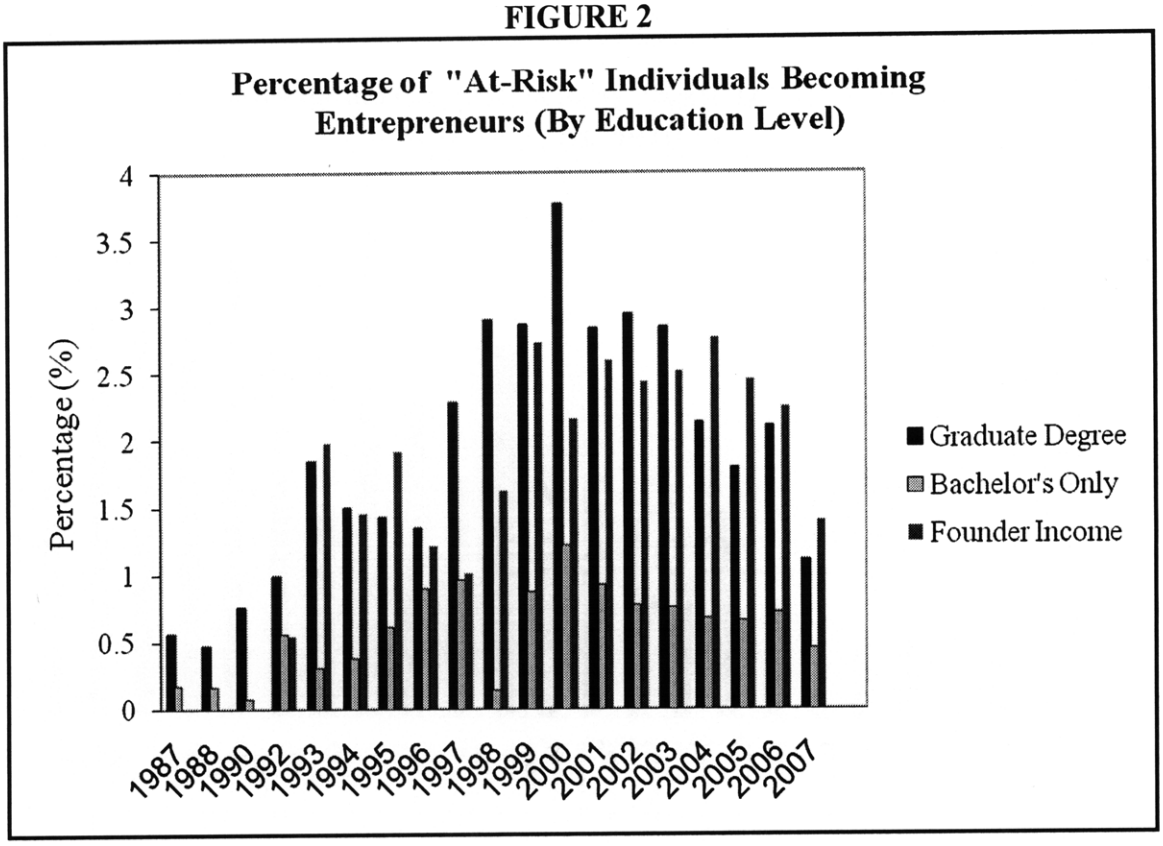

Percentage of "At-Risk" Individuals Becoming Entrepreneurs (By Education Level)
Percentage (%)
4
3.5
3
2.5
2
1.5
1
0.5
0
1987
1988
1990
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Graduate Degree
Bachelor's Only
Founder Income

FIGURE 3

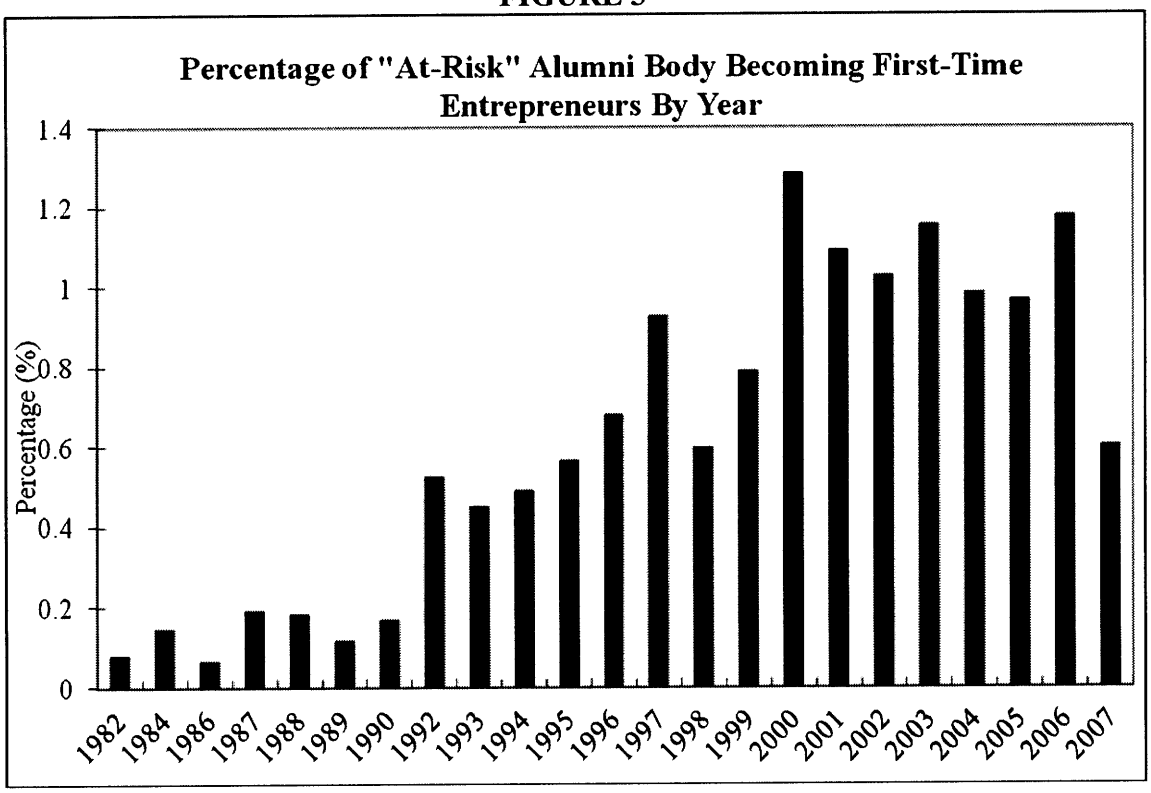

Percentage of "At-Risk" Alumni Body Becoming First-Time Entrepreneurs By Year
Percentage (%)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1982
1984
1986
1987
1988
1989
1990
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

FIGURE 4

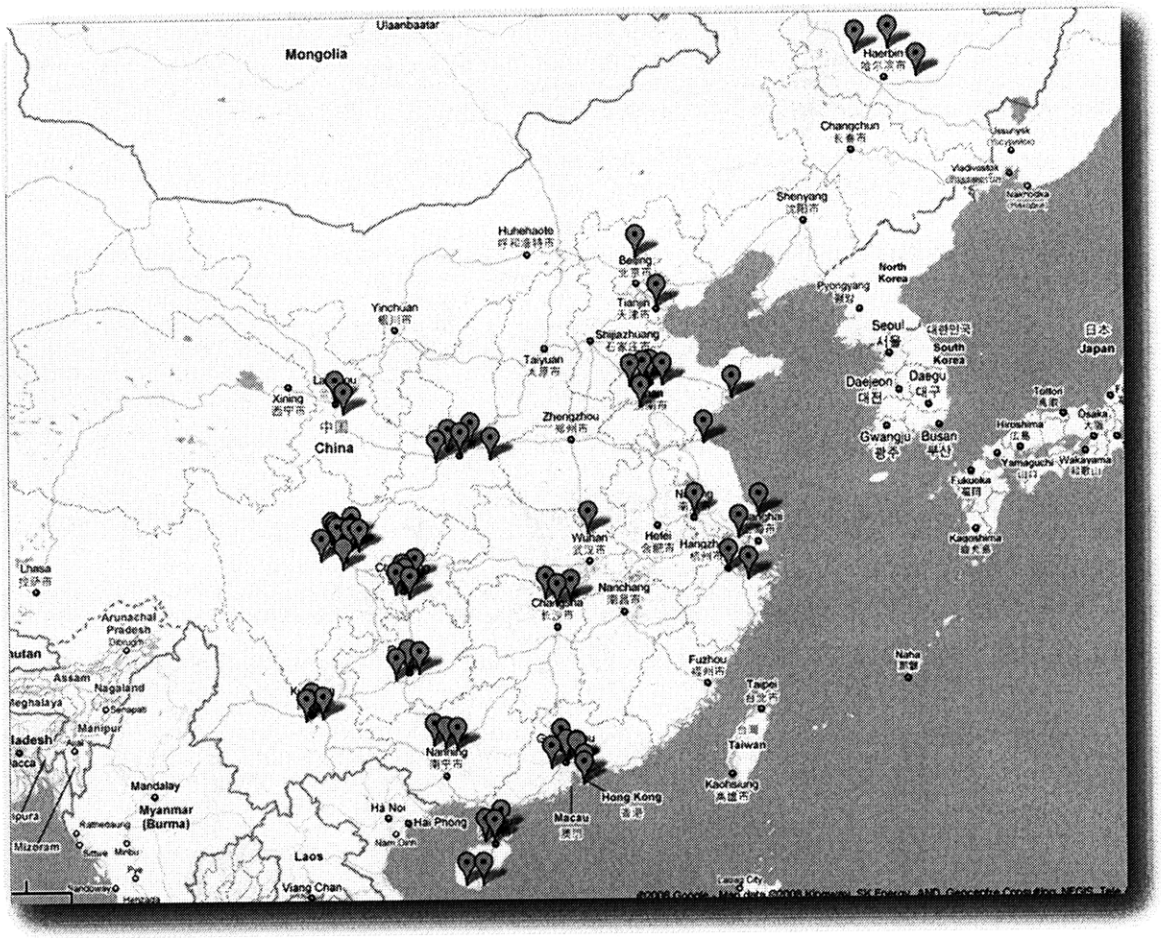

Ulaanbaatar
Mongolia
Haerbin
Changchun
Shenyang
Huhehaote
Beijing
Tianjin
North Korea
Pyongyang
Yinchuan
Shijiazhuang
Taiyuan
Seoul
South Korea
Japan
Daejeon
Daegu
Xining
China
Zhengzhou
Gwangju
Busan
Hiroshima
Yamaguchi
Wakayama
Fukuoka
Kagoshima
Wuhan
Hefei
Hangzhou
Lhasa
Changsha
Nanchang
Arunachal Pradesh
Assam
Nagaland
Manipur
Fuzhou
Taipei
Taiwan
Naha
Nanning
Kaohsiung
Mandalay
Myanmar (Burma)
Hong Kong
Macau
Mizoram
Laos
Viang Chan

FIGURE 5

Plot of Residuals Generated by Income Regression

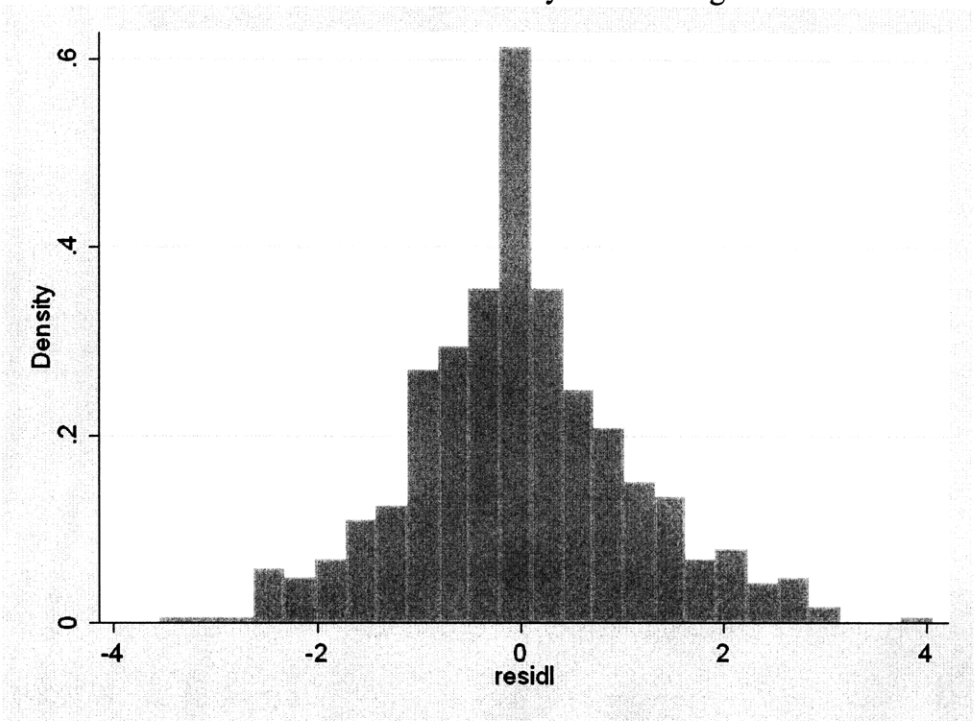


FIGURE 6

Kaplan-Meier Curves to Test Hazard Rate Assumptions

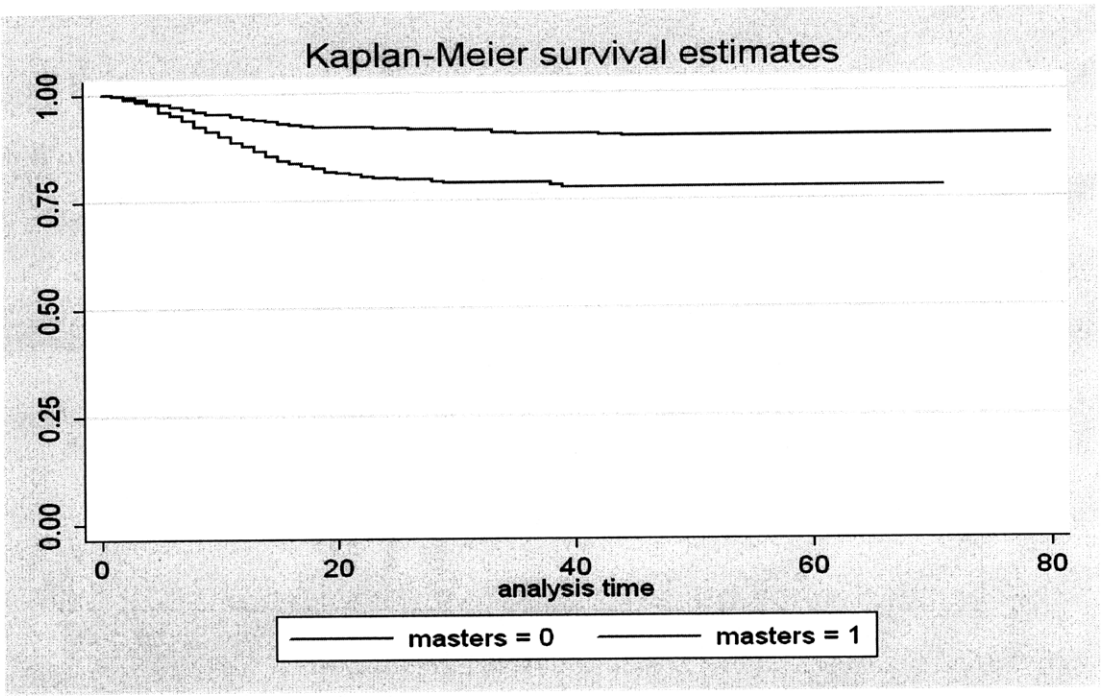


FIGURE 7

Graph of Shoenfeld Residuals to Test Hazard Rate Model Assumptions

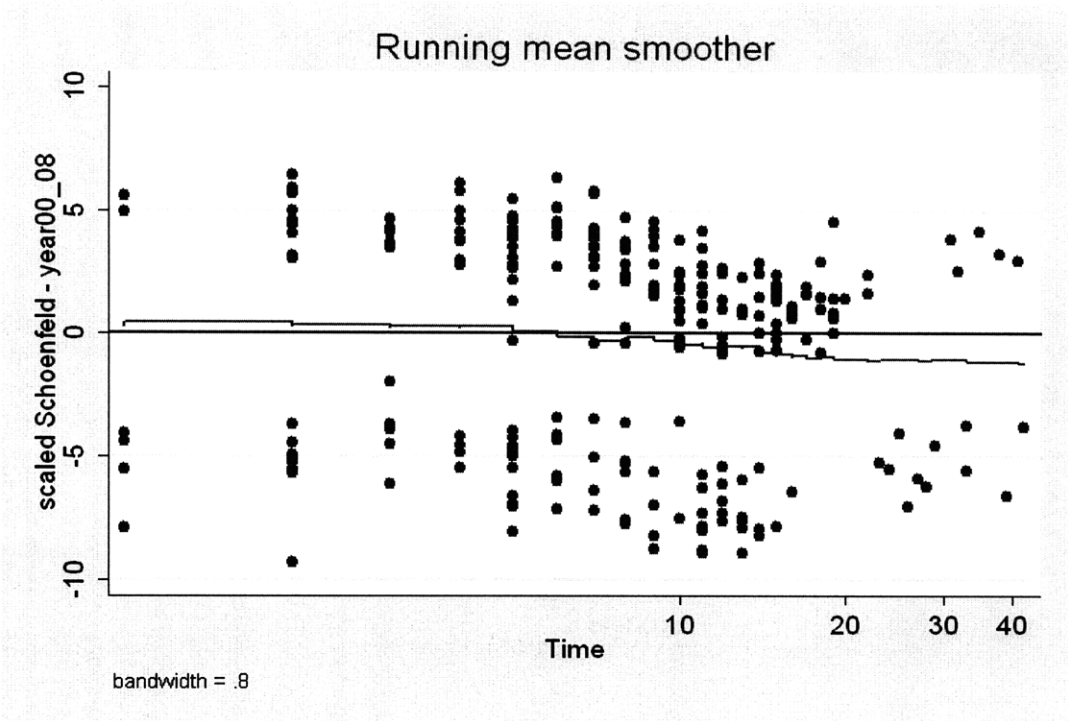


TABLE 1
Industry Breakdown

Industry	Number of Firms	Percentage
AEROSPACE	3	0.90
ARCHITECTURE	13	3.88
BIOTECH AND DRUGS	7	1.09
CHEMICALS	8	2.39
CONSUMER PRODUCTS	17	5.07
ELECTRIC	12	3.58
ELECTRONICS	69	20.60
ENERGY	14	4.18
FINANCE	10	2.99
INTERNET	33	9.85
LAW, ACCOUNTING	22	6.57
MACHINERY	19	5.67
MANAGEMENT	21	6.27
MATERIALS	13	3.88
MED DEVICES	4	1.19
OTHER MFG	16	4.78
PUBLISHING	11	3.28
SOFTWARE	34	10.15
TELECOM	9	2.69
TOTAL	335	100

TABLE 2
Pairwise Correlations

		1	2	3	4	5	8	9	10	11	12	13	14	15	17	18	19	20	21
1	*Last job academia*	1																	
2	*Last job business*	-0.618	1																
3	*High government*	-0.051	-0.080	1															
4	*Low government*	-0.102	-0.385	-0.105	1														
5	*Ever job academia*	0.425	-0.085	-0.009	-0.056	1													
8	*Number of Positions*	-0.149	0.175	-0.011	0.036	0.135	1												
9	*Avg. Tenure*	0.047	-0.088	-0.036	0.077	-0.117	-0.060	1											
10	*Gender*	-0.046	0.047	-0.029	0.007	0.008	0.120	0.032	1										
11	*Entrepreneur Parents*	-0.041	0.002	0.018	-0.004	-0.058	0.054	-0.048	-0.016	1									
12	*High Salary*	-0.138	0.320	-0.050	-0.180	0.158	0.284	-0.305	0.057	0.009	1								
13	*Family economic status*	-0.030	-0.018	-0.004	0.030	-0.054	-0.081	0.098	0.154	-0.115	-0.196	1							
14	*Student Leader*	0.009	-0.028	0.011	0.051	0.011	0.075	-0.130	-0.010	0.043	0.144	-0.070	1						
15	*Communist Party*	-0.002	-0.092	-0.019	0.114	-0.043	-0.011	0.071	0.034	-0.037	-0.070	0.037	0.008	1					
17	*Master's*	0.037	0.053	-0.025	-0.032	0.103	0.119	-0.278	-0.013	-0.014	0.317	-0.090	0.234	-0.092	1				
18	*PhD*	0.273	-0.1	-0.0	-0.0	0.114	-0.0	-0.1	0.030	0.040	0.121	-0.0	0.142	-0.0	0.215	1			

			76	21	22		17	14				40		25					
19	*Overseas Experience*	-0.029	0.088	0.013	-0.001	0.030	0.093	-0.083	0.009	0.059	0.040	-0.097	0.076	-0.044	0.047	0.030	1		
20	*Bachelor's Grad Year*	-0.159	0.268	0.027	-0.136	0.014	0.098	-0.433	0.031	0.083	0.460	-0.104	0.242	-0.130	0.457	0.160	0.232	1	
21	*Age*	-0.154	0.273	0.028	-0.142	0.023	0.099	-0.438	0.036	0.087	0.475	-0.117	0.236	-0.136	0.471	0.171	0.240	0.989	1

TABLE 3
Summary Statistics and Variable Definitions

VARIABLE	DEFINITION	MEAN	SD
Panel A: Firm and Individual-level measures			
First start-up founded	Year in which first firm was founded (censored if not observed by 2007)	2000.38	5.20
Firm age	Age of the firm	3.50	2.44
Privatized	=1 if firm was privatized	0.10	0.47
Entrepreneur	=1 if the individual was an entrepreneur	0.26	0.46
Entrepreneur Parents	=1 if parents were entrepreneurs	0.09	0.29
Graduation year	Year of graduation (Bachelor's)	1980.66	17.80
Family economic status	Family's economic status in China during college, 4=top 10%, 3=top 10-25%, 2=top 25-50%, 1=bottom 50%	3.78	1.01
Age	Individual's age	49.82	18.35
Gender	Dummy = 1 if male	0.88	0.32
Panel B: Work history-level measures			
Recent Salary	Most recent pre-founding salary (5 categories)	3.32	1.43
Avg. Tenure	Average number of years in each job	7.11	9.45
Number of Positions	Number of different positions (R&D, sales & marketing, general manager, etc.) that were held	2.37	1.26
High government	=1 if ever had job in government (minister, province, Bureau or municipal levels	0.03	0.17
Low government	=1 if ever had job in government (below municipal level)	0.17	0.38
Last job academia	= 1 if last job was in academia (inclusive of faculty, researcher, staff, etc)	0.19	0.39
Last job business	= 1 if last job was in business	0.62	0.49
Ever job academia	= 1 if ever had job in academia (inclusive of faculty, researcher, staff, etc)	0.32	0.47

TABLE 4
Cox Hazard Rate Regressions

Independent Variables	Dependent Variable = Start-up founded (subjects start being at risk upon graduation) Note: reported coefficients are hazard ratios, coefficients above 1.0 represent an increased likelihood of entrepreneurship; (N=1,821)													
	(4-1)		(4-2)		(4-3)		(4-4)		(4-5)		(4-6)		(4-7)	
Master's degree	0.444**	(0.121)												
Master's x POST	1.771*	(0.581)												
Doctorate degree	1.131	(0.630)												
Doctorate x POST	0.889	(0.549)												
Parents' edu.			0.724**	(0.040)										
Parent edu.xPOST			1.417**	(0.089)										
Log (Work exp.)					0.832**	(0.022)								
Log(Work) xPOST					0.999	(0.027)								
Promoted							0.216**	(0.112)						
Promoted x POST							3.361*	(1.953)						
High GPA									0.350**	(0.111)				
GPA x POST									1.811*	(0.651)				
Highest salary (pre-founding)											0.771**	(0.079)		
Salary x POST											1.225*	(0.147)		
Student leader													0.718**	(0.097)
Leader x POST													1.336*	(0.209)
Years 2000-07	0.054**	(0.016)	0.002**	(0.001)	0.060**	(0.019)	0.012**	(0.007)	0.020**	(0.006)	0.007**	(0.004)	0.027**	(0.007)
Years 1991-99	0.064*	(0.01	0.043*	(0.00	0.056*	(0.01	0.067*	(0.01	0.064*	(0.01	0.050*	(0.00	0.068*	(0.01

	**	0)	**	8)	**	2)	**	1)	**	2)	**	9)	**	2)
		(0.15	0.675*	(0.13	0.555*	(0.12	0.622*	(0.12	0.595*	(0.12		(0.15	0.615*	(0.12
Overseas	0.860	1)	*	5)	**	4)	*	3)	*	0)	0.754	0)	*	2)
		(0.23	0.390*	(0.13	0.205*	(0.08	0.440*	(0.15		(0.18	0.369*	(0.14	0.482*	(0.17
Last job acad.	0.734	3)	**	8)	**	5)	*	7)	0.512*	4)	*	4)	*	0)
		(0.19		(0.27	0.377*	(0.14		(0.19		(0.18		(0.22		(0.18
Last job govt.	0.657	0)	0.879	8)	*	4)	0.607	0)	0.563*	5)	0.654	0)	0.599	8)
High		(0.28		(0.35		(0.45		(0.36		(0.38		(0.32		(0.37
govt.(ever)	0.772	8)	0.896	6)	1.139	2)	0.913	1)	1.015	3)	0.775	0)	0.954	0)
		(0.30		(0.27		(0.25		(0.30		(0.33		(0.32		(0.33
Low govt (ever)	1.322	1)	1.143	4)	0.916	6)	1.306	6)	1.385	3)	1.310	8)	1.417	3)
		(0.26	1.517*	(0.31		(0.35	1.491*	(0.30		(0.26		(0.30	1.506*	(0.30
Ever job acad.	1.195	5)	*	3)	1.531*	2)	*	2)	1.236	2)	1.423*	1)	*	9)
	1.361*	(0.07	1.305*	(0.07	1.353*	(0.08	1.412*	(0.08	1.324*	(0.07	1.300*	(0.08	1.345*	(0.07
Num. positions	**	7)	**	5)	**	8)	**	8)	**	7)	**	0)	**	7)
		(0.45	2.551*	(0.85		(0.66	1.990*	(0.63	2.633*	(0.87	2.083*	(0.71	2.151*	(0.69
Gender	1.437	4)	**	9)	1.820	8)	*	8)	**	9)	*	0)	*	6)
		(0.07		(0.23		(0.24		(0.19		(0.21		(0.26		(0.21
Entrep. parent	0.947	1)	0.54	6)	0.486	6)	0.450*	7)	0.482*	3)	0.5.9	1)	0.488*	0)
		(0.14		(0.09		(0.09		(0.07		(0.07		(0.07		(0.07
Family Wealth	0.971	1)	1.078	7)	1.110	0)	1.015	6)	0.953	4)	0.982	9)	1.001	5)
Communist		(0.15		(0.14		(0.18		(0.14		(0.15		(0.12		(0.15
Party	0.86	1)	0.929	1)	1.080	2)	0.967	4)	1.025	3)	0.803	4)	1.033	5)

Note: *POST=Years 2000-07;* 308 failures; 44,248 total years at risk; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All models include controls for Bachelor's graduation year (age), Bachelor's Major (academic department), and region fixed effects.

TABLE 5
Quantile Regression on Unobservable Human Capital

Panel A	***Dependent variable = income residuals***				
Percentiles	***10***	***25***	***50***	***75***	***90***
Founded in 1978-89	0.737***	0.502***	0.085**	-0.362**	-1.427*
	(0.229)	(0.151)	(0.039)	(0.175)	(0.777)
Founded in 1990-99	0.771***	0.344***	0.034	-0.094	0.206
	(0.143)	(0.131)	(0.063)	(0.201)	(0.655)
Founded in 2000-07	0.571***	0.740***	0.429***	0.736***	0.586**
	(0.181)	(0.158)	(0.122)	(0.189)	(0.232)
Constant	-1.556***	-0.894***	-0.156***	0.420***	1.184***
	(0.110)	(0.098)	(0.049)	(0.110)	(0.107)
Observations	595	595	595	595	595
Pseudo R-squared	0.058	0.034	0.021	0.042	0.023
Panel B	***Dependent variable = income residuals (Entrepreneurs only)***				
Percentiles	***10***	***25***	***50***	***75***	***90***
Ln(profit)	0.215	0.093	0.195	0.242**	0.246**
	(0.295)	(0.234)	(0.155)	(0.123)	(0.126)
Controls					
Ln(firm age)	0.479	0.332	0.273	0.241	0.196
	(0.483)	(0.434)	(0.403)	(0.379)	(0.415)
Ln(registered capital)	0.154	0.110	-0.037	-0.022	0.010
	(0.207)	(0.146)	(0.109)	(0.109)	(0.104)
Privatized	1.308	0.406	0.687	0.435	0.242
	(1.182)	(0.901)	(0.690)	(0.666)	(0.752)
Bought	0.857	0.537	0.616	0.690	0.852
	(1.324)	(1.189)	(0.847)	(0.566)	(0.544)
Ln(income from firm)	-0.068	-0.074	-0.05	-0.015	-0.050
	(0.112)	(0.089)	(0.063)	(0.062)	(0.053)
Constant	-90.977	-61.093	-28.173	-17.581	-28.286
	(98.614)	(86.086)	(62.509)	(62.713)	(70.683)
Observations	132	132	132	132	132
Pseudo R-squared	0.461	0.360	0.293	0.418	0.601

The top of the talent distribution was more likely to found a firm after 1999 and conditional on founding a firm, had higher profits. Dependent variable is the residual from the income regression in Appendix E. Bootstrapped standard errors (100 repetitions); Panel B uses newly generated residuals from the sample of entrepreneurs only and includes founding year, industry, coastal region, Beijing and Shanghai controls; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Sample includes non-entrepreneurs matched on graduation year and job ending year.

TABLE 6
Tobit Models: Returns to Human Capital in Entrepreneurship Increase Post-1999

Independent Variables	Log(profit margin)				Log(income from start-up)			
	(6-1)	(6-2)	(6-3)	(6-4)	(6-5)	(6-6)	(6-7)	(6-8)
POST-1999 founding	-0.301	-0.448	-0.753	-2.200**	-1.329	-0.139	1.027	-6.443**
	(0.455)	(0.598)	(0.563)	(0.937)	(0.977)	(0.686)	(0.819)	(1.861)
Master's degree	-0.449			-0.269	-1.037			0.090
	(0.276)			(0.340)	(0.905)			(0.928)
POST x Master's degree	0.236			-0.111	1.783*			0.163
	(0.345)			(0.412)	(1.039)			(1.054)
High GPA		-0.279		-0.523		-1.191		-1.417
		(0.427)		(0.589)		(0.737)		(0.903)
POST x High GPA		0.639		0.866		2.348**		2.376**
		(0.453)		(0.595)		(0.887)		(1.042)
Income residual			0.073	--			-3.239**	--
			(0.255)				(0.901)	
POST x income residual			0.152	--			2.624**	--
			(0.312)				(0.987)	
Promoted				-0.900				-1.123
				(0.611)				(1.182)
POST x Promoted				1.751**				5.803**
				(0.768)				(1.678)
Privatized	-0.297	-0.385	-0.083	-0.423	0.986	0.921	-1.307	1.264
	(0.400)	(0.363)	(0.758)	(0.388)	(1.043)	(1.015)	(1.432)	(1.141)
Bought	-0.079	-0.106	-0.022	-0.189	3.233**	2.919**	3.004**	2.721**
	(0.586)	(0.620)	(0.660)	(0.577)	(1.165)	(1.034)	(1.430)	(0.975)
Log(revenues)	0.275**	0.274**	0.234**	0.242**	0.334*	0.324	0.058	0.207
	(0.089)	(0.093)	(0.098)	(0.089)	(0.194)	(0.203)	(0.249)	(0.155)
Log(registered capital)	-0.226**	-0.225**	-0.305**	-0.210*	-0.036	0.044	-0.451	0.029
	(0.111)	(0.112)	(0.126)	(0.111)	(0.256)	(0.253)	(0.377)	(0.252)
Log(employees)	0.027	0.024	-0.056	-0.001	0.116	0.021	1.018*	-0.015
	(0.152)	(0.156)	(0.175)	(0.154)	(0.392)	(0.416)	(0.548)	(0.351)
Log(firm age)	0.438	0.614	0.087	0.388	2.742*	0.804	1.157	0.635
	(0.486)	(0.541)	(0.562)	(0.583)	(1.413)	(0.561)	(0.782)	(0.513)
Overseas	--	-0.175	0.272	-0.234	0.772	0.557	1.119	0.283
		(0.299)	(0.404)	(0.274)	(0.978)	(0.935)	(1.147)	(0.891)
Coastal province	0.137	0.222	-0.592	0.191	-0.563	-0.709	0.657	-0.396
	(0.254)	(0.262)	(0.385)	(0.260)	(1.002)	(1.106)	(1.320)	(1.056)
Bach. Grad. year	0.011	0.013	0.022**	0.021*	-0.052	-0.037	-0.028	-0.008
	(0.012)	(0.012)	(0.011)	(0.012)	(0.036)	(0.037)	(0.039)	(0.035)

Constant	-237.31	-320.76	-152.01	-213.95	-876.14	76.92	50.50	23.04
	(239.94)	(278.33)	(267.88)	(301.93)	(643.57)	(75.60)	(77.01)	(70.12)
Observations	149	147	94	147	150	148	93	148
R-squared	0.27	0.27	0.31	0.35	0.15	0.15	0.17	0.18

Standard errors are robust. The dependent variable is potentially censored below zero. Main results are robust to a Poisson specification (as well as not taking the natural log). All independent variables are not run together due to collinearity. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All models include controls for year and region fixed effects.

TABLE 7
Years 1988 – 1999

Independent Variables	Dependent Variable = Start-up founded (subjects start being at risk upon graduation) Note: reported coefficients are hazard ratios (N=1,540 individuals)					
	(7-1)	(7-2)	(7-3)	(7-4)	(7-5)	(7-6)
Master's degree	0.675*					0.562**
	(0.158)					(0.152)
Doctorate degree	0.344**					0.641
	(0.166)					(0.323)
Low work exper. (0-10 yrs.)		1.333				1.500
		(0.351)				(0.442)
High work exper. (>30 yrs.)		0.060***				dropped
		(0.039)				-
Promoted			0.689			0.686
			(0.251)			(0.270)
High GPA (above median)				0.685*		1.288
				(0.150)		(0.325)
Last Salary (Pre-founding)					0.667***	0.694***
					(0.065)	(0.071)
Overseas	0.914	0.745	0.807	0.775	1.154	0.929
	(0.247)	(0.199)	(0.217)	(0.211)	(0.329)	(0.280)
Last job acad.	0.973	0.744	8.30E-01	1.02E+00	8.62E-01	0.778
	(0.413)	(0.314)	(0.349)	(0.434)	(0.408)	(0.384)
Last job govt	0.504	0.513	0.509	0.425*	0.340**	0.402*
	(0.219)	(0.219)	(0.217)	(0.194)	(0.169)	(0.206)
High govt.(ever)	0.841	0.964	0.883	0.807	0.987	0.916
	(0.504)	(0.578)	(0.528)	(0.485)	(0.602)	(0.557)
Low govt (ever)	1.202	0.985	1.079	0.927	1.137	0.963
	(0.356)	(0.289)	(0.313)	(0.277)	(0.358)	(0.318)
Ever job academia	1.312	1.105	1.155	1.184	1.227	1.425
	(0.419)	(0.352)	(0.367)	(0.380)	(0.405)	(0.492)
Number of positions	1.530***	1.489***	1.499***	1.527***	1.414***	1.288***
	(0.120)	(0.115)	(0.118)	(0.126)	(0.120)	(0.117)
Gender	1.062	0.934	1.018	1.134	1.118	1.045
	(0.428)	(0.375)	(0.410)	(0.456)	(0.478)	(0.464)
Family Wealth	0.753***	0.769***	0.750***	0.798**	0.768**	0.787*
	(0.078)	(0.078)	(0.077)	(0.083)	(0.089)	(0.097)
Communist Party	0.76	0.807	0.77	0.774	0.776	0.808
	(0.167)	(0.176)	(0.169)	(0.173)	(0.185)	(0.195)
Bach.Grad. Yr.	1.154***	1.090***	1.145***	1.107***	1.099***	1.067**
	(0.023)	(0.026)	(0.022)	(0.022)	(0.025)	(0.029)

Note: coefficients below 1.0 represent a decreased likelihood of entrepreneurship; 102 failures; 30,716 total years at risk; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All models include controls for Bachelor's graduation year (age), and region fixed effects

APPENDIX A: Roy Model

The base model here is a Roy Model as extended by Borjas (1987). Three cases will be generated from the model, one where more talented wage employees become better performing entrepreneurs, one where less talented employees become less talented entrepreneurs and a final one where less talented employees become higher performing entrepreneurs. The case that will apply depends on the returns to talent in entrepreneurship relative to the wage sector (more precisely the variance in wage income relative to the variance in entrepreneurial income). Economic intuition behind the model is that there is a trade-off between increased returns to talent in one sector selecting talented individuals and the relative compression of wages in the other sector subsidizing (and attracting) less talented workers. The paper examines the impact on self-selection into entrepreneurship of a shift in the returns to entrepreneurship relative to the wage sector implemented through a reform in the institutional environment. An increase in this ratio should push self-selection towards the first case of positive hierarchical selection, a finding supported by the results.

Consider the wage sector and entrepreneurship denoted as two labor markets 0 and 1, respectively. Log earnings in the wage sector are given by:

$$w_0 = \mu_0 + \varepsilon_0$$

where $\varepsilon_0 \sim N(0, \sigma_0^2)$. The de-meaned value of worker's 'skill' or talent in the wage sector can be thought of as ε_0. The wage sector earnings would be the following if everyone from the wage sector were to migrate to entrepreneurship (ignoring general equilibrium effects):

$$w_1 = \mu_1 + \varepsilon_1$$

with $\varepsilon_1 \sim N(0, \sigma_1^2)$.
Assume that the cost of becoming an entrepreneur is C, which can be relabeled as $\pi = C/w_0$. Further assume that π is constant, meaning that C is directly proportional to w_0. Assume further that each worker knows C, μ_0, μ_1 and his individual epsilons: ε_0, ε_1. If C is higher than the net present value of the future difference between w_1 and w_0 then this represents a barrier to entry. What can be inferred about what the wages for entrepreneurs would have been had they stayed in wage employment? What would wages in entrepreneurship be for non-entrepreneurs had they become entrepreneurs?

The correlation between entrepreneur and wage worker earnings is $\rho = \dfrac{\sigma_{01}}{\sigma_0 \sigma_1}$.

where σ_{01} is $\text{cov}(\sigma_0, \sigma_1)$. A worker will choose entrepreneurship if

$$(\mu_1 - \mu_0 - \pi) + (\varepsilon_1 - \varepsilon_0) > 0 \qquad (1)$$

(Define the indicator variable I, equal to 1 if this selection condition is satisfied, 0 otherwise). Define $v = \varepsilon_1 - \varepsilon_0$. The probability that a randomly chosen worker from the wage sector chooses to entrepreneurship is equal to:

$$P = Pr[v > (\mu_0 - \mu_1 + \pi)]$$

$$= Pr\left[\frac{v}{\sigma_v} > \frac{(\mu_0 - \mu_1 + \pi)}{\sigma_v}\right]$$
$$= 1 - \Phi\left(\frac{(\mu_0 - \mu_1 + \pi)}{\sigma_v}\right)$$
$$\equiv 1 - \Phi(z)$$

where $\Phi(\cdot)$ is the CDF of the standard normal and $z = (\mu_0 - \mu_1 + \pi)/\sigma_v$. Note that z is rising in the mean earnings in the wage sector and the cost of becoming an entrepreneur. The larger is z, the lower is the probability of entrepreneurship. So $\partial P/\partial \mu_0 < 0$, $\partial P/\partial \mu_1 > 0$, $\partial P/\partial \pi < 0$. In this model, lower barriers (costs) to entry increase the probability of entrepreneurship among all individuals. So we can focus on self-selection rather than mean differences, from here forward assume that $\mu_1 \approx \mu_0$.

Selection conditions

One can think about the institutional environment altering the returns to skill/talent in entrepreneurship relative to the wage sector in the case of lowering barriers to entry. On the other hand, lowering barriers to entry would lower the cost of becoming an entrepreneur. Now I calculate the expectation of earnings in the wage sector for workers who choose to become entrepreneurs.

$$E\left(w_0 \middle| Entrepreneur\right) = \mu_0 + E\left(\varepsilon_0 \middle| \frac{v}{\sigma_v} > z\right) \qquad (2)$$
$$= \mu_0 + \sigma_0 E\left(\frac{\varepsilon_0}{\sigma_0} \middle| \frac{v}{\sigma_v} > z\right)$$

Given the normality of ε_0, ε_1, the expectation of ε_0 given some value v is simply equal to the regression coefficient:

$$E\left(\varepsilon_0 \middle| v\right) = \frac{\sigma_{0v}}{\sigma_v^2} v$$

Applying this to (2),

$$E\left(\frac{\varepsilon_0}{\sigma_0} \middle| \frac{v}{\sigma_0}\right) = \frac{\sigma_{0v}}{\sigma_v^2} \cdot \frac{1}{\sigma_v^{-2}} \cdot \frac{1}{\sigma_0 \sigma_v} \cdot \frac{v}{\sigma_v}$$

$$= \frac{\sigma_{0v}}{\sigma_0 \sigma_v} \cdot \frac{v}{\sigma_v}$$

$$= \rho_{0v} \frac{v}{\sigma v}$$

Due to the normalizations, the covariance $\text{cov}(\varepsilon_0, \varepsilon_1)$ is reduced by $1/\sigma_0\sigma_1$ and the variance of v/σ_v is 1. We can rewrite (2) as:

$$\begin{aligned} E\left(w_0 \,\middle|\, Entrepreneur \right) &= \mu_0 + \sigma_0 E\left(\frac{\varepsilon_0}{\sigma_0} \,\middle|\, \frac{v}{\sigma_v} > z \right) \\ &= \mu_0 + \rho_{0v}\sigma_0 E\left(\frac{v}{\sigma_v} \,\middle|\, \frac{v}{\sigma_v} > z \right) \\ &= \mu_0 + \rho_{0v}\sigma_0 \left(\frac{\phi(z)}{1 - \Phi(z)} \right) \end{aligned} \tag{3}$$

where $\varphi(z) / (1 - \Phi(z))$ is equal to the conditional expectation of a standard normal random variable truncated from the left at point z, which is the Inverse Mills Ratio. The IMR answers what is the expectation of epsilon given that epsilon is greater than or equal to z? Or in other words, what is the probability of becoming an entrepreneur, given that one has not founded a firm already? One can calculate the expected wage in traditional employment for those who do become entrepreneurs as:

$$\begin{aligned} E\left(w_1 \,\middle|\, Entrepreneur \right) &= u_1 + E\left(\varepsilon_1 \,\middle|\, \frac{v}{\sigma_v} > z \right) \\ &= u_1 + \rho_{1v}\sigma_1 \left(\frac{\phi(z)}{\Phi(-z)} \right) \end{aligned} \tag{4}$$

Three Cases

Rearrange (3) and (4) to get:

$$E\left(w_0 \,\middle|\, Entrepreneur \right) = u_0 + \rho_{0v}\sigma_0 \left(\frac{\phi(z)}{1 - \Phi(z)} \right)$$

$$= u_0 + \frac{\sigma_0\sigma_1}{\sigma_v} \left(\rho - \frac{\sigma_0}{\sigma_1} \right) \left(\frac{\phi(z)}{1 - \Phi(z)} \right)$$

and

$$E\left(w_1 \,\middle|\, Entrepreneur \right) = u_1 + \rho_{1v}\sigma_1 \left(\frac{\phi(z)}{1 - \Phi(z)} \right)$$

$$= u_1 + \frac{\sigma_0\sigma_1}{\sigma_v} \left(\frac{\sigma_1}{\sigma_0} - \rho \right) \left(\frac{\phi(z)}{1 - \Phi(z)} \right)$$

Where

$\rho = \dfrac{\sigma_{01}}{\sigma_0\sigma_1}$ as before. Define $Q_0 = E(\varepsilon_0 | I = 1)$, $Q_1 = E(\varepsilon_1 | I = 1)$. We now have three cases.

Positive hierarchical sorting:

In this case, entrepreneurs are positively selected from the wage sector distribution and are also above the mean of the entrepreneurship distribution: $Q_0 > 0$, $Q_1 > 0$. This will be true iff

$$\frac{\sigma_1}{\sigma_0} > 1 \text{ and } \rho > \frac{\sigma_0}{\sigma_1}.$$

First, $\sigma_1/\sigma_0 > 1$ implies that entrepreneurship has a higher 'return to skill' than the wage sector. Second, $\rho > \sigma_0/\sigma_1$, implies that the correlation between the skills valued in the wage sector and in entrepreneurship is sufficiently high. If you were a skilled worker in wage work, you would not want to become an entrepreneur with a very high return to skills if the skills valued in entrepreneurship were uncorrelated (or negatively correlated) with skills value in wage work. In other words, that talent is of a general enough nature to have a large component which is transferable between wage work and entrepreneurship or that the type of talent necessary for overcoming entry barriers is correlated with that required for higher returns once in entrepreneurship. One way of restating this type of situation is: a wage sector with low earnings variance 'taxes' the earnings of high skill workers and insures the earnings of low skill workers. High skill workers may want to become entrepreneurs, accordingly. But this is not the only possibility.

This case embodies the classic developed economy view of technology entrepreneurship: 'The most talented leave wage work for greater opportunity (that is, higher return to skill) in entrepreneurship.

Negative hierarchical sorting

In this case, entrepreneurs are negatively selected from the wage sector distribution and are also below the average of the entrepreneur distribution: $Q_0 < 0$, $Q_1 < 0$. This will be true iff

$$\frac{\sigma_0}{\sigma_1} > 1 \text{ and } \rho > \frac{\sigma_1}{\sigma_0}.$$

This is the converse case where the wage sector is unattractive to low earnings workers because of high wage dispersion (higher return to skill in wage employment). Low skill workers will want to become entrepreneurs to take advantage of the 'insurance' provided by a narrow wage structure in entrepreneurship, assuming that wages are sufficiently correlated between the wage sector and entrepreneurship. This is the unattractive case where a compressed wage structure in entrepreneurship (low returns to skill relative to wage employment) 'subsidizes' low skill workers, thus attracting low skill entrepreneurs from the wage sector.

'Reverse' sorting

A third case is where $Q_0 < 0$, $Q_1 > 0$, that is, entrepreneurs are selected from the lower tail of the wage sector distribution but arrive in the upper tail of the entrepreneurship distribution. This can only occur if

$$\rho < \min\left(\frac{\sigma_1}{\sigma_0}, \frac{\sigma_0}{\sigma_1}\right).$$

meaning that the correlation between earnings in the two sectors is sufficiently low (could be negative).
This might occur in a number of different ways, for example, for the case of a non-market economy where the set of skills rewarded in wage sector work is quite different from those rewarded in entrepreneurship. Or for a group whose opportunities in entrepreneurship are depressed by entry barriers such that performance in entrepreneurship is determined more by the ability to overcome entry barriers than by the ability to perform in commercialization activities. Or it may possibly occur in the case of an immigrant from a very different country.

A fourth case?
Note that there is not a fourth case where $Q_0 > 0$, $Q_1 < 0$. This would only happen if an individual from the top of the wage sector distribution joined the bottom tail of the entrepreneurship distribution. A situation where the bottom of the entrepreneurship distribution is higher than the top of the wage distribution would be impossible to sustain.

Summary
The correlation between the skills valued in the wage sector and in entrepreneurship is sufficiently high to rule out reverse sorting in the third case (see Appendix Tables E, F, and J) and to reassure us that the second condition in the first two cases holds. To determine whether Case 1 or Case 2 holds, one needs to know either the ratio of the variance in the returns to wage employment to variance in returns to entrepreneurship. The Tsinghua survey asks respondents to indicate which of 6 wage income bands they were in at the end of each job, making inferences about the variance of wage income difficult. Yearly income from entrepreneurship is more precisely measured, however, additional sources of entrepreneurial income such as stock options or the value of the business are challenging to precisely measure. If the correlation between skills in the two sectors is sufficiently high (which the data appear to support), one may be able to eliminate Case 3 and use the clear predictions of the model in cases 1 and 2 to infer the ratio of interest from shifts in the returns to talent in each sector. One can infer which case holds from the model predictions of where in the wage employment distribution entrepreneurs are being drawn from and where in the distribution of entrepreneurial outcomes they wind up. The model also shows that the ideal experiment that the econometrician needs is one where the variance of returns is increased (or compressed) in one sector relative to the other. This requirement seems reasonable in this empirical setting. The institutional reform in 1999 appears to have shifted the environment from Case 2 towards higher returns to talent in entrepreneurship and more (Case 1) positive hierarchical sorting. Future drafts will extend this basic model to capture the possibility of different skills (which are correlated) in overcoming barriers to entry and in running the entrepreneurial firm. A limitation of this model is that it assumes that the individual knows the cost to becoming an entrepreneur, the average wages in each labor market and her skill levels in each sector ahead of time.

APPENDIX B
Comparison of Key Demographic Characteristics by Survey Wave

Variable	Responded before Aug. 2007 (N=2,667)	Responded during/after Aug. 2007 (N=299)	*t*-stat for equal means
Age	49.3	54.1	-4.216**
Age (founders only)	38.4	37.4	0.602
Bachelor's Graduation Yr	1980.9	1977.4	3.777**
Bach. Grad yr (founders only)	1991.6	1993.2	0.941
Years of Education	17.2	17.0	2.381**
Entrepreneur parents	0.09	0.12	-0.713
Entrepreneur	0.29	0.40	-2.168**
Privatized	0.10	0.05	1.392
First start-up founded	2000.3	2001.1	-0.661
Tech only	0.28	0.29	0.757
Business only	0.10	0.09	0.235
Gender	0.88	0.90	0.901
Family economic status	3.75	3.85	-1.871*
High Salary	3.21	2.93	3.351**
Avg. Tenure	6.94	8.01	-2.045*
Overseas work exp.	0.26	0.26	-0.126
Number of positions	2.39	2.26	-2.012*
High government	0.03	0.03	-0.239
Low government	0.18	0.17	0.617
Last job academia	0.19	0.19	-0.051
Ever job academia	0.32	0.27	2.323**
Last job business	0.62	0.61	0.348
Student Leader	0.61	0.57	0.874
GPA Rank	2.28	2.58	-2.661**
Bach. Grad Yr. 10^{th} percentile	1954	1953	--
Bach. Grad Yr. 25^{th} percentile	1965	1961	--
Bach. Grad Yr. 50^{th} percentile	1986	1979	--
Bach. Grad Yr. 75^{th} percentile	1996	1993	--
Bach. Grad Yr. 90^{th} percentile	2001	2001	--

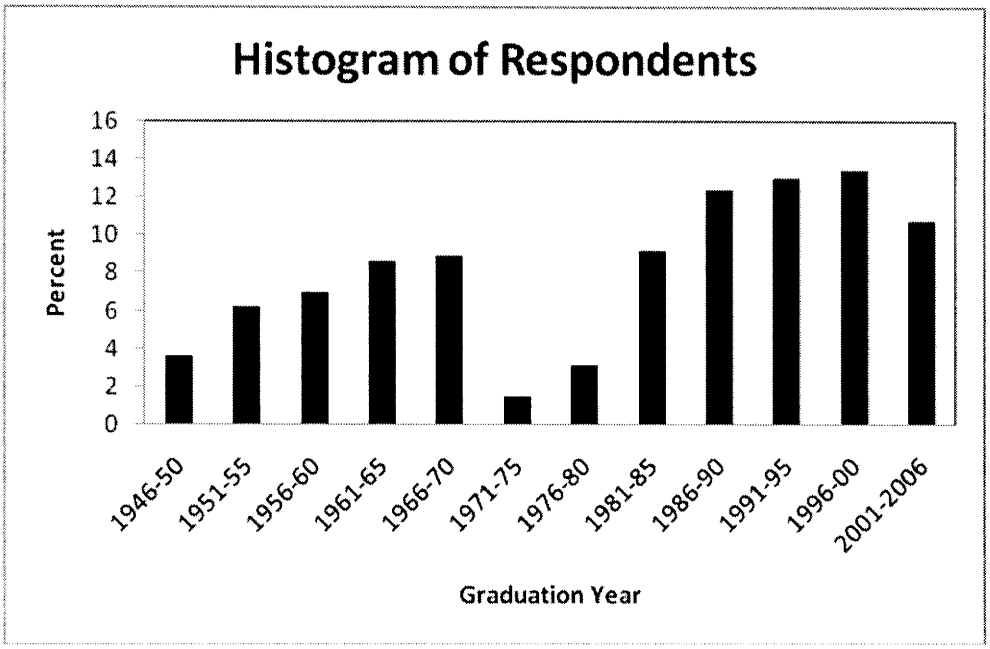
**, and * indicate statistical significance at the 1% and 5%, respectively.

APPENDIX C

Independent Variables	**Dependent Variable = Year start-up founded (subjects start being at risk upon graduation) Note: reported coefficients are hazard ratios (N = 1,910)**			
	(1)		(2)	
Master's degree			0.342***	(0.086)
Master's x Post-1999			2.215***	(0.664)
Doctorate degree			0.360*	(0.191)
Doctorate x Post-1999			2.646	(1.566)
High Status (Gov. and Comm. Party)	0.987	(0.243)	0.858	(0.211)
Status x Post-1999	0.924	(0.268)	1.098	(0.319)
Post-1999 dummy	0.102***	(0.023)	0.049***	(0.015)
1991-1999 dummy	0.075***	(0.011)	0.070***	(0.010)
Controls				
Overseas Experience	0.806	(0.133)	0.834	(0.139)
Last job academia	0.681	(0.213)	0.675	(0.211)
Ever job academia	1.186	(0.242)	1.222	(0.253)
Number of positions	1.296***	(0.067)	1.297***	(0.067)
Gender	1.363	(0.388)	1.257	(0.363)
Family Econ. Status	0.900	(0.060)	0.903	(0.062)
Log likelihood	-1460.714		-1466.769	

Note: 317 failures; 45,021 total years at risk; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All models include region, Bachelor's dept., and graduation year dummy variables. High Status is equal to 1 if the individual was a communist party member or worked in a government position. The pair wise correlations between *High Status* and various human capital measures are all at or below 0.101.

APPENDIX D


Histogram of Respondents
Percent
16
14
12
10
8
6
4
2
0
1946-50
1951-55
1956-60
1961-65
1966-70
1971-75
1976-80
1981-85
1986-90
1991-95
1996-00
2001-2006
Graduation Year

APPENDIX E
Income regression

Ordered Logit Independent Variables	Dependent variable = salary category (1-6)
Master's degree	0.466***
	(0.051)
Doctorate degree	0.905***
	(0.051)
Work exper. (0-10 yrs.)	0.938***
	(0.054)
Work exper. (10-30 yrs.)	1.065***
	(0.047)
Work exper. (>30 yrs.)	0.500***
	(0.055)
Gender (male=1)	0.498***
	(0.058)
GPA quartile (1^{st} = top)	-0.199***
	(0.046)
GPA quartile (3^{rd})	0.514***
	(0.046)
GPA quartile (4^{th} = bottom)	0.047
	(0.045)
Overseas exper.	0.407***
	(0.043)
Academia	-0.943***
	(0.051)
Business	0.335***
	(0.052)
Government	-0.326***
	(0.044)
Family Econ. Status	-0.273***
	(0.015)
Comm. Party	-0.062
	(0.045)
Region Effects	YES
Bachelor's Dept. Effects	YES
Year Effects	YES
Cut point 1	24.296***
	(0.026)
Cut point 2	25.714***
	(0.020)
Cut point 3	27.111***
	(0.021)
Cut point 4	28.614***
	(0.022)
Cut point 5	30.256***
	(0.028)
Observations	561
Pseudo-R squared	0.148

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are used.

APPENDIX F

Returns to Talent in Wage Employment

Ordered Logit Independent Variables	Dependent variable = salary category (1-6)	
Master's degree	0.693***	
	(0.137)	
Master's x POST	-0.228	
	(0.157)	
Doctorate degree	1.211***	
	(0.237)	
Doctorate x POST	-0.782***	
	(0.243)	
High GPA	-0.028***	0.384**
	(0.005)	(0.170)
High GPA x POST	0.179	-0.292
	(0.149)	(0.193)
Tenure	-0.883***	-0.033***
	(0.160)	(0.008)
Business	-0.646***	0.24
	(0.165)	(0.238)
Government	0.073***	-1.054***
	(0.008)	(0.244)
Academia	0.044	-0.659***
	(0.084)	(0.248)
Bachelor's grad. year	0.812***	0.096***
	(0.112)	(0.012)
Communist Party	0.542***	-0.032
	(0.128)	(0.104)
Overseas	0.069***	0.995***
	(0.009)	(0.135)
Gender (male=1)	1.760***	0.638***
	(0.157)	(0.148)
Age (at end of job spell)	-0.276***	0.095***
	(0.045)	(0.012)
Years 2000-07 (POST)	-0.228	1.348***
	(0.157)	(0.177)
Family Economic Status	0.69273***	-0.309***
	(0.137)	(0.058)
Bachelor's Dept. effects	YES	
Region effects	YES	
Observations	3,276	2,043
Pseudo R-squared	0.206	0.171

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The unit of analysis is the job spell. Robust standard errors clustered at the individual level are used.

APPENDIX G
Negative Binomial Regressions on Macro-economic Data

	Dependent variable = number of firm foundings (1959-2007)		
Independent Variables	(1)	(2)	(3)
R&D to GDP ratio (t-1)			-0.143
			(0.723)
GDP per capita (in RMB, t-1)		3.43E-04***	3.30E-04***
		(8.59E-05)	(8.63E-05)
Shanghai Stock Exchange Market Cap (t-1)		-2.52E-05**	-2.36e-05**
		(1.16E-05)	(1.20E-05)
Domestic Patents Issued (t-1)	5.01E-06	-1.01e-05**	-9.48E-06*
	(3.60E-06)	(4.82E-06)	(5.04E-06)
Post-1999 dummy	4.326***	3.856***	2.901***
	(0.652)	(0.530)	(0.590)
1988-1998 dummy	3.521***	2.978***	1.967***
	(0.434)	(0.421)	(0.656)
Constant	-1.257***	-1.376***	-0.241
	(0.368)	(0.360)	(1.066)
Log likelihood	-96.992	-90.102	-81.378
Num. obs. (years)	48	48	29
Pseudo R2	0.265	0.317	0.260

The results show that there was an increase in entrepreneurship after the two institutional reforms even after controlling for other indicators of the economic environment. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

APPENDIX H

Strategic and Competitive Implications of Different Institutional Shifts

	Lower Barriers to Entry	Lower Barriers to Growth
Market/Commercialization Talent is Orthogonal to 'Bureaucratic' Talent (Bureaucratic talent refers to the ability to form connections, navigate a bureaucracy, greater family wealth or other factors which enable certain individuals to overcome barriers to entry.)	• Increase in high and low ability entrepreneurs • No prediction on the type of firms founded • Possibly greatest increase in marginal firms which were not profitable with the previously high cost of entry • Increased competition (possibly lower profit margins?)	• Unclear predictions on whether increase is among high or low ability • Easier to overcome the opportunity costs for entrepreneurship • Increase in high growth firms • More high-growth entrepreneurial opportunities supports venture capital
Market/Commercialization Talent is *NOT* Orthogonal to 'Bureaucratic' Talent (a large component is common between the two)	• Relative increase in low ability entrepreneurs • Those who cannot maintain wage employment can overcome the barriers to entry • Relative increase in low growth firms • Increased competition, smaller, less profitable firms	• Increase in high ability entrepreneurs • Easier to overcome the opportunity costs for entrepreneurship • Easier to recruit talented co-founders • More high-growth entrepreneurial opportunities supports venture capital • Increase in high-growth firms • Increase in innovative firms (higher returns can support higher risk of an innovation strategy)

APPENDIX I
Productivity

Independent Variables	Log(profit margin) (1)		Log(revenues) (2)		Log(employees) (3)		Log(survival) (4)		Pr(IPR important) (5)	
Promoted	-0.118	(0.228)	0.116	(0.369)	0.380*	(0.211)	-0.045	(0.046)	0.042	(0.966)
Log(work experience)	0.986	(1.230)	-2.965	(2.328)	-2.447**	(1.094)	-0.009	(0.214)	0.668	(4.723)
Years of Education	0.004	(0.086)	0.018	(0.149)	0.152*	(0.082)	-0.008	(0.018)	0.850**	(0.407)
Ability (wage residual)	0.410**	(0.180)	-0.243	(0.323)	-0.12	(0.159)	0.007	(0.034)	1.535*	(0.837)
Prior salary	-0.442**	(0.170)	0.036	(0.336)	0.173	(0.150)	0.025	(0.031)	-0.231	(0.727)
Overseas	0.731**	(0.359)	-0.804	(0.580)	0.128	(0.305)	-0.07	(0.060)	2.120	(1.672)
High GPA	0.308	(0.232)	-0.628	(0.427)	-0.321	(0.213)	0.011	(0.047)	-0.848	(0.914)
Worked in R&D		-		-		-		-	1.639*	(0.925)
Controls										
Log(employees)	0.246**	(0.107)	1.234**	(0.187)		-		-		-
Privatized	-0.979*	(0.539)	1.293	(0.894)	0.984**	(0.464)	0.075	(0.107)	(3.365)	(2.955)
Log(survival)	(0.280)	(0.504)	0.606	(0.851)	0.674	(0.453)		-		-
Bought	0.005	(0.519)	-1.406*	(0.782)	0.666	(0.498)	(0.023)	(0.111)	(2.961)	(2.138)
Industry Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

City Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Founding Year	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Graduation Year	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	2.369	(5.321)	15.983**	(7.581)	3.308	(2.895)	2.065**	(0.620)	-53.413	-
Observations	176		156		207		234		131	
R-squared	0.55		0.81		0.7		0.92		0.51	

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

APPENDIX J

Placebo Regression

Independent Variables	**Dependent Variable = Year start-up founded (subjects start being at risk upon graduation) Note: reported coefficients are hazard ratios**									
Years of Education	0.630***	(0.086)								
Educ. x POST	1.082	(0.205)								
GPA High			0.726	(0.231)						
GPA x POST			0.716	(0.317)						
Promoted					0.218**	(0.131)				
Promoted x POST					7.714**	(7.210)				
Ln(workexp)							0.454***	(0.116)		
Work exp. X POST							0.367***	(0.119)		
Talent (Income residual)									0.717	(0.179)
Residual x POST									1.333	(0.450)
Years 1997-99 (POST)	0.160	(0.521)	0.69	(0.256)	0.083***	(0.079)	4.362*	(3.346)	0.887	(0.349)
Years 1990-96	0.206***	(0.065)	0.307***	(0.098)	0.216***	(0.070)	0.258***	(0.097)	0.479*	(0.182)
Overseas Experience	0.743	(0.205)	0.619*	(0.170)	0.703	(0.189)	1.033	(0.338)	0.749	(0.299)
Last job academia	2.340*	(1.068)	1.877	(0.845)	2.299*	(1.055)	1.875	(0.986)	4.526**	(2.863)
Last job government	1.258	(0.519)	1.107	(0.477)	1.437	(0.569)	1.739	(0.831)	0.996	(0.568)
Ever job high gov.	1.159	(0.465)	1.129	(0.456)	1.108	(0.443)	1.804	(0.772)	3.835**	(2.160)
Ever job low gov.	0.892	(0.295)	0.657	(0.217)	0.663	(0.215)	0.318***	(0.140)	0.335**	(0.173)
Ever job academia	0.807	(0.277)	0.748	(0.252)	0.639	(0.216)	0.831	(0.338)	0.546	(0.252)
Number of Positions	1.344***	(0.115)	1.320***	(0.117)	1.410***	(0.128)	1.309**	(0.140)	1.607***	(0.231)
Gender (male=1)	1.111	(0.443)	1.212	(0.484)	1.093	(0.438)	2.124	(1.247)	2.686	(1.797)
Family Econ Status	0.740***	(0.079)	0.824*	(0.090)	0.781**	(0.083)	0.843	(0.114)	0.618***	(0.103)
Communist Party	0.939	(0.211)	1.033	(0.234)	1.014	(0.231)	0.765	(0.215)	0.587	(0.207)
Observations	1882		1225		1882		1829		526	

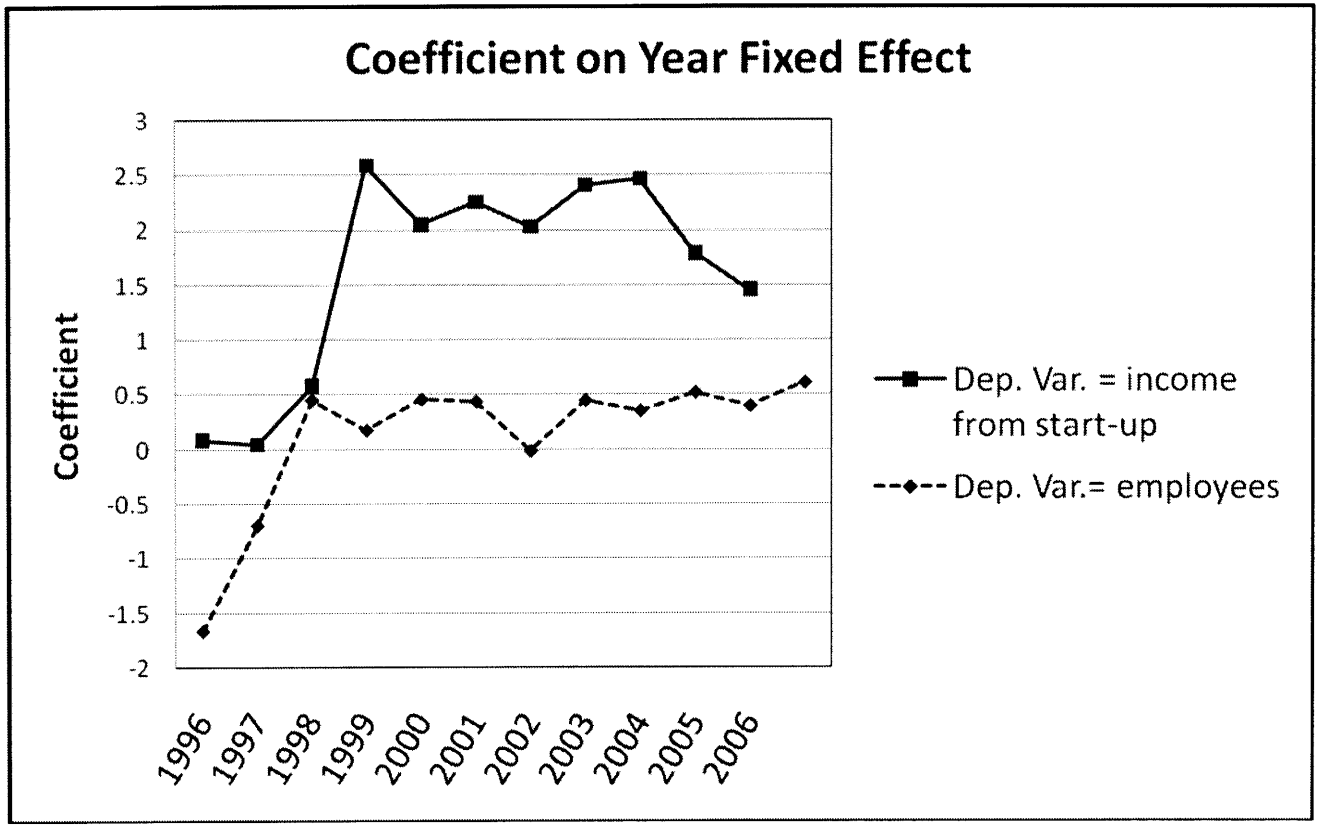
Note: 119 failures; 20,541 total years at risk; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All models include region, Bachelor's dept., and graduation year dummy variables.

APPENDIX K
U.S. Data Dotcom Boom Robustness Check

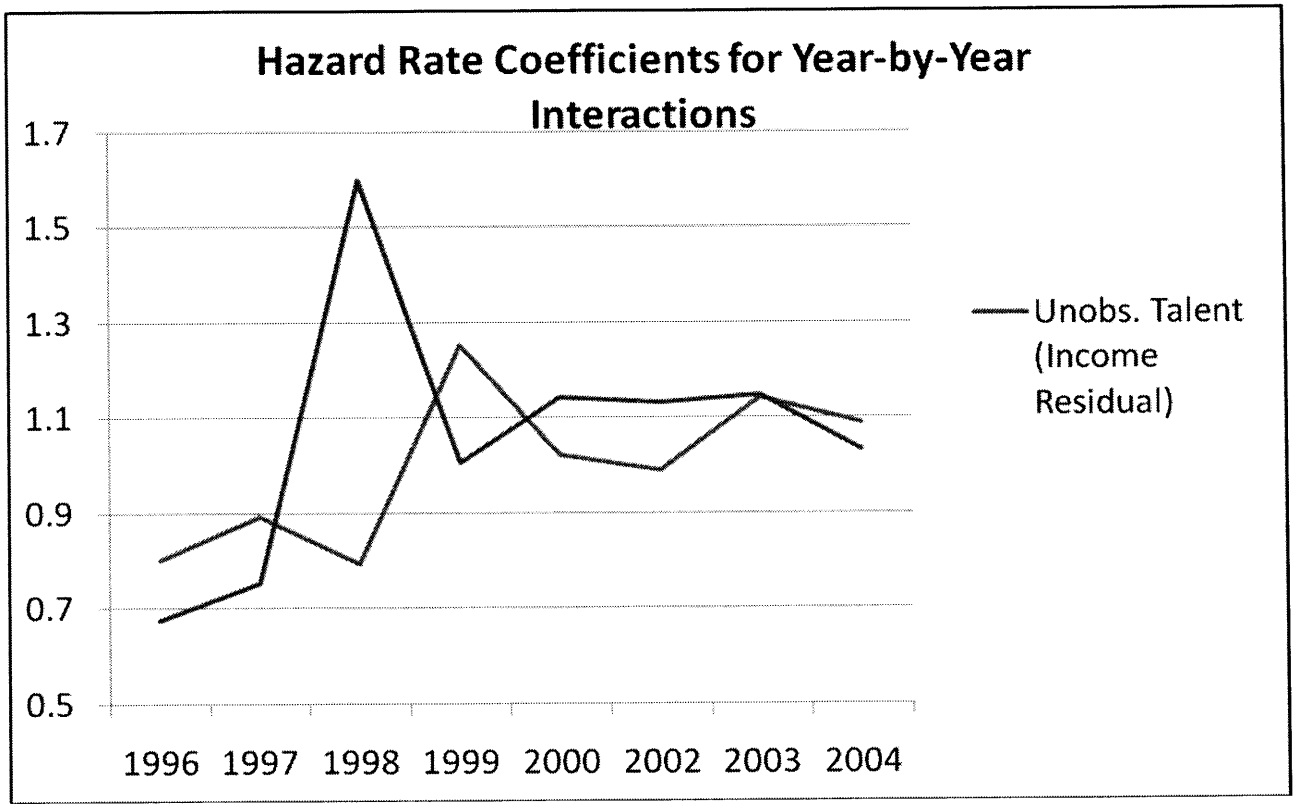
Independent Variables	Dependent Variable = Start-up founded (subjects start being at risk upon graduation) Note: reported coefficients are hazard ratios		
	Software firms only, only EE&CS grads	Software firms only, all grads	All Grads, All firms
Master's degree	0.281***	0.767	1.226
	(0.120)	(0.204)	(0.098)
Doctorate Degree	0.249**	0.733	1.261
	(0.153)	(0.333)	(0.127)
Master's x Years 98-00	7.466**	1.936*	0.936
	(5.844)	(0.741)	(0.152)
Doctorate x Years 98-00	5.560*	1.446	0.905
	(5.683)	(0.849)	(0.185)
Non-U.S. citizen	1.866*	1.172	0.825
	(0.634)	(0.292)	(0.078)
Gender (male=1)	5.814*	3.305***	1.495
	(5.934)	(1.302)	(0.169)
Years 1998-2000	0.001***	0.002***	0.011
	(0.001)	(0.001)	(0.002)
Years 1991-1997	0.755	0.665	0.240***
	(0.060)	(0.194)	(0.089)
Graduation year fixed effects	YES	YES	YES
Degree fixed effects	NO	YES	YES
Obs.	3,266	18,896	19,188

Note: Grad. Years 1980 and after (~age 40 and younger); 52 failures; 44,525 total years at risk; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All models include controls for Bachelor's graduation year (age), Bachelor's Major (academic department).

APPENDIX L


Coefficient on Year Fixed Effect
Coefficient
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Dep. Var. = income from start-up
Dep. Var.= employees

APPENDIX M


Hazard Rate Coefficients for Year-by-Year Interactions
1.7
1.5
1.3
1.1
0.9
0.7
0.5
1996
1997
1998
1999
2000
2002
2003
2004
Unobs. Talent (Income Residual)

APPENDIX N

Indep. Vars.	log(revenue)		log(employees)	
POST-1999	1.262**	(0.744)	0.510**	(0.309)
Master's degree	0.370	(0.348)	0.083	(0.164)
Doctorate degree	-0.342	(0.631)	0.200	(0.305)
Privatized	1.407**	(0.690)	1.409***	(0.315)
Bought	-1.212	(0.751)	0.087	(0.349)
Firm Age	0.460***	(0.085)	0.278***	(0.034)
Communist Party	0.128	(0.346)	0.039	(0.163)
Overseas	0.710	(0.449)	0.328*	(0.198)
Family Economic Status	-0.078	(0.179)	-0.018	(0.083)
Constant	2.544**	(1.208)	1.420**	(0.518)
Obs.	195		267	

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Chapter 6:

Entrepreneurial Ventures from Technology-Based Universities: A Cross-National Comparison

Descriptive Statistics from the MIT and Tsinghua Surveys

Understanding the differences in entrepreneurship associated with premier universities in advanced economies and those in developing economies is important for at least four reasons. First, it informs public policy to understand the relative intensity and types of entrepreneurship. This is important both for policy makers in developing countries as well as those in advanced economies seeing increasing competition on the horizon. Second, international variation helps to inform the debate about underlying drivers of entrepreneurship and the environmental influences on entrepreneurial behavior. Furthermore, it aids in understanding whether factors that influence the performance of entrepreneurial firms are universal in character, or whether "success factors" differ by international setting. Finally, focusing on entrepreneurial behavior emerging from specific universities helps to inform university administrators regarding relevant factors they may be able to influence to affect entrepreneurship among their students and alumni, and perhaps faculty and staff as well.

The empirical context for our specific comparative study is a sample of alumni from a top research/technology university in China and a top research/technology university in the U.S. While little work has been done focusing on the university's impact on entrepreneurship among alumni and students over the years, even less work has been done in this regard by looking at leading research universities outside of the U.S. For its part, Tsinghua University, often regarded as the top engineering school in China, has been widely referred to as the MIT of China.

MIT Survey

As indicated earlier in this dissertation, the MIT firm dataset was generated from an individual-level dataset composed of 43,668 records of MIT alumni who responded to a 2001 survey of all living alumni (105,928 surveys were sent out for a response rate of 41.2%). This dataset has been reported on previously (Hsu, Roberts, Eesley 2007). Of the respondents to the 2001 survey, 7,798 individuals (17.9% of the respondents) indicated that they had founded at least one company. These individuals were then mailed a second survey in 2003 asking more detailed questions about them and their firms. A total of 2,111 founder surveys were completed, representing a response rate of 27.1%. Eliminating duplicates for which more than one founder reported on the same firm brings the total number of unique firms to 2,067. One of the key features of this dataset is its long time horizon in the cross section (graduates from 1930-2001). We also observe wide variation in firm sizes, number of operating years, and outcomes. As in Chapter 3, for the purposes of this chapter, all non-U.S. located firms have been dropped from the MIT alumni survey so that we can more straightforwardly compare across U.S. and Chinese firms.

Tsinghua Survey

Also as indicated, we have undertaken a survey of alumni from the top engineering university in China, Tsinghua University. Since Tsinghua University is likely to be less familiar to the reader than MIT, a brief overview of the university may be helpful. Located in Beijing, China and established in 1911, Tsinghua University is regarded as one of the best and most selective universities in China. In 1952 it was reorganized according to the Soviet style of organizing universities by specialization. Rather than being involved with all disciplines,

Tsinghua was to focus on engineering. During the Cultural Revolution, 1966-1976, campus activities were disrupted as Tsinghua's campus became a battlefield. Different sects of Mao's Red Guards fought on the campus and it was a stronghold of the radicals. The university did not resume normal operations until 1977. In 1978, Tsinghua restored departments in sciences, economics and management, and humanities, no longer following the Soviet style. In 1984, Tsinghua established the first graduate school in China. The Tsinghua Science Park was established in 1998.

As described previously in Chapters 2 and 5, a survey was sent to all Tsinghua University alumni who had an address on record (a total of 30,000 according to the alumni association).[97] Just as with the MIT survey, this dataset includes alumni across all schools at Tsinghua. The Tsinghua firm dataset was generated from an individual-level dataset composed of 2,966 records of Tsinghua alumni who responded to a 2007 survey of all living alumni (~30,000 surveys were sent out for a response rate of about 10%). This dataset has been reported on previously in Chapter 5. Of the respondents to the survey, 718 individuals (24% of the respondents) indicated that they had founded at least one company. These individuals were then asked more detailed questions about themselves and their firms.[98] The response rates for both surveys along with descriptive statistics will be described in more detail below.

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[97] The sampling frame for both the MIT and Tsinghua alumni databases was likely to have been fairly accurate given the university alumni associations' efforts to maintain an accurate database, however both the 105,000 MIT alumni and the 30,000 Tsinghua alumni records may have included old addresses and deceased alumni. In this case the response rates should be higher than those reported.

[98] In addition to the survey data, the Tsinghua study includes extensive notes from interviews with 42 people (including entrepreneurs, investors, and government officials). The interviews included 26 Tsinghua alumni entrepreneurs, 2 Tsinghua staff (TLO, Science Park), 5 Chinese venture capitalists (VCs), 2 Government officials, 3 Other Chinese entrepreneurs (non-Tsinghua), 2 MIT Alumni (non-entrepreneurs), and 2 Tsinghua alumni (non-entrepreneurs). Unfortunately the interview selection procedure could not be randomized. The Tsinghua Alumni Association set up interviews for us and we specifically asked to talk with high-tech entrepreneurs and some who were not successful. Undoubtedly our interview population is weighted towards more successful entrepreneurs and those whose ventures are more high-tech than the average alumni. In addition, the majority of our interviews were in Beijing, though some were in Shanghai and Xi'an as well.

Descriptive Statistics and Comparisons of Datasets

Hsu, Roberts and Eesley (2007) reports on basic demographic statistics such as age, gender, and country of citizenship as well as trends over time for the MIT alumni dataset. Table 1 shows pair-wise correlations for the MIT dataset and Table 2 shows pair-wise correlations for the Tsinghua dataset. Tables 3 and 4 show variable definitions and summary statistics for the MIT dataset. Tables 4 and 5 show variable definitions and summary statistics for the Tsinghua dataset. From these tables the reader can see that there are many variables in common between the two datasets, such as basic demographic characteristics, measures of entrepreneurship and data on the firms such as idea and team characteristics, financing, and innovation measures. There are also elements that differ between the two surveys both because of the history of each country and university as well as improvements in the survey instrument for the Tsinghua survey. Two significant differences are worth mentioning. The first is that MIT has a much longer history of admitting foreign students and so many more of the MIT alumni are non-U.S. citizens. The second is that the Tsinghua respondents are much younger on average. The average year of Bachelor's graduation for the MIT alumni is 1973 while for the Tsinghua alumni it is 1990. The difference appears to be due to two reasons. First, a difference in the populations who were sent surveys and a slight difference in response rates by age for the Tsinghua survey with older respondents being less likely to respond. While we have some respondents from both universities who graduated in the 1930s, the Tsinghua alumni association appears to have kept fewer or less accurate contact information for the older graduates. Also, since Tsinghua was disrupted by the Cultural Revolution, admissions (and thus alumni) fall off in the 1970s (see Figure 3). The range of coverage for both surveys is

impressive with graduates from the 1930s all the way through graduates from 2007 (Tsinghua) and 2001 (MIT).

Table 7 shows means and t-tests of means for differences between respondents and non-respondents for the MIT 2001 and 2003 Founder surveys. Overall the means are very similar, yet due to the large sample size, some of the differences are statistically significant. In only a few instances do the differences between the sub-samples vary by three percentage points or more in absolute value (and for which the difference is statistically significant). For the 2001 MIT survey, only the variables *male*, *European citizen*, and *Middle Eastern citizen* meet these criteria. To foreshadow our statistical results, the regressions reveal only the first and third of these variables as statistically significant after controlling for the remaining factors (Hsu, Roberts and Eesley, 2007). We therefore further confine our discussion of possible bias to those variables. For both *male* and *Middle Eastern citizen*, a smaller fraction of individuals relative to the underlying population responded to the survey. Our estimates imply that belonging to each of these groups increases the hazard of becoming an entrepreneur, and so we are likely being conservative in our estimation (assuming a proportionate likelihood of entering entrepreneurship). For the 2003 survey only two variables have statistically significant differences between responders and non-responders, *engineering major* (more likely to respond) and *management major* (less likely to respond).

Table 8 shows similar means and t-statistics for the Tsinghua survey for all respondents. It shows *t*-tests of the null hypothesis that the average (observed) characteristics of the responders and non-responders are roughly the same statistically. Only the variables *gpa rank, age, entrepreneur, privatized,* and *high salary* show statistically significant differences in means at below the 1% level. It appears that non-respondents were more likely to be

entrepreneurs, were slightly older, had higher salaries, less likely to have been academics, and slightly more likely to have held a greater number of job positions, to have a higher GPA, and more likely to come from more wealthy families. *Years of education* is significant, but the means are very similar. Older founders appear to have been equally likely as younger founders to respond. The 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles of graduation years were also checked and are similar; offering some reassurance that there were not large differences over time in the response rates. Since there is evidence of some non-response bias, for regression analysis, weights were created using logistic regression and calculated as one over the predicted probabilities of responding. For the previous chapter, results are robust to using and also not using these weights.

Table 9 specifically examines the Tsinghua founders since the first part of the survey asked whether the individual had founded a firm. Only about half of these individuals completed the founder's section of the survey, so I test for response bias among founders as well. On an absolute basis, the means between the two sub-samples appear to be very well matched by observable characteristics. In only a few cases do the differences between the sub-samples vary by large percentage points or more in absolute value. Only the variables *number of jobs, work as a general manager, average tenure, work as an advisor, number of positions, Ever job government, and gender* show statistically significant differences in means at below the 10% level. For *number of jobs,* slightly fewer individuals who had held more jobs responded relative to the underlying population who responded to the Tsinghua Founder's survey. Our estimates imply that belonging to this group with more jobs decreases the hazard of becoming an entrepreneur, but has no significant impact on performance, and so it is likely that compared to our estimation, having more jobs does not decrease the likelihood of

becoming an entrepreneur. The lack of differences between these groups gives us further confidence that our results are not driven by respondent bias.

There is no claim that the MIT or Tsinghua datasets are representative samples from the general populations of each country. However, to quantify just how the Tsinghua sample looks compared to a representative sample of the Chinese population, Table 10 compares it to the Chinese Health and Nutrition Survey (CHNS) and the National Bureau of Statistics Household Survey (NBS HH). The Tsinghua alumni primarily wind up in urban areas once they graduate. The CHNS surveys both rural and urban residents while the NBS HH is more comparable to the Tsinghua sample in that it surveys primarily urban residents. Overall, the Tsinghua respondents are much more likely to be male (due to the university's historical admissions rates), slightly older (50 vs. 41 or 36, much more highly educated, less likely to have experienced a layoff, and more likely to be Communist party members. Whereas the CHNS and NBS HH surveys ask about self-employment broadly defined, the Tsinghua survey specifically asks about new firm founding. The entrepreneurship rate among the Tsinghua graduates is higher than for the CHNS survey, but probably not higher once the higher level of education is taken into account (previous studies in the U.S. find that education is a significant predictor of entrepreneurship). Also, when one looks at the percentage of individuals who are founders (or self-employed for the NBS) in a particular year, 1999 in this case, we find that the rate is actually much lower for the Tsinghua alumni. This is possibly due to the more narrow definition of entrepreneurship in our survey or to the higher opportunity costs (better wage employment opportunities) for the Tsinghua alumni. In comparison to a representative sample of rural and urban households from the China Health and Nutrition Survey (Popkin et al, 1993; http://www.cpc.unc.edu/projects/china) the Tsinghua sampled alumnus/a is 8.7 years older on

average, much more likely to be male, more highly educated, and slightly more likely to have founded a firm. The differences in age and education most likely contribute to differences in the entrepreneurship rates. The data were also benchmarked against a representative sample from the National Bureau of Statistics (NBS 1999). The MIT data can be compared to the Current Population Survey (asking about self-employment) or the National Longitudinal Surveys. However, comparing national samples of entrepreneurship is challenging, as data sampling strategies vary depending on the subject matter of study (compare, for example studies of self-employment [e.g. Blau 1987] and manufacturing [e.g. Dunne et al. 1988]). With these caveats in mind, we note that the percentage of individuals engaging in new firm creation is generally significantly higher in our sample relative to the four to five percent level often cited nationally (Dennis, 1997; Reynolds, 1994).

Figure 3 shows the histogram of Tsinghua alumni respondents by five year periods starting with 1946 graduates through 2006 graduates. Overall, the responses by graduating class are rather similar with the exception of the time period of the Cultural Revolution. One can see the impact of the Cultural Revolution when Tsinghua was largely disrupted between 1966 and 1976 when regular admissions resumed. The class size at Tsinghua and admissions numbers have increased over the years, particularly after the 1978 additions of the humanities and sciences back to the university. This addition to the class size contributes to the increases in the last two decades. For its part, MIT has also seen increases in the class size over time, albeit not comparable in magnitude. The size of the MIT undergraduate class has remained relatively constant in recent years at around 1,000 students. Each Tsinghua undergraduate class is currently about 3,475 students. In 2002, the class size was 3,000 and between 1984 when the

School of Economics and Management was added and 2002, the undergraduate class size increased by 200.

Next I will discuss what variables are common between the Tsinghua and MIT datasets followed by what is unique in each. Other differences and similarities found in comparing the descriptive statistics will be discussed as well.

Elements Common to Both Datasets

Basic demographic information

Insert Table 1-6 here

Table 11 shows the breakdown of graduates from each university by department and then the proportion becoming entrepreneurs from each department. Tsinghua breaks down the academic departments by a slightly different system than MIT so I created a procedure to map the Tsinghua departments into their corresponding MIT departments and schools. Consistent with being primarily engineering schools, the engineering department makes up 51.3% of the MIT alumni and 69.7% of the Tsinghua alumni. Overall, Tsinghua has more graduates from engineering and fewer from management since their School of Economics and Management was founded much more recently. Among the Tsinghua graduates, 59% held a Master's degree as their highest degree and 9% held doctorate degrees (not necessarily from Tsinghua). There are slightly more doctorate degree holders among the MIT alumni (16%) and 41% with a Master's degree as the highest degree (not necessarily from MIT). Consistent with many years of admitting primarily men at both institutions, 94% of the Tsinghua sample is male (compared to 93% of the MIT sample).

Entrepreneurs

A higher percentage of the Tsinghua engineering and social sciences graduates reported having founded firms. These differences appear to mainly be driven by differences between the universities in the chemical engineering alumni and the humanities.

Figure 2 shows the distribution of the entrepreneurial respondents by birth year. The Tsinghua founders are markedly younger than the MIT founders. This is likely due in part to the labor market changes in China where earlier generations were assigned to job positions and entrepreneurship was illegal. The cohort born in 1960 would have been 18 in 1978 when many of the economic reforms began occurring. Consistent with the older age of the alumni respondents, the firms founded by MIT alums are on average older than the firms founded by Tsinghua alumni. Figure 1 shows the distribution of firms by founding year for the U.S. (MIT alumni) and China (Tsinghua alumni). Overall, there is a similar pattern, particularly when looking at firms founded between 1984 and 2000. The MIT sample stops at 2001 in year of receiving a degree and the Tsinghua sample ends at 2007. We see similar upward trends over time, in part due to more graduating classes being added each year so that the number of individuals "at risk" for entrepreneurship increases in the sample with each year. We see a downturn at the end due to right-side censoring (since we have fewer years to observe the most recent graduates) and the fact that enrollment has increased over the years at each university. It is not accurate to interpret this decline as a trend in entrepreneurial activity. Similarly, the increase that appears between 1992 and 2000 is largely due to the fact that with each year, additional cohorts of graduates are added to the sample and become "at-risk" for firm foundings. Thus, more sophisticated analysis would need to be done to determine the actual trends in the rate of entrepreneurship, net of these effects due to the sampling procedure. The

fact is that we are not following a single cohort of graduates, but successive cohorts of alumni graduating classes and there is typically a long lag from graduation to a firm founding. This can be a source of confusion for those not accustomed to seeing data from alumni surveys or similar sampling methodologies. Figure 4 shows the percentage of "at-risk" Tsinghua alumni becoming entrepreneurs in each year. There is almost no entrepreneurial activity in this population prior to 1982. After the economic reforms in the early 1990s and in the late 1990s, as indicated in Chapter 5, we see increases in the levels of entrepreneurial activity.

Table 12 shows the mean characteristics and t-statistics for the founders compared to non-founders. Overall the Tsinghua entrepreneurs are 10 years younger, more likely to be male, from more wealthy families, have lower average tenure in each job, are more likely to have gone overseas for education or work experience, and had a higher number of job positions. Consistent with having higher opportunity costs, the non-entrepreneurs had higher salaries than the entrepreneurs (pre-firm founding), were more likely to have worked in lower levels in government or to have worked in academia, and were less likely to have been student leaders at Tsinghua. Some of the non-founders may eventually found firms. For the MIT alumni, founders are just slightly older than non-founders and also more likely to be male. However, for MIT, those with a Master's or Doctorate degree are slightly less likely to found firms. Most likely this is due to higher opportunity costs. The other work history variables are not available in the MIT dataset.

Table 13 shows the median age at first founding for the MIT and Tsinghua firms. Since entrepreneurship was illegal until the economic reforms of the late 1970s, for the earlier graduation cohorts in China, there is a very long lag between graduation and their first firm founding (if they became founders at all). Despite the fact that the MIT alumni respondents are

older on average, the Tsinghua alumni appear to wait slightly longer to found their first firms, though the lags are much more similar for the graduation cohort from the 1990s. While the MIT alumni respondents are older on average (more of them come from older graduating classes), once one holds constant the graduating class cohort, there are longer lags from graduating to founding a firm for the Tsinghua alumni. Consistent with the younger age of the average Tsinghua alumni respondent, overall the median age at founding for the MIT founders is 37.5 whereas for the Tsinghua founders it is 32.

Insert Figures 3-5 and Tables 7-13 here

Serial Entrepreneurs

For both the MIT and Tsinghua surveys we asked respondents about the total number of firms founded. In both cases we found substantial numbers of entrepreneurs who had founded multiple firms. In the case of China, this came as a surprise since we had been told that the distinctly American culture of founding a firm and then selling it was not part of Chinese culture where individuals founded firms that they wanted to run themselves rather than sell and move on. In addition, liquidity events, such as initial public offerings and acquisitions have been more rare in China and are typical transition points for U.S. entrepreneurs. Future analysis should determine whether the serial entrepreneurship we observe in China is more likely to be due to first firm failures and if after a success Chinese entrepreneurs are more likely to stay with the business. Overall, 45.7% of the MIT alumni entrepreneurs had made more than one founding attempt and 48.1% of the Tsinghua alumni entrepreneurs claimed more than one founding attempt in their lives. Table 14a shows the Tsinghua repeat founders (or serial

entrepreneurs) by decade of their Bachelor's graduation. We can see that several individuals made as many as 10 or more firm founding attempts. The most recent cohorts of graduates from the 1990s and 2000s have lower rates of repeat entrepreneurship, no doubt due to the fact that they have had less time since graduation for even one founding, never mind two. Table 14b displays the same figures for the MIT alumni. The MIT alumni appear to have higher rates of repeat entrepreneurship among both the older alumni and the most recent graduates. My interviews with Tsinghua entrepreneurs paint a picture consistent with these tables in that many of them told stories of having founded multiple firms. Their stories also shed light on their motivations. In some of the cases the first firm had been unsuccessful and went out of business. In other cases, they were simply searching for a new firm idea that better fit them and their passions. One entrepreneur had been in the business of importing electronics and told me that this business had been so lucrative that life was too easy and became boring. He left the business to start his current company, an extremely successful children's clothing retail business. Table 15 shows the aggregate breakdown across the decades of the number of Tsinghua entrepreneurs by the number of companies they have founded. Table 16 shows some of the more specific data that we have on up to three companies founded by each Tsinghua entrepreneur. The table shows median aggregate employment, survival, revenue and initial public offering data for all first companies, all second companies and all third companies. The second and third companies are typically founded more recently.[99] Similar data are available in the MIT survey on up to five companies. The table shows that the trend of increasing median revenues and employment figures for the subsequent firms is consistent across the MIT and

[99] In the "Cutting Your Teeth" chapter the fact that the second and third firms are younger is accounted for with a control variable for the age of the firm in the regression analysis.

Tsinghua datasets. The increase in revenues is quite sharp for the 3rd firms in the Tsinghua dataset, however, there are only 17 3rd firms reporting revenue data to calculate this median.

Entrepreneurial Firms

Figure 5 shows the distribution of industries for the MIT and Tsinghua alumni firms. The industry breakdown is strikingly similar across the two, providing a reassuring level of similarity in industrial sector distribution and reducing the likelihood that the results may be driven by industry differences. Both are primarily engineering schools and the industries reflect this fact, with software and electronics forming the first and second largest categories (25% vs. 27% software and 16% vs. 19% electronics for MIT and Tsinghua firms respectively). Both finance and drugs/biotech are less represented among the Chinese firms (5% vs. 1% and 7% vs. 3%) that may result from the fact that these are heavily regulated industries in China and entry has traditionally been strictly controlled by the government.

Performance

Several variables that can be thought of as firm performance measures are included in both the MIT and Tsinghua surveys including survival, the number of employees, revenues, acquisitions and initial public offering (IPO). Figure 6 shows a comparison of the distribution of firm size (measured by the number of employees) for the MIT and Tsinghua firms. Despite the fact that the Tsinghua firms are younger on average, the distributions are fairly similar with the exception of the 20-100 employee range where there appear to be relatively more Tsinghua firms. There are more U.S. firms in the 500-750 employee range.

Table 17 shows a comparison of the revenues for the MIT and Tsinghua firms. All revenues exclude financial firms and firms older than 15 years to make them slightly more comparable. All revenues are for the most recent year that the firm was in operation (or for

2006 for those still in operation). The Tsinghua dataset also contains the revenue numbers for each of the first 3 years and the revenues (plus employees) for the second to last year that the firm was in operation (or for 2005 for those still in operation). These data allow us to look at some growth trends over time. Tsinghua revenues have been converted for the exchange rate and for purchasing power parity (PPP). The former can be thought of as a lower bound while the PPP conversion gives a lower bound. MIT revenues have been adjusted for inflation. We can see that overall the MIT firms are significantly larger.[100] Both surveys contain data on acquisitions and IPOs, though these have been very rare in China until very recently. In addition, the Tsinghua survey has a couple of unique performance measures that will be discussed more below.

Idea and Team Characteristics

Figure 7 shows the number of different sources of the founding team reported for each co-founded firm. The instructions on the survey were to "mark as many as apply." The figure shows that as expected, as the number of co-founders increases, the number of team sources shows a corresponding increase. For the MIT firms with 2 founders, just under 90% met in one setting and 10% knew each other from two settings (for example, at MIT and through common work experience). For the teams with 4 founders, 64% met via one source and 27% met via two sources. For the Tsinghua firms with 2 founders, 90% met via one source and 10% via two sources and for those with 4 founders, those numbers are 68% and 23%, respectively.

Examining the entrepreneurial teams assembled by MIT and Tsinghua alumni shows that team size is significantly larger for the Tsinghua firms. For MIT the mean team size is 2.15 (median=2) vs. 3.35 (median=3) for Tsinghua. However, this difference is largely due to

[100] There may be some concerns that the largest Chinese firms may be reluctant to share revenue data even in an anonymous, non-government survey.

the family business model contributing to a relative lack of single-founder teams in China with 38.03% of the MIT alumni firms being founded by 1 individual vs. 9.67% for Tsinghua.

Insert Figures 7-12 about here

Figures 8a and 8b show the number of idea sources reported by the founders. Again we see a similar pattern in both sets of alumni that firms with larger founding teams were more likely to report a greater number of sources for the idea. This effect seems just slightly more pronounced for the Tsinghua firms. A larger number of sources for the idea may indicate combining knowledge from different areas to generate the start-up.

Figure 9a shows the source of ideas for MIT alumni firms and Figure 9b shows the same for the Tsinghua alumni firms. Both figures are divided into recent graduates (blue) and older graduates (red). The recent graduates comprise about 20% of the sample when the 5 year cutoff is used. Compared to Tsinghua, the MIT alumni entrepreneurs more frequently get their ideas from work experience. This is true for both recent and older graduates. However, for both, older graduates are more likely to get ideas from work experience and younger graduates are more likely to get their ideas from research settings. The shift is most likely due to the fact that these recent graduates have had less time to accumulate work experience and have had more recent exposure to university research. For the Tsinghua alumni, compared to the MIT alumni, they are more likely to get their ideas from social networking, fewer get ideas from work experience and more of the ideas appear to come from research settings. Again, for the more recent graduates, the distribution of idea sources shifts away from work experience and towards ideas coming from socializing and research. The differences are significant at the 1% level with the exception of the differences between recent and older Tsinghua graduates in

getting ideas from social networking, which is significant at the 10% level. The finding that a higher percentage of Tsinghua alumni get their ideas from research is unexpected. In particular, it is due to higher percentages of Tsinghua alumni getting their start-up ideas while at the university, either through conversations with visiting scientists and engineers, from the professional literature, or through informal discussions with other students than is true for MIT alumni. It is speculation at this point, but it may also be due to the more applied nature of the research going on in Chinese universities compared to the U.S. where basic research is likely to be relatively more common.

Figure 10 shows the same figures but for the team formation. The results are very similar overall across MIT and Tsinghua. Most of the teams came from work experience, followed by social activities and then research. Consistent with the idea sources, as graduates get older, they tend to form their teams more from work experience and less from research or social activities. For the Tsinghua case, it is interesting that while many of the ideas came from research, a smaller percentage of the teams were formed in a research setting. Teams from research were less likely among Tsinghua cofounders than for the MIT cofounders. For both the team and idea sources, the respondents could indicate more than one source. The MIT alumni appear to have identified slightly more diverse sources of the founding team than the Tsinghua alumni did, despite the fact that the Tsinghua teams were more often cofounded. The older Tsinghua alumni were more likely than the MIT alumni to identify family members as cofounders.

Figure 11 shows the median revenues (in constant 2001 dollars) for the MIT firms plotted by the idea source. While the revenues for firms originating from work experience ideas are higher and those from ideas from socializing are lower, the standard deviations are

high enough that the differences are not statistically significant. A similar figure has not been plotted for the Tsinghua alumni because the sample sizes are smaller in each category. Figure 12 shows the standard deviations of the revenues and we see that the variance appears to be lower for ideas from research. Similar results also hold when looking at the team sources, but again the differences do not reach statistical significance.

Insert Table 14-18 here

Table 18 shows the responses to the question of "what was the primary source of the idea" that led to the founding of the firm. Overall the patterns are strikingly similar with ideas from industry and from discussions at social or professional conferences forming the largest two categories in each sample. We observe that more of the U.S. firms resulted from ideas uncovered while working in industry (41.4% vs. 24.8%) or doing outside-funded research (2.1% vs. 0.8%). More of the Chinese firms resulted from informal discussions with students at school (11% vs. 3.4%), from classes at the university (5.9% vs. 2%), and from the professional literature or from visiting scientists and engineers. Table 19 shows the team and idea source characteristics of the MIT firms broken out by founding decade and aggregate sources. We see that most of the teams were formed from work or social activities and most of the ideas came from working in the industry. The average team size appears to be slightly larger for the Tsinghua firms at 3.35 compared to 2.29 for the MIT firms. For the firms founded in the 2000s the numbers are much more similar with the average team size at 3.3 for the MIT firms and 3.36 for the Tsinghua firms. Tables 20 and 21 show much more detail on the team and idea sources for the MIT alumni. Table 20 shows the most frequent combinations of sources for the team. The most common combinations are working in business combined

with family or networking, MIT lab combined with MIT course, and socially while at MIT with socially after leaving university. Table 21 shows the same table but for the idea sources. The most common combinations are "Working in the Industry" with "Working in the Military/Government" or "Discussions with social/professional acquaintances."

Table 22 shows a comparison of the channels that the MIT and Tsinghua founding teams met through including family/relatives, classmates, or colleagues. The Tsinghua responses are broken down by the first co-founder (designated by the respondent) only and then all co-founders. We find that the MIT teams were more likely to meet via classmates and the likelihood that the team met via family or work colleagues was similar for both the MIT and Tsinghua founding teams. The second panel breaks out the Tsinghua data by how the respondent met each co-founder. We see that if there was only one co-founder then there is a higher likelihood that it was a relative than for the remaining co-founders or for larger teams. For all alumni, the most common channel for founders to meet was as work colleagues followed by classmates.

Insert Figures 13-19 and Tables 19-26 about here

Financing

Figure 13 shows the distribution of initial capital raised for the business (in the first year). The figures have all been converted to constant U.S. dollars (2005) using purchasing power parity (PPP) as calculated by the 2005 World Bank International Comparison Program.[101] The Chinese firms appear to be raising (or reporting) considerably smaller

[101] A detailed review of the methodological difficulties in constructing PPP indices is beyond the scope of this paper (see Kravis, Heston, and Summers, 1982 for a discussion of these issues).

amounts of initial capital.[102]

Table 23 shows the number and percentage of companies using each source of capital for the firms. We find that the most common source for the MIT alumni by far is the savings of the founding team followed by venture capital and then friends and family. For the Tsinghua alumni savings is also the most important source followed by friends and family. The Tsinghua survey did not break out state government, cash flow or customers separately as sources.

Figure 14 shows the pattern of the breakdown of the sources of capital for the MIT and Tsinghua firms. Across the x-axis we have the founding decades and along the y-axis the proportion of firms using that source of capital. Overall the MIT and Tsinghua firms appear roughly similar in their financing with savings making up the largest category. The "other" category is made up largely of capital from suppliers. High use of supplier credit has in other studies been used as a measure of financial constraints on firms. The Tsinghua firms appear to use founders' savings less frequently than the MIT firms and capital from friends and family slightly more frequently. The proportion of firms using loans from banks is similar across the two countries. In recent decades, the proportion of MIT firms raising money from angel investors or venture capitalists has increased and is higher than that proportion for Tsinghua firms. We do see an increase in the use of venture capital among the MIT firms over the decades. It is likely that this is restricted to those firms that are raising large amounts of initial capital.

Innovation

[102] For the Chinese firms, we asked about "registered capital" which is the initial capital that firms are required to report when registering the founding of a new firm. While this is not perfectly symmetric to the MIT survey question of "initial capital in the first year of the company," it is close and the best we currently have available.

One of the advantages of these data is that we have multiple measures (particularly in the Chinese survey) of the importance of innovation in the firms. Using these data, we have a number of innovation measures (both patent-based and non-patent based) including: whether the start-up owned or licensed any intellectual property (IP), whether IP was considered critical for the success of the business, if one of the co-founders was the creator of the innovation, the source of the idea, if there were any patents (foreign or domestic for the Tsinghua firms), and how much of the firm's revenues were spent on R&D activities. We have also linked the MIT firms with the USPTO patent database to merge in the number of patents and the patent characteristics.

Patents are typically used as a measure of innovation because they offer extremely detailed and rich data that are easy to access. However, there are limitations of patents as a measure of technical change or innovation (Comanor & Scherer 1969; Graham & Higgins, 2007). There are problems with great skewness in quality, differences in propensity to patent across industries, countries and firm types. The range of patentable innovations constitutes just a sub-set of all research outcomes, it is unclear whether patents should be seen as a research input (like a working paper) or an output, patenting is a strategic decision, and not all patentable innovations are actually patented.

Figure 15 presents the reported most recent year spending on R&D (as a percentage of revenue) for the firms that were founded in a given year.[103] The levels are roughly similar for both the MIT and Tsinghua firms over the years. However, the MIT alumni firms are consistently spending more on R&D than the Tsinghua alumni firms. Further, this appears to be due to higher R&D spending by R&D performers rather than a lower proportion of R&D performing firms among the Tsinghua alumni firms.

[103] For inactive or failed firms, this was reported for the most recent year in operation.

Table 24 displays the responses to the questions of whether the founder was the creator (author) of the intellectual property that the firm is using, whether the firm owns IP and whether they consider intellectual property to be important for the venture. A higher proportion of the Tsinghua alumni report having created the intellectual property (a finding that is consistent with weaker IP protection in China where selling or licensing IP would be more difficult or with a greater orientation toward starting firms that have higher IP). Similar percentages between the schools report owning IP (53.2% vs. 59.4%) and that IP is important for their businesses (33.8% vs. 37.9%). It is interesting to note from these responses that a subset of the IP owners (or even the authors) consider the IP to be important for their start-up. The bottom panel shows the breakdown of the R&D investment by the firms as a percentage of revenues. We see very similar aggregate patterns between the two countries even broken down by the 25th percentile, the median and the 75th percentile. The bottom panel of Table 24 breaks down the R&D spending data by industry. As expected, we see higher levels of R&D spending in electronics and software than in law and accounting (chosen as a low tech contrast). Also, we find slightly higher R&D spending in the MIT electronics and software firms than the Tsinghua firms in those industries.

Table 25 shows the breakdown of patenting as a measure of innovative activity. Panel A shows that out of the sample of all Tsinghua alumni, just under 1.5% hold at least 1 foreign (non-Chinese) patent and 15.5% hold at least 1 Chinese patent. In panel B, we report the number of patents per firm. This includes only USPTO patents for the U.S. firms, but includes any foreign or domestic patents for the Chinese firms. Fewer than 20 of the Chinese firms reported holding foreign (non-Chinese) patents. The first set of columns report patents for all firms. The results show that while only 25.1% of the U.S. firms hold at least one patent, 79.9%

of the Chinese firms report holding at least one patent. Since many of the U.S. firms hold many patents due to their older average firm age compared to the Chinese firms, the next set of columns restricts the firms to only those less than 15 years old. We see that the proportions are now 12% (U.S.) and 92.3% (China). While it may be true that there is a stronger orientation to starting firms with IP, the Chinese firms likely have such high patenting rates because there are many government incentives and subsidies for firms that hold patents, particularly for the science parks. Some of these results may be due to filing a patent simply in order to qualify for one of these benefits. If we take the response of whether intellectual property (broadly defined) will be important for the firm, then in each country roughly 30% of the firms were innovating. From the results on patenting, we could then conclude that patenting activity undercounts innovating firms in the U.S. but drastically over-counts innovating firms in the Chinese context. Patenting appears to be a poor proxy for innovating firms in an international comparison.

Many additional non-patent measures of innovation are available in the Tsinghua survey, including responses to the question of whether the products/services offered by the firm were available on the market three years ago.

Elements Unique to the Tsinghua Survey

Since the Tsinghua survey was done almost 4 years after the MIT survey and subsequent to the first publication from the MIT dataset, many improvements were made on the data collected for the Tsinghua alumni.

Unique Demographic Characteristics

Tables 5 and 6 show the means for some of the unique demographic characteristics that the survey includes. We asked about the economic status of the individual's family relative to

the rest of Chinese society when they were in high school. This gives an indication of socio-economic status while side-stepping the tricky compensation issues where many individuals were compensated through housing, bonuses or other perks rather than compensation. Rather than giving a dollar amount, the respondents were asked whether their family was in the top 10%, the top 10-25th percentiles, 25-50th percentile, or the bottom 50 percent. The overall mean response was 3.63 which would be in the top 25th or 10th percentile of Chinese society. We also capture whether the individual was a member of the Communist party (54% of respondents), what year they joined and if he/she was a member of other political parties (non-communist political parties include such groups as the Revolutionary Committee of the Chinese Kuomintang, the China Democratic League, the China Democratic National Construction Association, the China Association for Promoting Democracy, the Chinese Peasants and Workers Democratic Party, the China Zhi Gong Party). Nine percent of the respondents had parents who were entrepreneurs. We also asked about other family members, neighbors or colleagues and whether they were entrepreneurs. Another unique aspect of the survey tailored to the Chinese setting was the phenomenon of graduates going overseas for educational or work experience. Among the Tsinghua alumni respondents, 21% had overseas experience. We also collected a wide range of variables characterizing this overseas experience in a separate "Overseas" section of the survey to be analyzed in a future paper. The survey asked whether the individual was a student leader in one of a number of well-defined student groups while an undergraduate. Sixty-seven percent of the non-entrepreneurs and 90.3% of the entrepreneurs had been student leaders. Finally, we asked for GRE and TOEFL scores as well as what quartile of the GPA distribution the respondent was in. The distribution of GPA quartiles appears fairly balanced, with slightly less than one quarter reporting that they were in the

bottom quartile. Without access to the university transcripts we have no way of definitively knowing about possible inflated reporting of all these measures as opposed to response bias. From the analysis of response bias in Table 8, it appears that there may be some over-reporting. Those with higher GPA levels were slightly less likely to respond to the survey.

Work History

The Tsinghua survey added a major section collecting career histories of the respondents, starting with the first job after graduation all the way to the most recent job. Figure 16 shows a histogram of the number of jobs reported on. The most common were one job or five jobs and t-tests of means were performed. The main differences for those reporting only one job was that they were younger. On average, respondents had held 2.37 different job positions (R&D, sales & marketing, etc.) and had held each job for 7.11 years on average. We know the salary (inclusive of bonuses) for each job by five categories of salary levels. We captured the sector for each job (government, business, academic, or non-profit) along with whether the individual at some point had work experience in R&D, technical management, general management, or in sales and marketing. Twenty-three percent had worked in academia and 21.6% had worked in government. Several phone calls were made to verify the work history information.[104] If the individual was in government, we captured the precise level. Four percent held high positions in government at the minister, province, Bureau or municipal levels. Seventeen percent held jobs in lower levels of government, below the municipal level. Figure 17 shows the percentages of those in academia, business or government becoming entrepreneurs plotted by the founding year. We find that the highest percentages come from lower levels of government while the lowest percentages come from academia. The figures

[104] During these calls it was discovered that some had counted research assistant jobs that they held during graduate school as work experience in academia.

separate out those who had worked previously in that sector from those transitioning directly from that sector to entrepreneurship. Individuals were least likely to transition directly from academia to entrepreneurship. Academic and high government jobs have traditionally been among the most prestigious in Chinese society so this appears to make sense. We also capture whether the individual left each job position voluntarily or if they were fired. On average 12.8% of respondents indicated they had been fired at some point in their careers.

To better illustrate the typical career histories of the Tsinghua respondents, we follow the average career paths of a graduate from the 1970s and one from the 1990s. The typical graduate from the 1970s majored in mechanical engineering and 63% took first jobs in business, typically in state-owned enterprises (SOEs). The median salary at the end of the first job was reported in the lowest salary category (the 0 to 20,000 yuan category). Since salaries during this time were set by the government, we find that 63% of the graduates (the same percentage with jobs in state-owned enterprises) received this salary of 0 to 20,000 yuan. On average 11.2 years were spent in this first job. The shift to stop the government from setting salaries for specific jobs occurred as part of the SOE reforms in the mid-1980s. The second job was also most likely in a state-owned enterprise as were subsequent jobs. The most common industry for such an alum would have been machinery or chemicals.

The typical graduate from the 1990s majored in electrical engineering or computer science (followed closely by mechanical engineering) and 70.8% took first jobs in business, some in state-owned enterprises, some in foreign multi-nationals and some in private firms. The salary at the end of the first job was typically between 20,000 and 100,000 yuan, however the variance is much higher with only 28% receiving this salary level. On average 4.8 years were spent in the first job compared to 11.2 years for the earlier graduate from the 1970s. The

second job was also most likely in business as were subsequent jobs. The most common industries for such an alum would have been machinery or chemicals, followed closely by electric utilities, electronics and architecture. Work history data are currently being merged into the MIT dataset from LinkedIn, ZoomInfo, Facebook, etc., starting with the Electrical Engineering and Computer Science graduates.

Entrepreneurship and Privatization

In China, entrepreneurship also is interpreted to include privatizing a state-owned enterprise. We asked about privatization separately and found that about 6% of the respondents had privatized an SOE.

Table 26 contains self-reports of why non-entrepreneurs from the Tsinghua sample chose not to found firms. Panel A shows that among the 685 who responded to the question, 65.1 percent reported considering becoming an entrepreneur, but in the end did not start the project. Another 27.2 had never considered it and 7.7 percent did not view entrepreneurship as a worthwhile activity. Of those who did not become an entrepreneur, we asked them to rate their reasons on a scale of one to eight, with one being the most important reason. The top two reasons were a difficulty in raising capital and a lack of good ideas. Thirty-one percent chose difficulty in raising capital as the most important reason and thirty-seven percent rated "lack of good ideas" as the most important reason for not becoming an entrepreneur. In the order that they were chosen, the next most important reasons were that the risk is too great, difficulty in finding partners, inability to leave the current job, and a handful indicated that their family was against entrepreneurship, the government discouraged entrepreneurship at the time, and the least important reason was that their concept was easily copied. The finding that "concept easily copied" was the least reported primary reason for not founding a firm provides some

evidence against the idea that inability to legally protect IP is discouraging entrepreneurship in China.

The Tsinghua survey also contains data on several other aspects of the entrepreneurial process including whether the founder had prior relationships with the technology, the market, suppliers, customers, or investors, whether there were shifts in the market or technology targeted over time. In terms of financing, we have responses on whether particular investors were involved in management decisions and had control rights in the firm and whether employees had stock option plans. The respondents were also asked whether they had formed a board of advisors or directors and they were also asked about the importance of several dimensions including innovation, low cost, and speed to market on the firm's success.

Performance

Since reporting revenue numbers is a sensitive subject (even for an anonymous survey that does not ask the firm's name), we sought to ask other performance measures. In interviews we were told that while accounting methods had improved, Chinese firms were known to keep not one but three sets of books: one for investors, one for the government and one for themselves. In the development literature it has become standard to ask about profits as a percentage of firm gross revenues, especially when surveying micro-enterprises that do not often keep good records. The Tsinghua survey asked this question both for the most recent year that the firm was in operation (2006 for firms still in business) and for the year prior to that. Figure 18 shows a histogram of this measure of the profitability of the firms. Most of the firms are clustered at the lower (but actually quite good) end of the profitability distribution (around 10-20%). These smaller firms appear to have grown on average from the first year measured to the second year. The firms at the very bottom and at the top of the distribution

appear not to have grown on average over the two-year period. In future analyses, this measure can also provide a check on which firms are simply larger (in terms of employees or revenues) and which firms are actually more profitable.

Conclusion

The MIT and Tsinghua surveys offer a promising and exciting methodology for cross-country comparisons in innovation and the entrepreneurial process and outcomes. The alumni received strikingly similar educations in terms of their major fields and the caliber of the universities. They founded firms at roughly similar rates and those firms tend to be in very similar industries. However, the legal, financial and institutional environments that these individuals encountered in their work experience and in founding their firms differed dramatically, particularly for the early Tsinghua entrepreneurs.

What is the same and what is different about entrepreneurship by alumni from MIT vs. from Tsinghua? The results of the Tsinghua and MIT alumni surveys can be compared along three overarching dimensions; 1) factors that affect who becomes an entrepreneur, 2) factors in the process of founding a firm, and 3) performance outcomes for these firms. The outcomes, in terms of survival, employees, and revenues may result, in part from the first two sets of factors along with the influence from other differences in the legal and institutional contexts of the U.S. and China.

Table 12 examines some of the differences and similarities. In both cases, men appear much more likely than women to found firms. The Tsinghua entrepreneurs tend to be significantly younger than the non-entrepreneurs. This is likely due in part to the labor market changes in China where earlier generations were assigned to job positions and entrepreneurship was illegal. The cohort born in 1960 would have been 18 in 1978 when many of the economic

reforms began occurring. Most significantly, in 1988 the state officially recognized the growing number of private businesses (known in Mandarin as '*saying qiye*') with eight or more employees (Xu and Zhao, 2008) and made them legitimate.

Another significant difference is that those earning a master's degree were much more likely to become entrepreneurs in China compared to master's degree holders from MIT. Chapter 5 explores one institutional change in China that led to higher rates of entrepreneurship for those with Master's degrees. Another contributing factor may be Tsinghua alumni who went to the U.S. for their Master's degree and then were exposed to entrepreneurship there. Some of these individuals would have come back to China to found their firms. For both Tsinghua and MIT, doctorate degree holders are not significantly more (or less) represented among entrepreneurs. Both universities see the highest rates of entrepreneurship among the engineering and management alumni. There are high rates of entrepreneurship in the architecture graduates, however, this is due to the small firm partnership nature of that industry. A higher percentage of the Tsinghua engineering and social sciences graduates reported having founded firms. These differences appear to be driven mainly by differences between the universities in the chemical engineering alumni and the humanities. It is possible that the social sciences graduates are more less likely to found product-oriented firms, opting instead for services. If this holds up to further analysis, it might explain some of the differences in start-up factors and firm performance levels. Alternatively, it could be that these are the types of firms that the Chinese business environment is more suited to building.

It was surprising to find similar proportions of Tsinghua entrepreneurs becoming serial entrepreneurs with multiple firm foundings as has happened with the MIT alumni. We speculate that a higher percentage of the MIT serial entrepreneurship comes as a result of

successful firm acquisitions or IPO (simply become acquisition and IPOs have been rarer in China). Yet, future work is needed to confirm this as well as the implications for the availability of high quality mentors and investors for the next generation of entrepreneurs. Another surprising result is the fact that the Tsinghua non-entrepreneurs appear not to have been deterred by government intervention or cultural attitudes, but more by the lack of capital or good ideas for new businesses. Similar data are not available on the decisions of MIT non-entrepreneurs.

Next we turn to examine what affects the start-up process factors such as ideas, teams, innovation and financing. One of the rationales for choosing to study a sample of individuals trained at top technical universities was that these alumni are more likely to found technology-based firms. In theory, this should impose some desired similarity on the entrepreneurial process that the founders go through in creating their firms. Yet, in different countries, faced with different economic, legal and institutional environments, an intriguing possibility is that there is a different start-up process across companies. If we do see differences in the factors related to the process of founding a firm, then the question becomes one of whether these differences represent deviations from an ideal or optimal process. Alternatively, they may simply be appropriate differences influenced by idiosyncratic or unique characteristics of various entrepreneurial environments.

We begin with the entrepreneur's stated sources for the start-up idea. For both the MIT and Tsinghua entrepreneurs, we see a correlation where start-ups founded by a single individual tend to have one idea source and larger founding teams result in more diverse sources of the start-up idea. When we look at the specific idea sources, we also see a lot of similarities between the MIT and Tsinghua firms. In both countries, the most common source of the start-

up idea was work experience in industry. For both countries, the idea sources for more recent graduates are more likely to be from research or social networking rather than from work. However, there are also differences in the idea sources across the two university alumni groups. Fewer of the Tsinghua entrepreneurs got their ideas from work experience and more of them came from discussions with other students and visiting scientists or engineers. This difference may be due to graduate students getting ideas while studying in the U.S. or differences in the labor market in China. Historically many Chinese graduates worked in government or in public research institutes. While fewer Tsinghua alumni indicated getting the idea from work experience primarily, more comparable percentages indicated work as a secondary idea source. Another possibility is that many industries that have been present in the U.S. for many years, have only relatively recently and rather quickly come to China. Software and the internet are two examples that come to mind. If this scenario were true, then one could imagine that the opportunities for work experience in these new industries were rare, but yet the individuals still knew about possible opportunities through discussions with peers or from colleagues overseas.

The data show differences in the team sources that are interesting as well. Alumni from both schools tended to form companies primarily with co-workers. The Tsinghua entrepreneurs appear less likely to find their start-up ideas from work experience in industry and more likely to use social networking as well as family members rather than co-workers or lab members. This may be due to the nature of the state-owned enterprise system in which many of them had worked where political factors rather than customer demand may have been important. To the extent that teams from work experience tend to be more successful, the smaller proportion of Tsinghua cofounding teams from work experience and the relatively higher number from networking and family might be hurting performance. From previous

literature, we know that successful entrepreneurship tends to be more of a team activity than an individual activity. Examining the entrepreneurial teams assembled by MIT and Tsinghua alumni shows that team size is significantly larger for the Tsinghua firms. For MIT the mean team size is 2.15 (median=2) vs. 3.35 (median=3) for Tsinghua. However, this difference is largely due to the relative lack of single-founder teams in China with 38.03% of the MIT alumni firms being founded by 1 individual vs. 9.67% for Tsinghua. Perhaps this might be due to cultural differences commonly referred to as individualistic vs. collective. It may also be because the teams of Tsinghua entrepreneurs, especially those with only two cofounders appear to still be more in the family business model than the MIT alumni firms. This was consistent with our interviews as well which indicated that while things are rapidly changing, the family business model is still common in China. Family is particularly entrusted with keeping the books by some of the Tsinghua entrepreneurs we interviewed.

Some would argue that many of the MIT firms are likely to be doing work at the world's technological frontier, whereas the Chinese entrepreneurs are mostly adapting existing technologies to their markets. Yet the comparative data suggest that the situation may not be so simple and straightforward. Admittedly, innovation is a difficult concept to measure empirically. Both the Tsinghua and MIT entrepreneurs appear to be reporting that they rely on innovation (where innovation might be defined as something new for their country's market) at similar rates. Nonetheless, the most basic observation we found is that the levels of innovation depend on how the question is asked and the pattern of these differences appears to match the incentives facing the Tsinghua alumni entrepreneurs.

Perhaps most surprising, it appears that when patent-based measures of innovation are used, little innovation is occurring in the Tsinghua firms. However, once non-patent based

measures are examined, there is evidence for similar levels of innovation in the Tsinghua firms as in the MIT firms. While this may not be innovation at the world's cutting edge of technology, it nonetheless represents innovation in the eyes of these entrepreneurs and in comparison to their home market.

Of course, good entrepreneurial teams and ideas need capital to survive and expand. At first glance (much more detailed analysis is needed) the patterns of financing for the firms is similar overall. The savings of the founders is the single most frequently used source of early capital in both countries. It is clear that the Tsinghua firms raise lower amounts of initial capital than the MIT firms. It is difficult to know whether differences in the legal environment and financial institutions are leading to financial frictions and inefficiently lower amounts of capital being raised by the Tsinghua firms. An alternative explanation is that the types of entrepreneurs and firms being created do not need or merit larger amounts of capital. In our interviews, we asked many of the Tsinghua alumni entrepreneurs about the fundraising for their own firms and about their perceptions of the entrepreneurial finance environment in general. Many expressed frustration that it was extremely difficult to raise capital in China, particularly from domestic banks; however, the proportion of firms using loans from banks is similar across the two countries. Nonetheless, the Tsinghua alumni appear to be using money from friends and family or from supplier credit more frequently than the MIT firms. Heavy use of these sources could be interpreted as a sign of financial constraints or perhaps reflect cultural differences in regard to family ties. The Tsinghua entrepreneurs also tend to be much younger than the MIT entrepreneurs, so they may not have as much in personal savings on average.

In recent decades, the proportion of MIT firms raising money from angel investors or venture capitalists has increased and is higher than that proportion for Tsinghua firms. We do

see an increase in the use of venture capital among the MIT firms over the decades. It is likely that this is restricted to those firms that are raising large amounts of initial capital. Again, it is difficult to know from these data whether these forms of external capital are as yet unavailable to Tsinghua alumni or whether their firms do not fit the investment criteria. While we do not have similar data on the MIT firms, the Tsinghua survey data does tell us that while 25 firms obtained venture capital, 80 firms sought VC money. Similarly, 43 firms reported seeking angel investor funding, but only 22 received it.

Finally, what firm outcomes are created by the Chinese environment, founders and start-up factors as compared to the U.S. environment, founders and entrepreneurial process? The firms created by the MIT alumni appear to be larger and more successful in terms of revenues, employees, and liquidity events (acquisitions and IPOs). We begin by simply letting the data speak for themselves and showing the differences in firm outcomes along several dimensions. Then we discuss how to interpret the similarities and differences along with a few possible explanations of why we may be seeing the differences in performance that we do. At this stage, it is difficult to definitely trace the causes leading to lower firm performance for the Tsinghua firms. We will draw on some of our interview notes in suggesting possible explanations that seemed likely to the Tsinghua entrepreneurs and Chinese investors that we spoke with in China.

In terms of employees, there are similar proportions of MIT and Tsinghua firms represented at the very smallest sizes of 5-10 employees (and the larger 5,000 and above employee sizes). However, there are more MIT firms in the 500-750 size range and relatively more Tsinghua firms with 20-100 employees. However, the MIT alumni firms are significantly older than the Tsinghua firms.

Entrepreneurship was all but illegal in the earlier years of the Communist regime making older private firms very rare. Even after that time, foreign-invested firms and state-owned enterprises continued to be privileged in many ways and encouraged to grow larger than the emerging private enterprises. However, once we stratify by age, the Tsinghua firms are not significantly smaller in terms of the number of employees. In fact, among the firms younger than five or 10 years, the Tsinghua firms tend to have more employees. This result may be due to lower wage labor costs in China. Further analysis is needed to say for sure, however interviews with the Chinese entrepreneurs also indicated that this was the case. One pair of founders reported that they had located the firm in Shanghai rather than in the U.S. partially because of lower labor costs for scientists and lab space and that as a result they had been able to expand the lab much more quickly. They actually indicated that this had been a problem because the administrative infrastructure for the firm was having trouble keeping up with the growth in employees.

When we turn to look at revenues, the differences are even more pronounced in favor of the MIT alumni firms being larger. Two caveats apply to these statements. The first is the concern about the accuracy of the revenue figures. Respondents could be underreporting or biasing results in the opposite direction, they could be not responding if they have low revenues. Also, these results include privatized Chinese state-owned enterprises. Even though the government "grasped the big and let go of the small," still the privatized firms tend to be larger in terms of revenues and older than the newly founded firms.

Earlier in China's history, there were some geographic restrictions on trade across the provinces since the government wanted to build up industrial capacity in a dispersed manner across the country. Figure 19 shows that the proportion of out-of-state (U.S.) or out-of-

province (China) sales broken down by industry is very similar.[105] It appears from the initial evidence in Figure 19, that the Chinese firms are not significantly more geographically constrained in their sales than the U.S. firms. If smaller demand or more constrained markets are to explain the performance differences, the explanation would have to be for international sales or overall customer wealth. Per capita wealth levels differ dramatically with coastal regions and larger cities (Beijing and Shanghai) being more wealthy than inland/non-coastal areas. Mean and median revenues do not differ significantly for firms located in coastal areas (coastal mean= 4,378 RMB vs. non-coastal mean=5,034 RMB) or in Beijing and Shanghai (4,196 RMB) compared to those that are not (5,158 RMB). The initial evidence indicates that the geographic differences in individual wealth levels within China do not significantly drive firm revenue differences, casting doubt on the extent to which such economic differences across the countries might explain in large part the differences in firm outcomes across the countries.

Acquisitions and IPOs have been a relatively recent phenomenon in China. Accordingly, we see far fewer of these types of events in the Tsinghua firms. Our interviews indicated that Chinese managers and entrepreneurs have not adopted the serial entrepreneur style of their U.S. counterparts. Once a business is relatively successful, they would rather continue to run it than sell it and move on to another. Many Western investors have run into difficulties due to this cultural difference. The data show that there are similar relative proportions of serial entrepreneurs, but they appear to be serial entrepreneurs for different reasons and motivations.

Systematically determining the causes of cross-national differences in firm performance

[105] Only a handful of the Tsinghua alumni reported the percentage of sales from outside of China, so due to lack of sufficient number of observations, I do not show that comparison to the MIT alumni firms and their foreign sales.

is difficult and will require more sophisticated future analysis. However, we can begin to point out areas that appear to be important. The differences in firm performance appear to be the result of several factors; 1) differences in the types of individuals becoming entrepreneurs, 2) differences in factors related to the entrepreneurial process 3) differences in the legal and institutional environment, 4) differences in the economic environment (lower consumer demand in China, larger markets in the U.S.). It would be overly simplistic to claim that these four factors are independent of each other. Clearly, they are interrelated and feedback on one another. However, for clarity of discussion, we will review them one at a time, drawing on the previous chapters as well as the results discussed above.

First, there are slight differences in who tends to become an entrepreneur among the MIT and Tsinghua alumni. In particular, there have been changing trends over time that have been different in each country. As we discussed above, recently Tsinghua alumni with Master's degrees have been much more likely to found firms. These firms have had higher performance, but tend to be younger firms. The Tsinghua founders tend to be younger on average as well and higher percentages of Tsinghua humanities majors found firms than is true for MIT alumni.

Second, we found that there are some significant differences in the factors related to the entrepreneurial process, including the sources of ideas and teams, innovation, and fundraising. Some of the differences in the sources of ideas and teams appear to be contributing to lower performance of Tsinghua firms. However there do not appear to be large differences in the proportion of firms using innovation strategies (though there are higher levels of R&D spending for the MIT firms) or specific capital sources. There is some evidence of capital constraints for the Tsinghua firms, but there is not strong evidence that financial constraints are

significantly to blame for the smaller size of the Tsinghua firms.

Third, we should expect that a large part of these differences are due to differences in the legal and institutional or policy environments for business between the two countries. Chapter 3 reviewed the massive policy changes in China related to entrepreneurship shifting from an activity that was illegal to one that is actively supported and encouraged. Chapter 5 explored in one particular institutional change, that through lowering barriers to growth, encouraged more highly educated individuals to become entrepreneurs and larger, more successful firms to be created.

Finally, while our data do not speak directly to the economic differences between China and the U.S., it is clear that these are two countries at very different stages of economic and market development. There is a large middle class in the U.S. with significant disposable income, whereas China has a few well-developed cities, but large rural areas where people's livelihoods are largely the same as they have been for centuries. On the whole the GDP per capita in China was under $5,000 (constant PPP$) whereas that figure in the U.S. was $35,000 (constant PPP$).[106] These differences in wealth and market demand should be expected to lead to differences in the performance and size of the firms located in China (perhaps even the start-up process factors) even if all else was equal.

To conclude, it appears that much is similar in terms of the characteristics of entrepreneurs and the start-up process factors between the MIT and Tsinghua alumni. Nonetheless, there are some relatively subtle differences that in combination with the differences in the environment for entrepreneurial firms and the institutional history of China have led to vastly different outcomes for the entrepreneurial firms from MIT and Tsinghua.

[106] OECD website, accessed May 29, 2009 (http://www.oecd.org/statsportal/0,3352,en_2825_293564_1_1_1_1_1,00.html).

This comparative analysis has so far left relatively unexplored the causal mechanisms through which the factors that affect who becomes an entrepreneur can both lead to differences in factors related to the start-up process as well as firm outcomes. Yet, it does seem clear that the shorter time frame in which entrepreneurial activity has been occurring in China results in a younger, smaller set of entrepreneurial firms. Similarly, the younger age of Tsinghua entrepreneurs contributes to a different mix of idea and team sources (fewer from work experience) that might also partially explain the differences in firm outcomes. The mix of funding sources and proportions of firms relying on technological innovation are strikingly similar. While firm size in terms of employees is roughly similar, the MIT firms are much larger in terms of revenues than the Tsinghua firms. We hope that this study represents a step towards a better understanding of international differences in technology entrepreneurship.

Figures and Tables

Figure 1

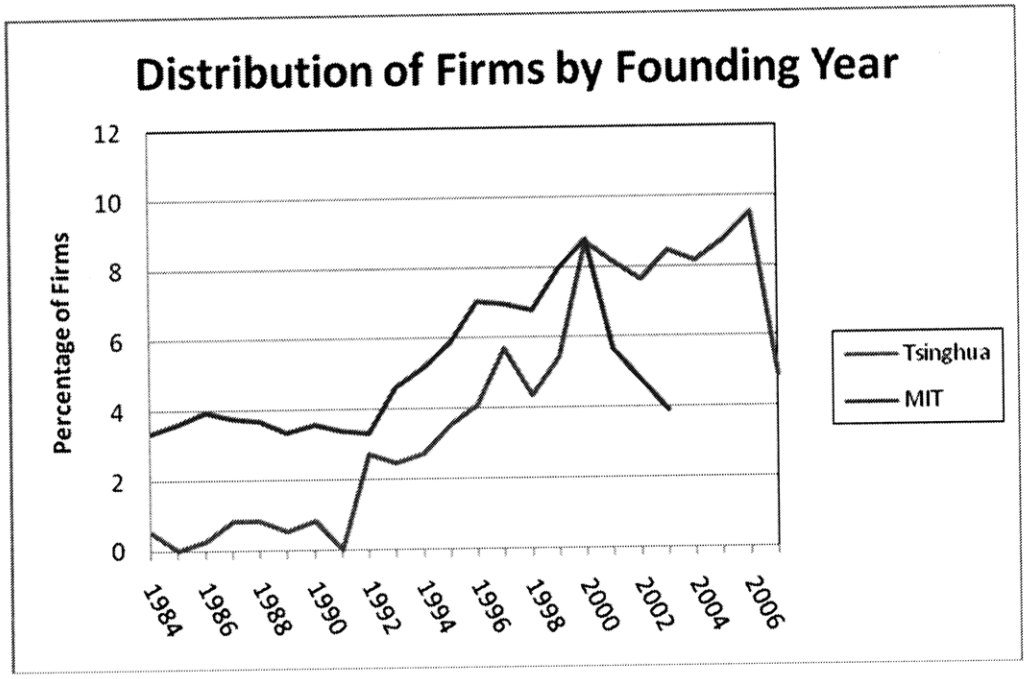


Figure 2

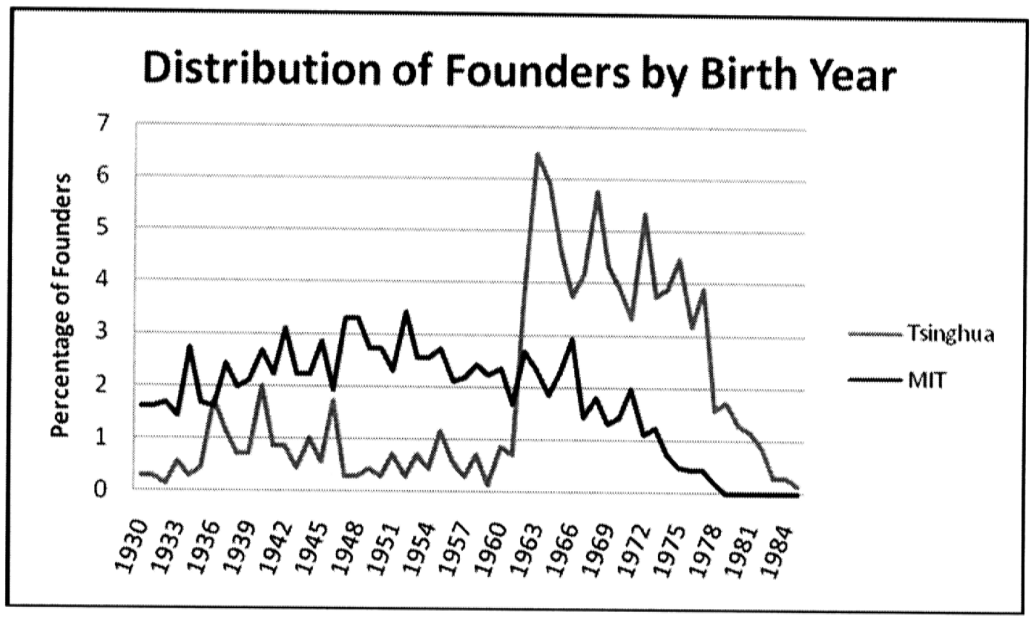

Distribution of Founders by Birth Year
Percentage of Founders
0
1
2
3
4
5
6
7
1930
1933
1936
1939
1942
1945
1948
1951
1954
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
Tsinghua
MIT

Figure 3
Tsinghua

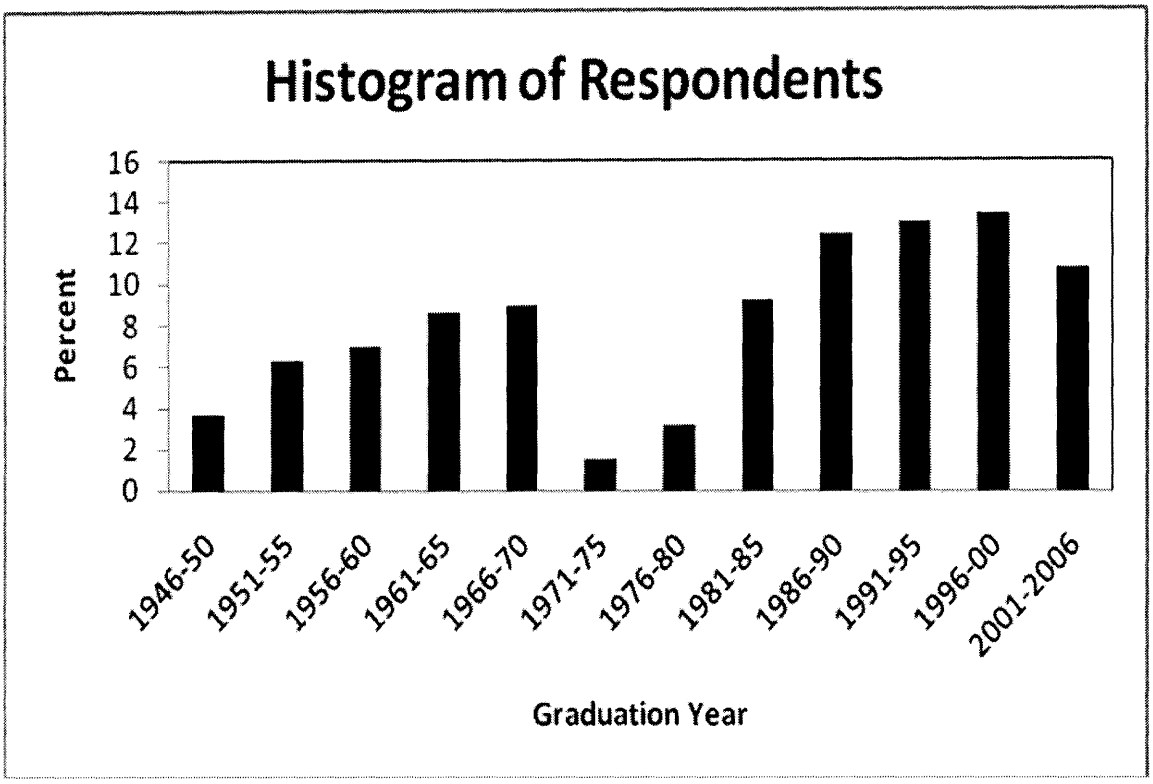


Figure 4
Tsinghua

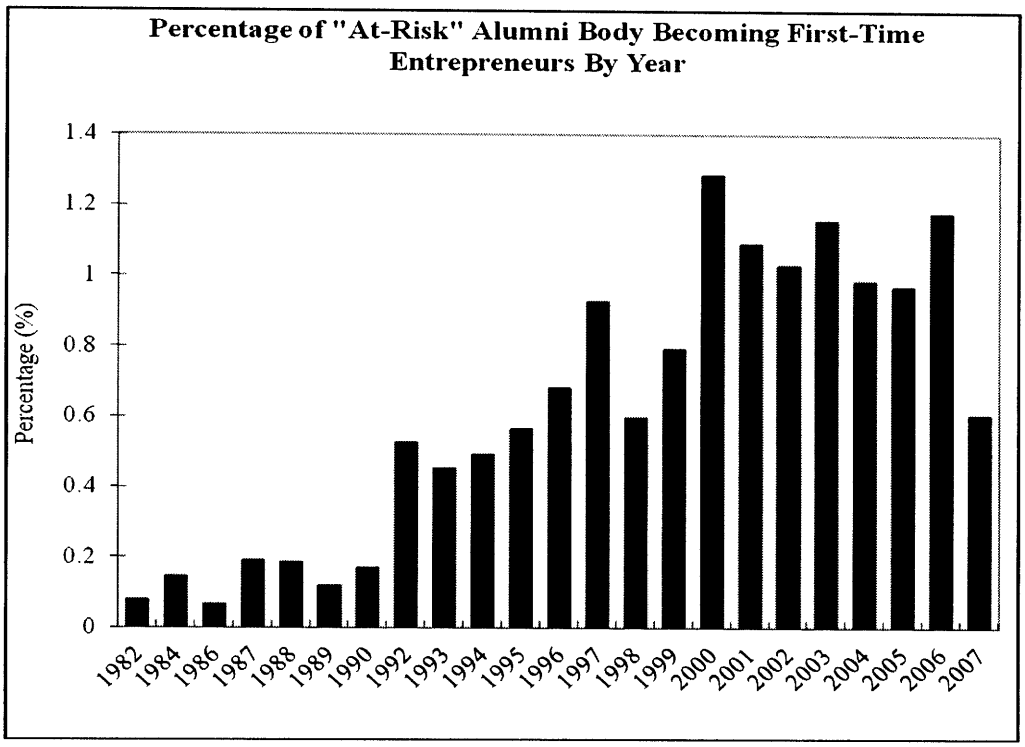
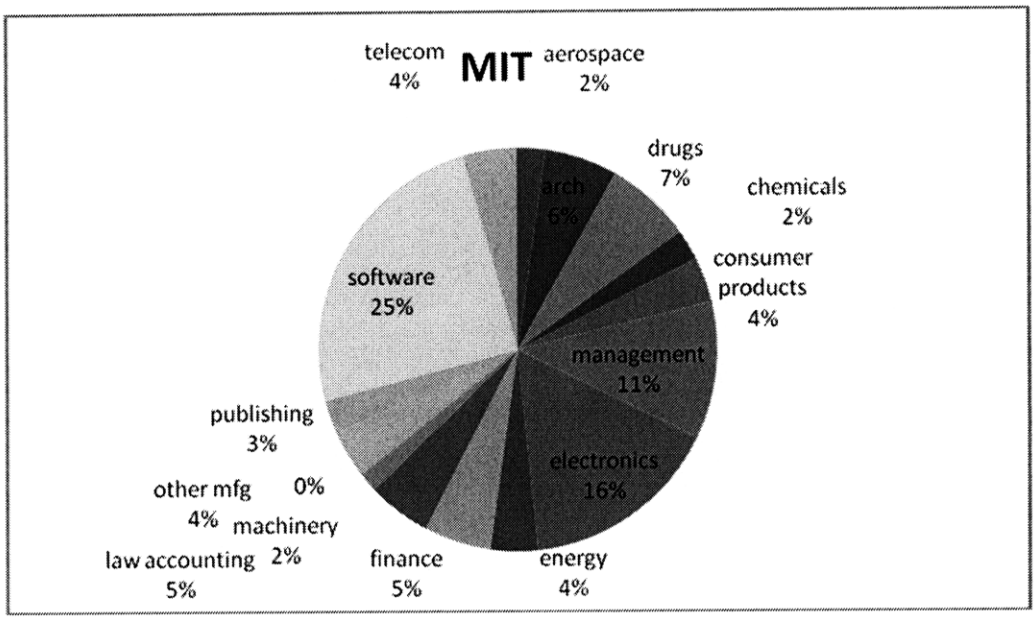


Figure 5
Industries



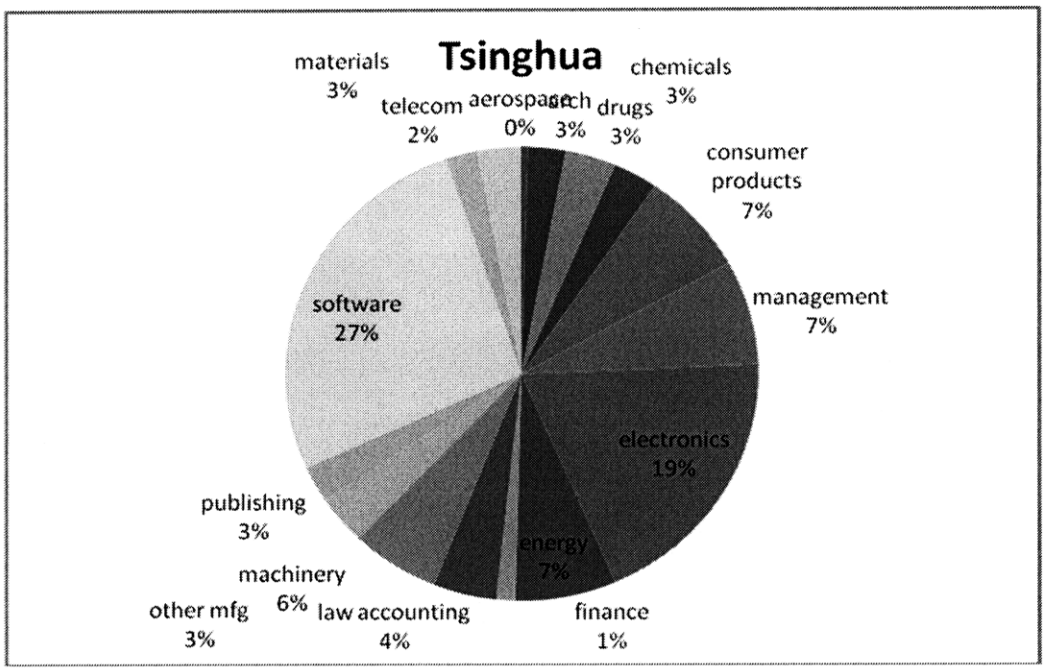


Figure 6

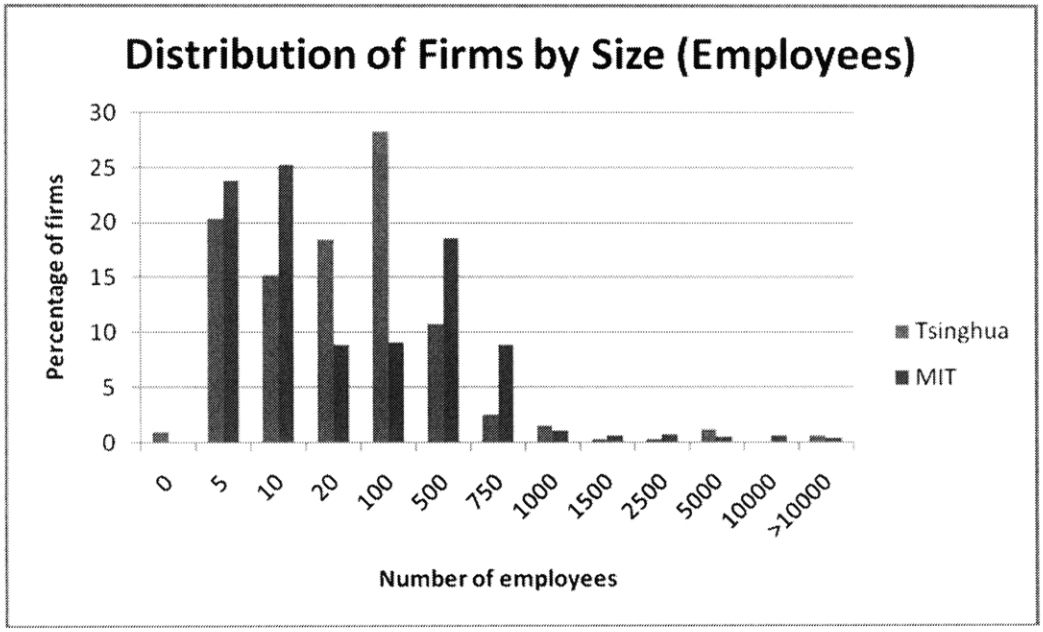

Distribution of Firms by Size (Employees)
Percentage of firms
30
25
20
15
10
5
0
0
5
10
20
100
500
750
1000
1500
2500
5000
10000
>10000
Number of employees
Tsinghua
MIT

Figure 7a: MIT

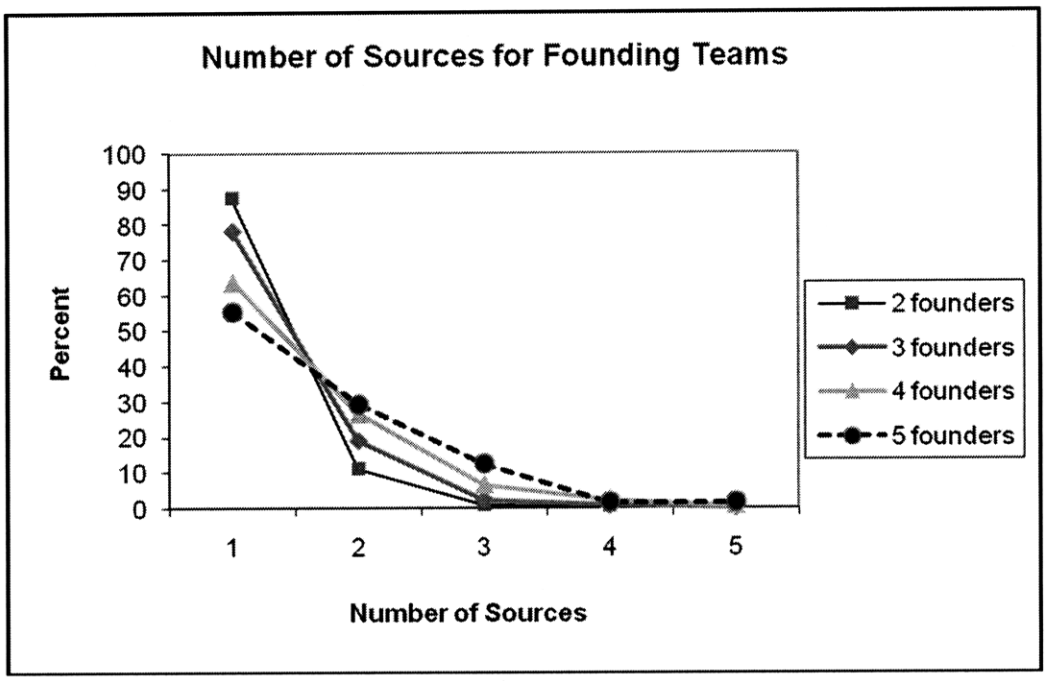


Figure 7b: Tsinghua

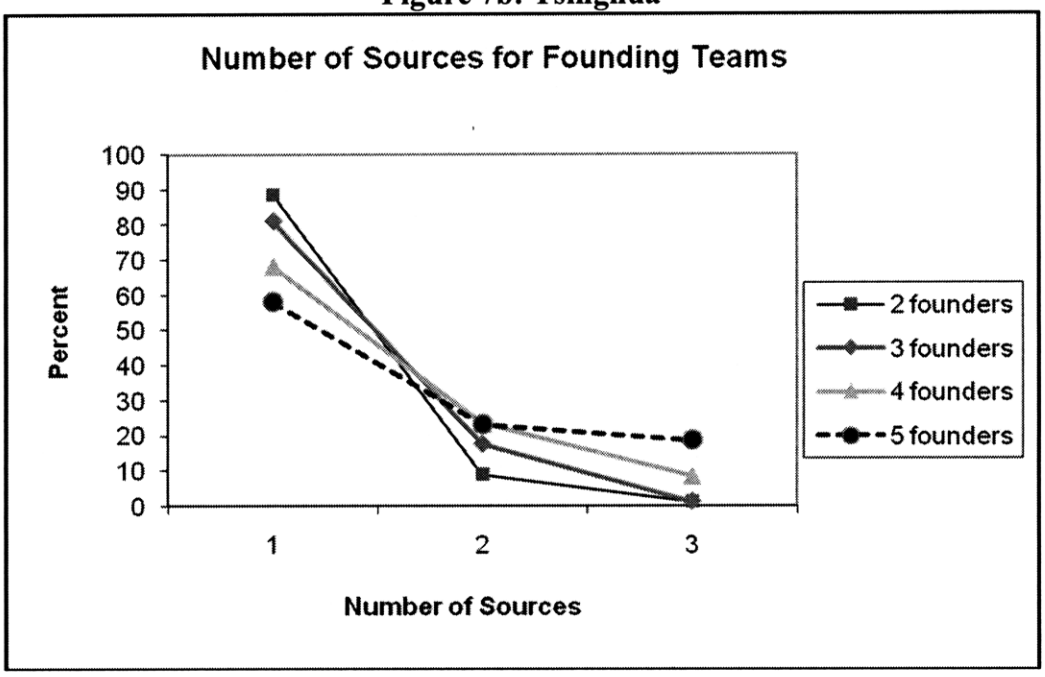


Figure 8a: MIT

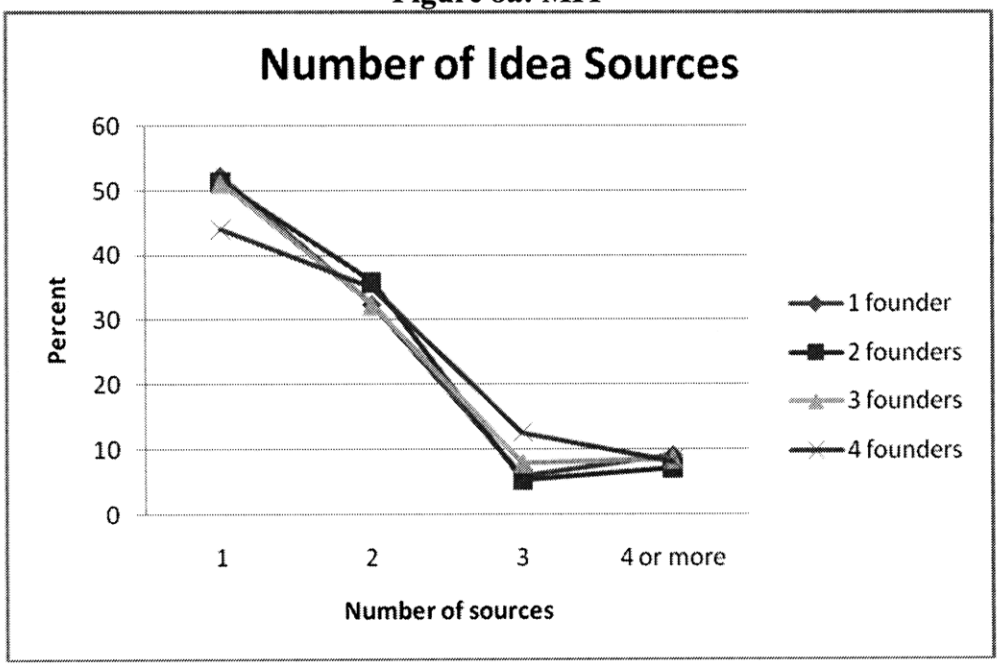


Figure 8b: Tsinghua

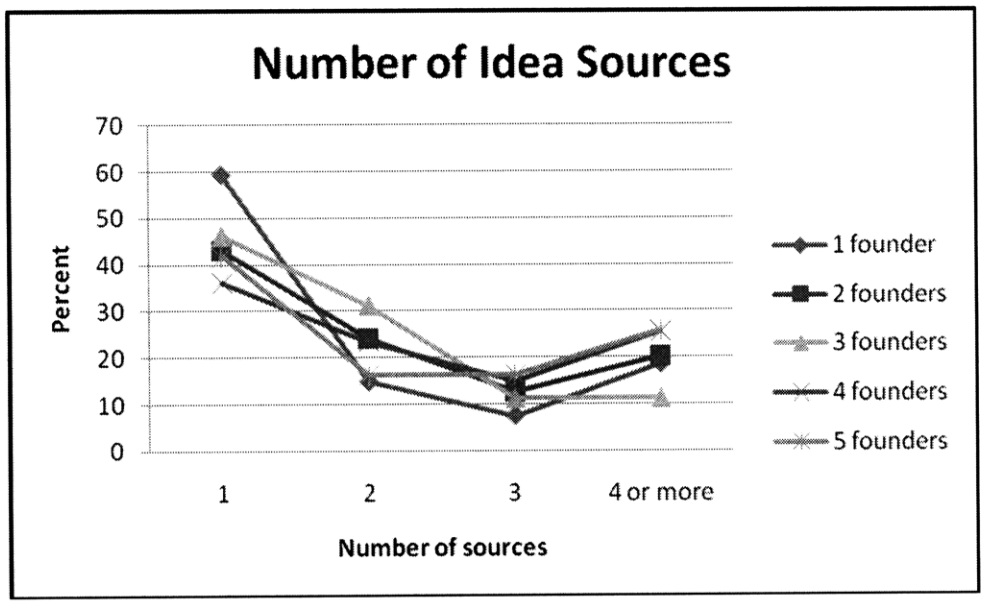


Figure 9a
Primary and Secondary Idea Sources

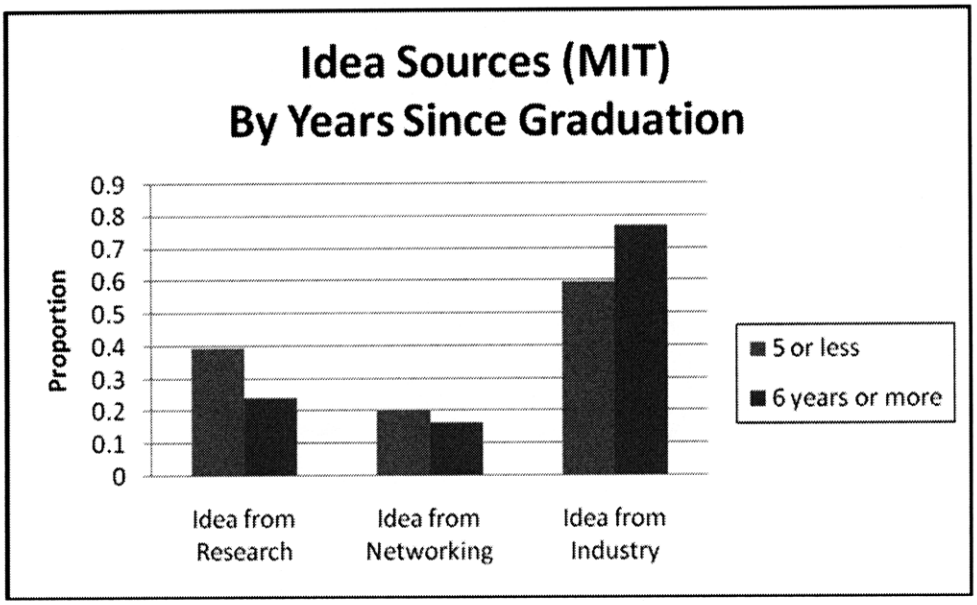


Figure 9b
Primary and Secondary Idea Sources

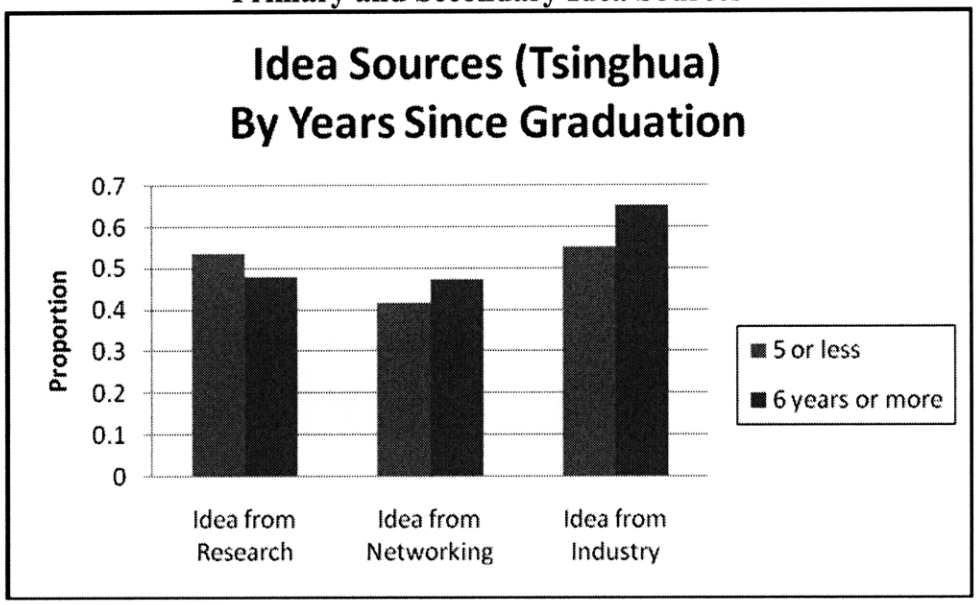


Figure 10a

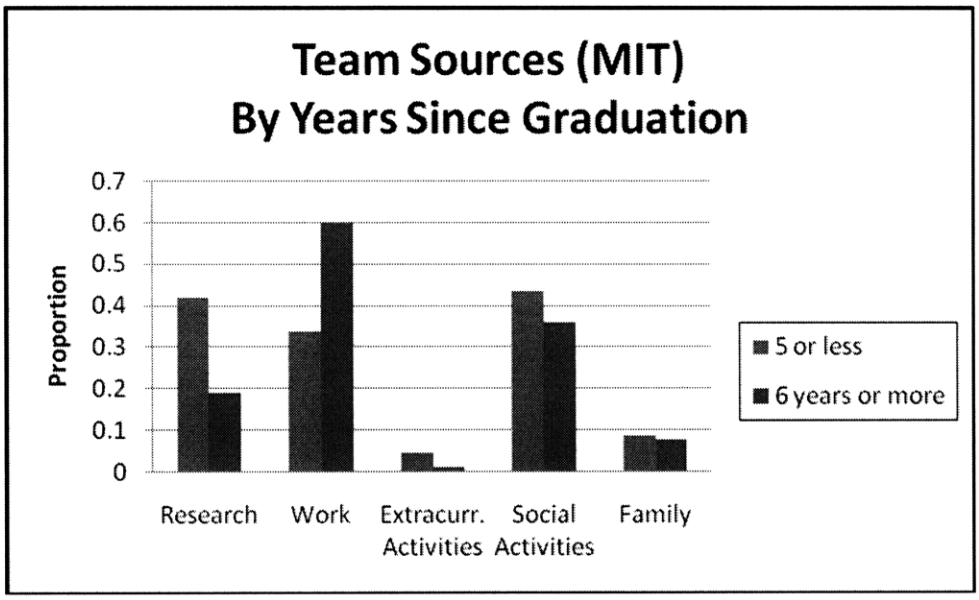


Figure 10b

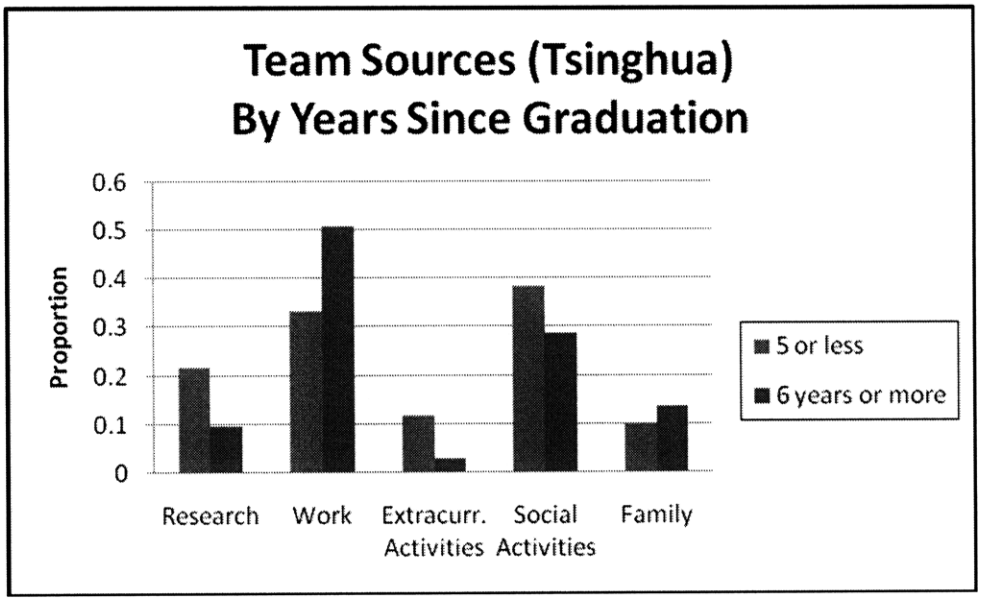


Figure 11
MIT

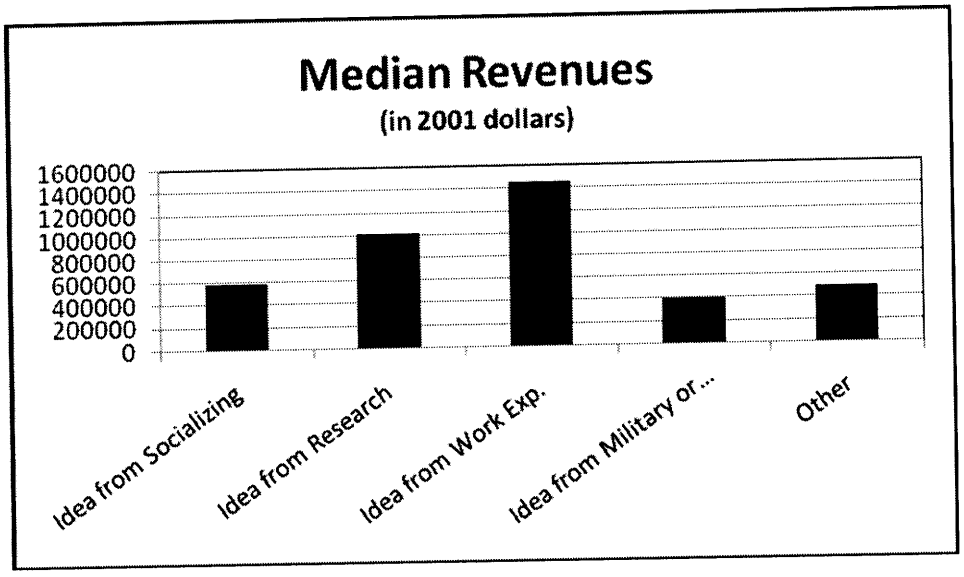


Figure 12

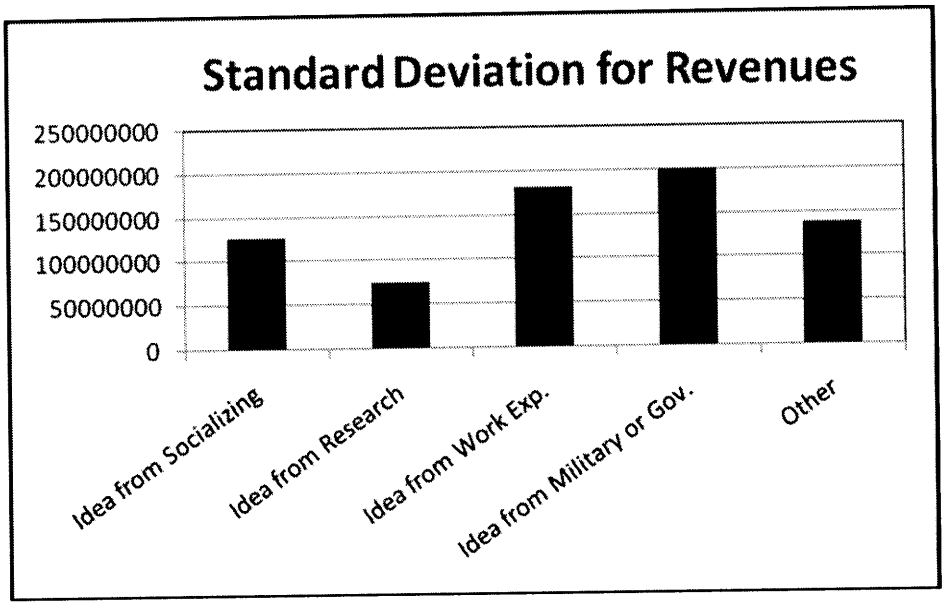
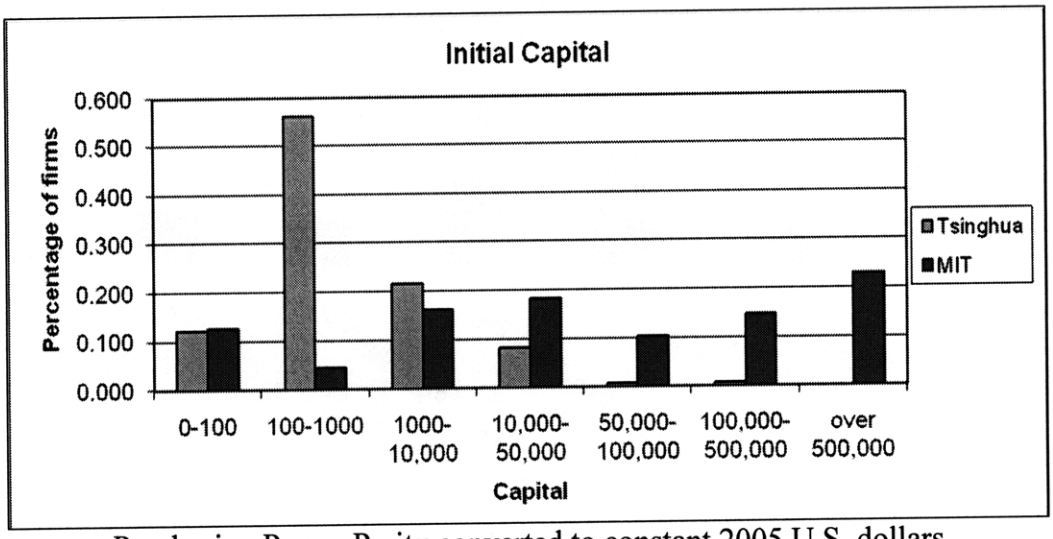


Figure 13



Purchasing Power Parity converted to constant 2005 U.S. dollars

Figure 14a
MIT

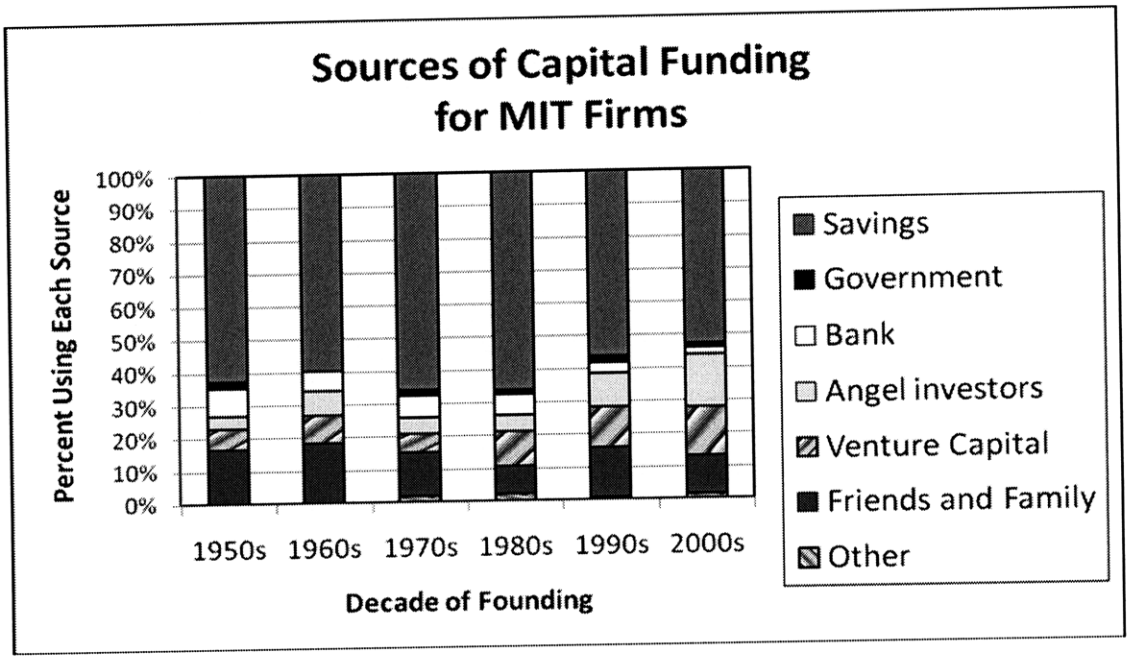


Figure 14b
Tsinghua

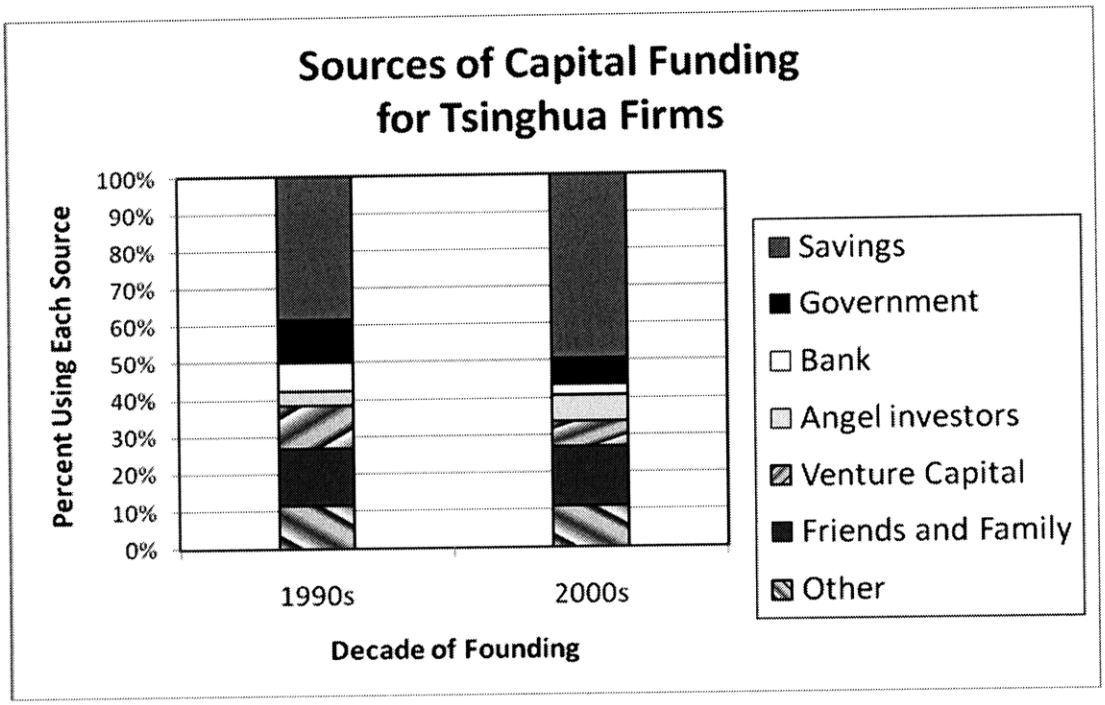


Figure 15

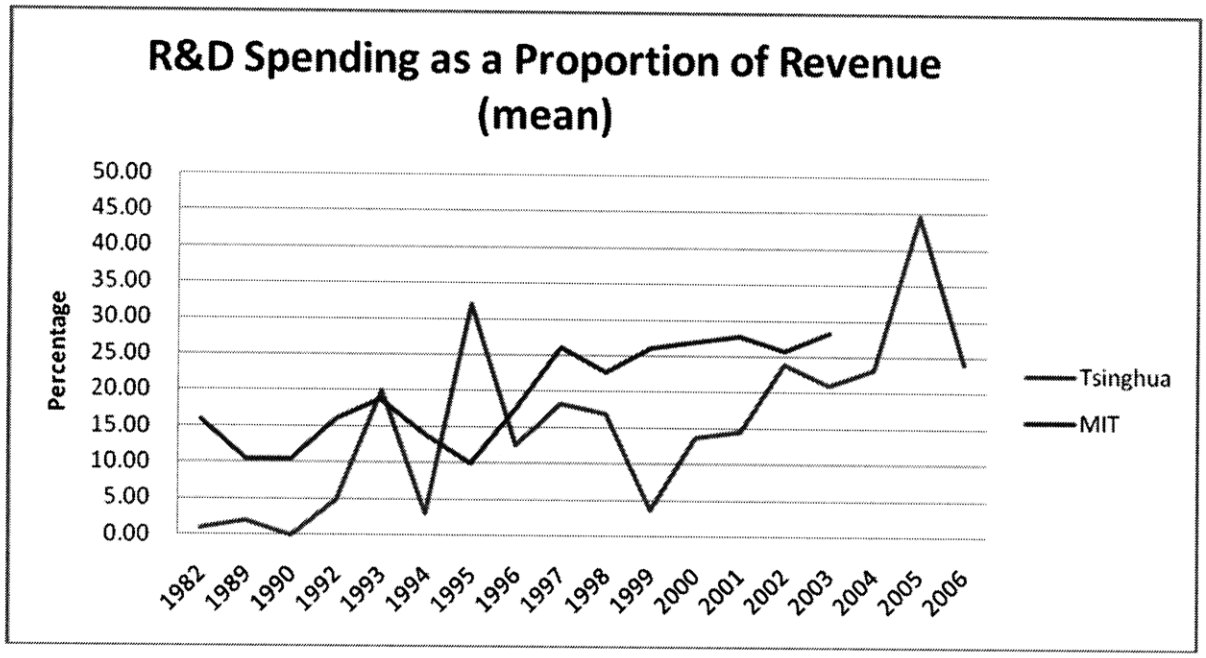

R&D Spending as a Proportion of Revenue (mean)
Percentage
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1982
1989
1990
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Tsinghua
MIT

Figure 16
Tsinghua

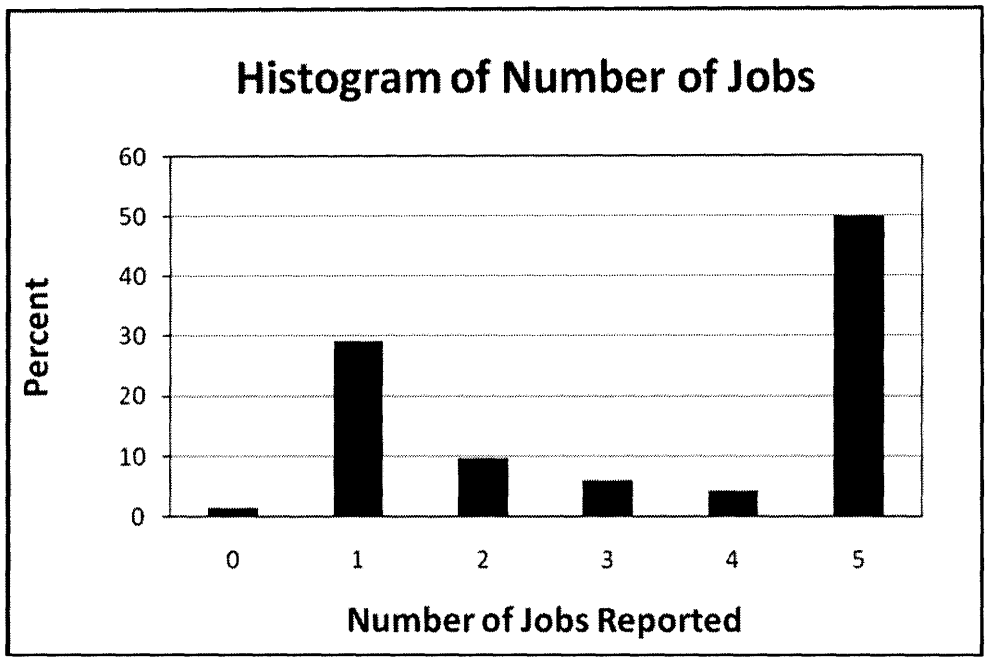


Figure 17

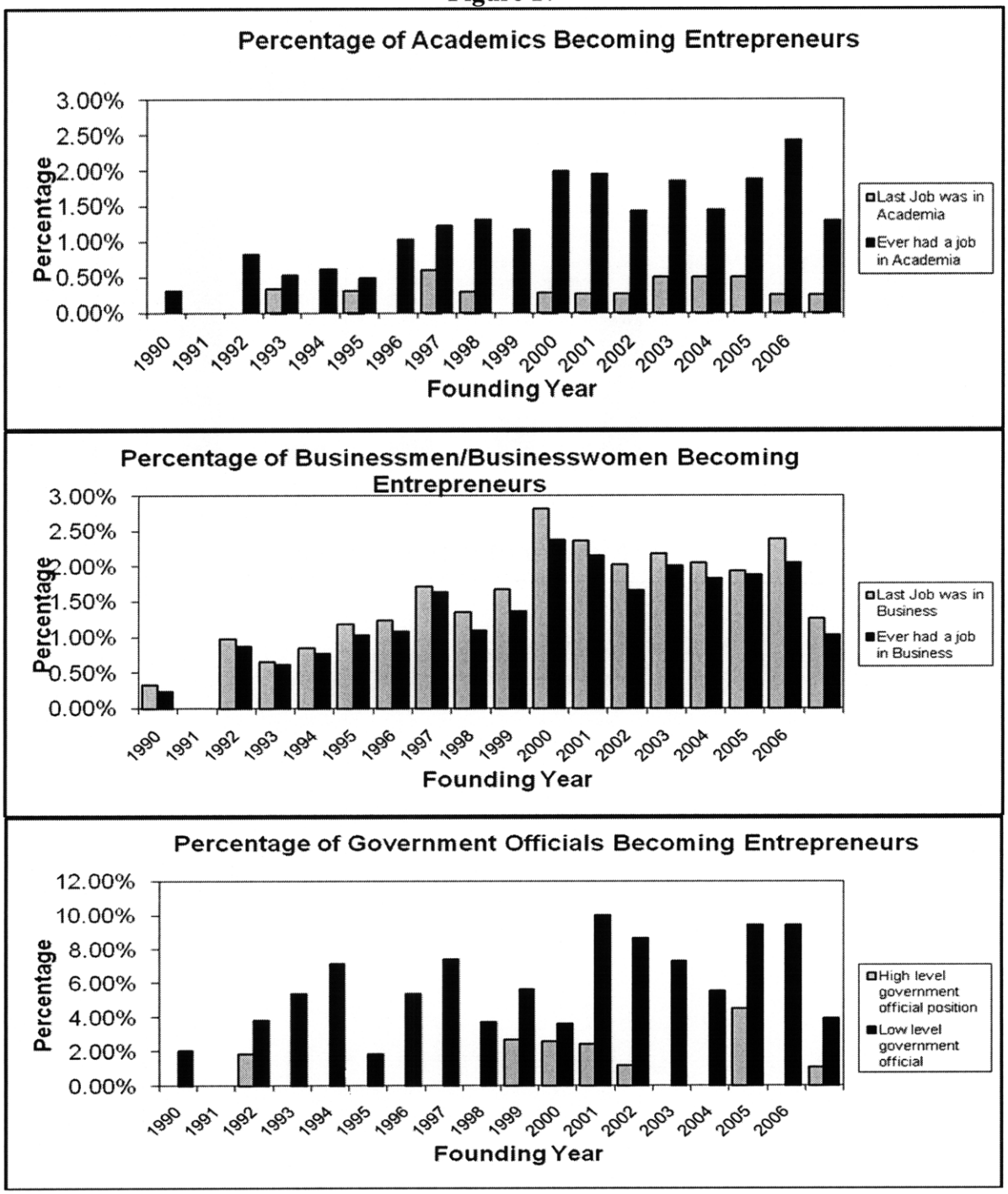

Percentage of Academics Becoming Entrepreneurs
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
Percentage
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Founding Year
Last Job was in Academia
Ever had a job in Academia
Percentage of Businessmen/Businesswomen Becoming Entrepreneurs
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
Percentage
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Founding Year
Last Job was in Business
Ever had a job in Business
Percentage of Government Officials Becoming Entrepreneurs
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Percentage
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Founding Year
High level government official position
Low level government official

Figure 18

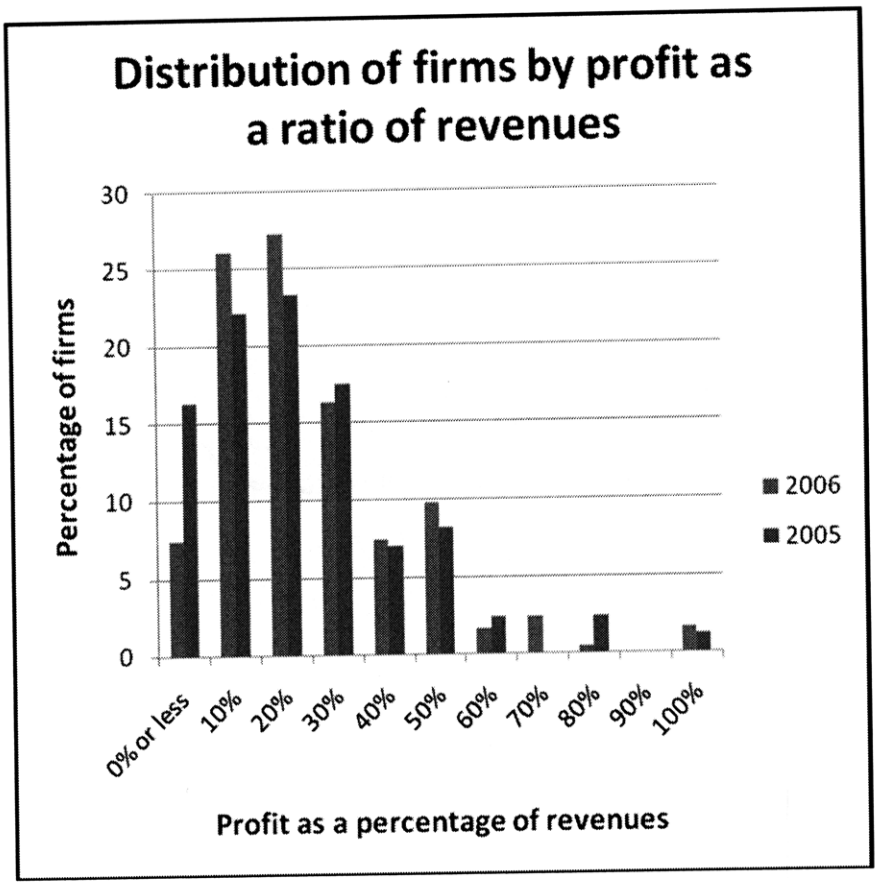

Distribution of firms by profit as a ratio of revenues
Percentage of firms
30
25
20
15
10
5
0
0% or less
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Profit as a percentage of revenues
2006
2005

Figure 19

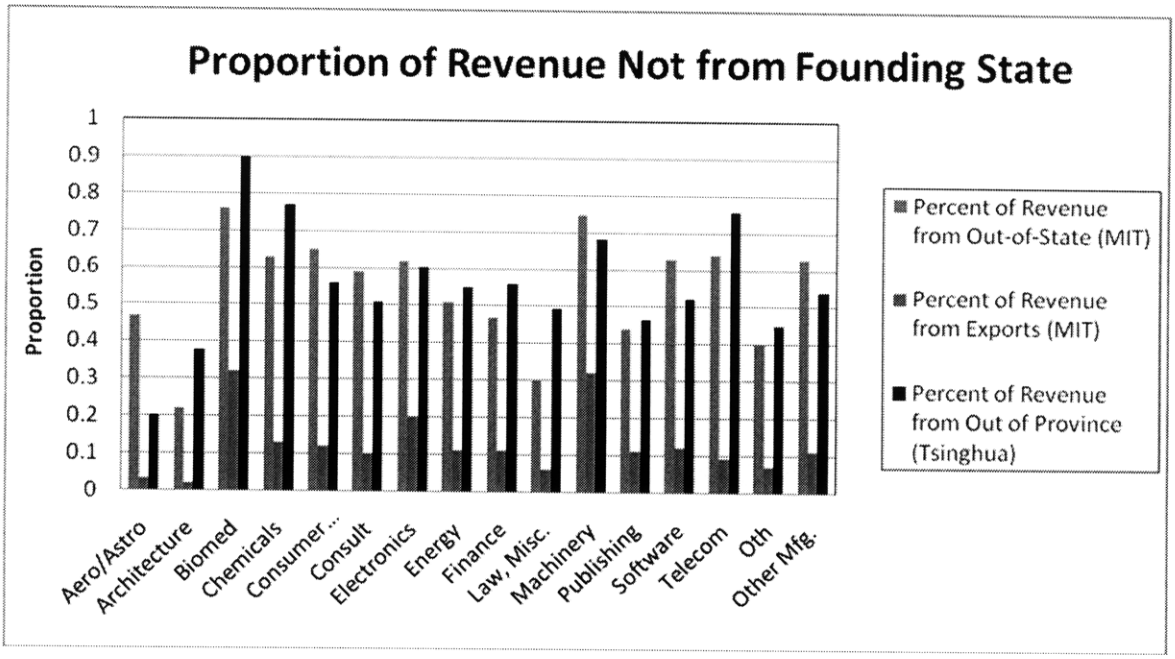

Proportion of Revenue Not from Founding State
Proportion
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Aero/Astro
Architecture
Biomed
Chemicals
Consumer ...
Consult
Electronics
Energy
Finance
Law, Misc.
Machinery
Publishing
Software
Telecom
Oth
Other Mfg.
Percent of Revenue from Out-of-State (MIT)
Percent of Revenue from Exports (MIT)
Percent of Revenue from Out of Province (Tsinghua)

TABLE 1
Pair-wise Correlations MIT

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	log revenues	1.00																	
2	log employees	0.76	1.00																
3	log years survival	0.30	0.23	1.00															
4	public	0.49	0.42	0.15	1.00														
5	acquired	0.24	0.20	0.16	0.27	1.00													
6	funcational diversity	0.11	0.17	0.03	0.16	0.12	1.00												
7	role_faculty	0.11	0.06	0.10	0.05	0.04	0.06	1.00											
8	role research	0.05	0.07	0.07	0.09	-0.01	0.05	-0.06	1.00										
9	role_groups	-0.03	-0.05	0.04	0.00	-0.06	-0.06	0.05	0.05	1.00									
10	idea from work	0.07	0.02	-0.01	0.00	0.02	0.03	-0.07	-0.15	-0.04	1.00								
11	idea from social	-0.04	-0.03	-0.05	-0.01	0.02	-0.03	0.10	-0.05	0.03	-0.48	1.00							
12	idea from research	0.03	0.06	0.03	0.04	0.01	0.05	0.03	0.26	0.03	-0.46	-0.15	1.00						
13	idea from other	-0.08	-0.04	0.02	-0.05	-0.04	-0.05	-0.03	-0.01	-0.02	-0.39	-0.13	-0.12	1.00					
14	idea from military/gov.	-0.06	-0.05	-0.01	0.02	-0.05	0.01	-0.01	0.01	0.00	-0.22	-0.07	-0.07	-0.06	1.00				
15	team via work	0.14	0.09	0.06	0.02	-0.03	0.06	0.02	-0.14	0.06	0.31	-0.07	-0.22	-0.21	0.05	1.00			
16	team via research	0.02	0.00	-0.03	0.00	0.01	-0.05	0.04	0.19	-0.06	-0.29	-0.03	0.39	0.03	-0.03	-0.47	1.00		
17	team via social	-0.06	-0.04	-0.07	0.05	0.08	0.03	0.06	0.00	-0.18	-0.10	0.12	-0.03	0.12	-0.06	-0.43	-0.09	1.00	
18	team via extracurricular	-0.06	-0.05	-0.03	-0.04	0.01	-0.03	-0.04	-0.04	0.04	-0.09	0.05	0.05	0.05	-0.02	-0.10	0.05	0.00	1.00

TABLE 2
Pairwise Correlations Tsinghua

		1	2	3	4	5	8	9	10	11	12	13	14	15	17	18	19	20	21
1	*Last job academia*	1																	
2	*Last job business*	-0.618	1																
3	*High government*	-0.051	-0.080	1															
4	*Low government*	-0.102	-0.385	-0.105	1														
5	*Ever job academia*	-0.425	-0.085	-0.009	-0.056	1													
8	*Number of Positions*	-0.149	-0.175	-0.011	0.036	-0.135	1												
9	*Avg. Tenure*	-0.047	-0.088	-0.036	-0.077	-0.117	-0.060	1											
10	*Gender*	-0.046	-0.047	-0.029	-0.007	-0.008	-0.120	-0.032	1										
11	*Entrepreneur Parents*	-0.041	-0.002	-0.018	-0.004	-0.058	-0.054	-0.048	-0.016	1									
12	*High Salary*	-0.138	-0.320	-0.050	-0.180	-0.158	-0.284	-0.305	-0.057	-0.009	1								
13	*Family economic status*	-0.030	-0.018	-0.004	-0.030	-0.054	-0.081	-0.098	-0.154	-0.115	-0.196	1							
14	*Student Leader*	-0.009	-0.028	-0.011	-0.051	-0.011	-0.075	-0.130	-0.010	-0.043	-0.144	-0.070	1						
15	*Communist Party*	-0.002	-0.092	-0.019	-0.114	-0.043	-0.011	-0.071	-0.034	-0.037	-0.070	-0.037	-0.008	1					
17	*Master's*	-0.037	-0.053	-0.025	-0.032	-0.103	-0.119	-0.278	-0.013	-0.014	-0.317	-0.090	-0.234	-0.092	1				
18	*PhD*	-0.273	-0.176	-0.021	-0.022	-0.114	-0.017	-0.114	-0.030	-0.040	-0.121	-0.040	-0.142	-0.025	-0.215	1			
19	*Overseas Experience*	-0.029	-0.088	-0.013	-0.101	-0.030	-0.093	-0.083	-0.009	-0.059	-0.240	-0.097	-0.076	-0.044	-0.147	-0.130	1		
20	*Bachelor's Grad Year*	-0.159	-0.268	-0.027	-0.136	-0.014	-0.098	-0.433	-0.031	-0.083	-0.460	-0.104	-0.242	-0.130	-0.457	-0.160	-0.232	1	
21	*Age*	-0.154	-0.273	-0.028	-0.142	-0.023	-0.099	-0.438	-0.036	-0.087	-0.475	-0.117	-0.236	-0.136	-0.471	-0.171	-0.240	-0.989	1

TABLE 3
MIT: Summary Statistics and Variable Definitions (for main sample used in analysis, founded between 1950-1998)

VARIABLE[107]	DEFINITION	MEAN	SD
Dependent variables			
Public	Dummy = 1 if venture went public by '03	0.16	0.37
Acquired	Dummy = 1 if venture was acquired by '03	0.26	0.44
L years survival	Number of years in operation	2.74	0.65
L Employees	Number of employees	3.40	2.10
L Revenues	Inflation adjusted Revenues in $M	1.78	1.73
Used VC	Dummy = 1 if venture received VC funding	0.13	0.33
Basic venture characteristics			
Year founded	Year in which a venture was founded	1988.59	11.86
Number of cofounders	Count of the number of cofounders	0.99	1.23
Total team sources	Count of the number of team sources listed	1.34	0.61
Total secondary idea sources	Count of the number of secondary idea sources	0.77	1.24
US located	Dummy = 1 if located in the US	0.92	0.28
Massachusetts	Dummy = 1 if located in Massachusetts	0.31	0.46
California	Dummy = 1 if located in California	0.18	0.39
Human asset (team) formation characteristics			
Functional diversity	Count of the number of distinct functions (sales, marketing, engineering, etc.) on the founding team	1.22	0.47
Role of MIT Faculty	Dummy = 1 if MIT faculty played a role	0.05	0.22
Team met via work	Dummy = 1 if the venture team met through work	0.54	0.50
Team met via research	Dummy = 1 if the venture team met through research	0.22	0.41
Team met via socializing	Dummy = 1 if the venture team met through social networking	0.37	0.48
Team met via extracurriculars	Dummy = 1 if the venture team met through extracurricular activities	0.02	0.13
Team met via family	Dummy = 1 if the venture team was related	0.09	0.29
Num. prior foundings	Count of the number of prior foundings	1.35	0.71
Num. prior acquired	Count of the number of prior foundings resulting in an acquisition	0.13	0.41
Non-human asset (idea) formation characteristics			
Role of MIT Research	Dummy = 1 if MIT research played a role	0.05	0.23
Role of MIT groups	Dummy =1 if MIT groups played a role	0.09	0.29
Idea from work	Dummy = 1 if the venture idea arose through working in industry	0.60	0.49
Idea from socializing	Dummy = 1 if the venture idea arose through social networking	0.14	0.34
Idea from research	Dummy = 1 if the venture idea arose through research	0.13	0.33
Idea from military/govt.	Dummy = 1 if the venture idea arose through military or government experience	0.03	0.18
Idea from other source	Dummy = 1 if the venture idea arose through some other source	0.10	0.29
Held at least 1 patent	Dummy = 1 if held at least 1 patent	0.25	0.44

[107] "L" preceding the variable name in the regression tables denotes natural log.

TABLE 4
Summary Statistics and Variable Definitions (MIT)

VARIABLE[108]	DEFINITION	MEAN	SD
First start-up founded	Year in which first firm was founded (censored if not observed by 2003)	1985.10	12.30
Second start-up founded	Year in which second firm was founded (censored if not observed by 2003)	1989.96	10.43
Individual Characteristics			
Graduation year	Year of MIT graduation	1973.2	15.04
Bachelor's Degree	=1 if highest degree	0.43	
Master's Degree	=1 if highest degree	0.41	
Doctorate Degree	=1 if highest degree	0.16	
Male	Dummy = 1 if the individual is male	0.93	--
Academic major	Set of dummies for academic major: engineering (53%), management (14%), social science (5%), architecture (4%), and natural science (the excluded category)		
Country of citizenship	Set of dummies for country of citizenship: Latin America (2%), Asia (7%), Europe (6%), Middle East (1%), Africa (1%) or North America (the excluded category)		
First Firm Level Characteristics			
Age at 1st firm founding	Age of the entrepreneur the year the first firm was founded	37.5	10.27
Recession Year	Dummy = 1 if the firm was founded during a recession year as categorized by the NBER.	0.22	0.41
Lag to First Firm	Lag (in years) from graduation to the first firm founding	14.28	9.95
VC funded	Dummy = 1 if the firm received venture capital funding	0.14	0.35
Angel funded	Dummy = 1 if the firm received funding from angel investors	0.09	0.29
L Initial Capital	Capital "raised to get the company off the ground"	11.97	2.71
Acquired	Dummy = 1 if the firm was acquired	0.21	0.41
Public	Dummy = 1 if the firm had an IPO	0.13	0.33
L Revenues	Firm revenues for a specific year	14.24	3.03
# Cofounders	Number of cofounders	2.15	1.78
Out of Business	Dummy = 1 if the firm closed	0.33	--
Operating Years	Number of years the firm has been in operation	15.27	12.01

[108] "L" preceding the variable name in the regression tables denotes natural log.

TABLE 5
Summary Statistics and Variable Definitions (Tsinghua)

VARIABLE	DEFINITION	MEAN	SD
Panel A: Individual-level measures (Tsinghua data, entrepreneurs only)			
Work in R&D	=1 if the individual held an R&D position	0.60	-
Work as Tech Manager	=1 if the individual held a technical manager position	0.71	-
Ever job in Academia	=1 if the individual has held an academic job	0.23	-
Overseas Experience	=1 if the individual traveled outside of China for education or work	0.21	-
Master's degree	=1 if the individual was an entrepreneur	0.59	-
Ph.D. degree	=1 if parents were entrepreneurs	0.09	-
Graduation year	Year of graduation (Bachelor's)	1990.1	9.69
Family economic status	Family's economic status in China during college, 4=top 10%, 3=top 10-25%, 2=top 25-50%, 1=bottom 50%	3.63	1.01
Age	= Individual's age	40.03	9.86
Gender	=1 if male	0.94	-
Communist Party	=1 if member of the Chinese Communist Party	0.54	-
Panel B: Firm-level measures (Tsinghua)			
First start-up founded	Year in which first firm was founded (censored if not observed by 2007)	2000.38	5.20
Firm age	Age of the firm	4.12	3.69
Employees	= Number of employees in the most recent year in operation	628.43	6424.94
R&D / Revenue	Firm R&D expenditures as a percentage of revenues	22.36	37.21
Initial Capital	Capital registered with the government at time of founding (China) (converted to USD and PPP, IMF 2005)	2005.88	10391.42
Venture capital funded	=1 if funding was received from venture capital	0.07	-
Angel investor	=1 if funding was received from angel investors	0.07	-
Funded Num. cofounders	= Number of cofounders	3.35	1.85
Privatized	=1 if firm was privatized	0.06	-
Panel C: Macro-economic measures (China)			
stock exchange market cap	Shanghai stock market capitalization	11185.18	39921.34
VC disbursements	Venture capital disbursements (Asian Venture Capital Journal)	807.29	657.77
R&D expenditure	Total public R&D expenditures (in 100M RMB, converted for PPP to constant USD, Zheng, 2006)	484.36	747.96
total SE pubs	Total number of scientific and engineering publications in that year	12414	7325.87
GDP	Gross Domestic Product (Purchasing Power Parity, IMF, constant dollars)	109184	177895.9

TABLE 6
Summary Statistics and Variable Definitions (Tsinghua)

VARIABLE	DEFINITION	MEAN	SD
Panel A: Firm and Individual-level measures			
First start-up founded	Year in which first firm was founded (censored if not observed by 2007)	2000.38	5.20
Firm age	Age of the firm	3.50	2.44
Privatized	=1 if firm was privatized	0.10	0.47
Entrepreneur	=1 if the individual was an entrepreneur	0.26	0.46
Entrepreneur Parents	=1 if parents were entrepreneurs	0.09	0.29
Graduation year	Year of graduation (Bachelor's)	1980.66	17.80
Family economic status	Family's economic status in China during college, 4=top 10%, 3=top 10-25%, 2=top 25-50%, 1=bottom 50%	3.78	18.35
Age	Individual's age	49.82	0.32
Gender	Dummy = 1 if male	0.88	
Panel B: Work history-level measures			
Recent Salary	Most recent pre-founding salary (5 categories)	3.32	1.43
Avg. Tenure	Average number of years in each job	7.11	9.45
Number of Positions	Number of different positions (R&D, sales & marketing, general manager, etc.) that were held	2.37	1.26
High government	=1 if ever had job in government (minister, province,	0.03	0.17
Low government	Bureau or municipal levels	0.17	0.38
Last job academia	=1 if ever had job in government (below municipal level)	0.19	0.39
Last job business	= 1 if last job was in academia (inclusive of	0.62	0.49
Ever job academia	faculty, researcher, staff, etc) = 1 if last job was in business = 1 if ever had job in academia (inclusive of faculty, researcher, staff, etc)	0.23	--

TABLE 7
MIT

Variable	Responded to 2001 survey (N=43,668)	Did not respond to 2001 survey (N=62,260)	t-stat for equal means
Male	0.83	0.86	10.11
Engineering major	0.48	0.47	-4.49
Management major	0.16	0.15	-5.75
Science major	0.23	0.23	0.37
Social sciences major	0.05	0.06	4.07
Architecture major	0.06	0.08	11.82
Non-US citizen	0.81	0.82	3.77
North American (not US) citizen	0.13	0.11	-4.14
Latin American citizen	0.13	0.12	-1.44
Asian citizen	0.33	0.34	1.45
European citizen	0.30	0.26	-5.08
Middle Eastern citizen	0.05	0.08	6.32
African citizen	0.03	0.05	6.25

Variable	Responded to 2003 survey (N=2,111)	Did not respond to 2003 survey (N=6,131)	t-stat for equal means
Male	0.92	0.92	0.12
Engineering major	0.52	0.47	-3.63
Management major	0.17	0.21	4.17
Science major	0.17	0.18	1.09
Social sciences major	0.06	0.05	1.18
Architecture major	0.09	0.09	1.06
Non-US citizen	0.82	0.81	-1.36
North American (not US) citizen	0.17	0.14	-1.34
Latin American citizen	0.19	0.19	0.13
Asian citizen	0.22	0.24	0.73
European citizen	0.31	0.32	0.38
Middle Eastern citizen	0.08	0.07	-0.59
African citizen	0.04	0.04	0.17

Note: bolded numbers indicate statistical significance at the 1% level.

TABLE 8
Tsinghua

Variable	Responded before Aug. 2007 (N=2,667)	Responded during/after Aug. 2007 (N=299)	*t*-stat for equal means
Age	49.3	54.1	-4.216**
Age (founders only)	38.4	37.4	0.602
Bachelor's Graduation Yr	1980.9	1977.4	3.777**
Bach. Grad yr (founders only)	1991.6	1993.2	0.941
Years of Education	17.2	17.0	2.381**
Entrepreneur parents	0.09	0.12	-0.713
Entrepreneur	0.29	0.40	-2.168**
Privatized	0.10	0.05	1.392
First start-up founded	2000.3	2001.1	-0.661
Tech only	0.28	0.29	0.757
Business only	0.10	0.09	0.235
Gender	0.88	0.90	0.901
Family economic status	3.75	3.85	-1.871*
High Salary	3.21	2.93	3.351**
Avg. Tenure	6.94	8.01	-2.045*
Overseas work exp.	0.26	0.26	-0.126
Number of positions	2.39	2.26	-2.012*
High government	0.03	0.03	-0.239
Low government	0.18	0.17	0.617
Last job academia	0.19	0.19	-0.051
Ever job academia	0.32	0.27	2.323**
Last job business	0.62	0.61	0.348
Student Leader	0.61	0.57	0.874
GPA Rank	2.28	2.58	-2.661**
Bach. Grad Yr. 10th percentile	1954	1953	--
Bach. Grad Yr. 25th percentile	1965	1961	--
Bach. Grad Yr. 50th percentile	1986	1979	--
Bach. Grad Yr. 75th percentile	1996	1993	--
Bach. Grad Yr. 90th percentile	2001	2001	--

**, and * indicate statistical significance at the 1% and 5%, respectively.

TABLE 9
Comparison of Key Demographic Characteristics by Survey

Variable	Did Not Respond to Founders survey (N=334) Mean	Responded to Founders survey (N=378) Mean	*t*-stat for equal means
Age	45.8	39.8	6.536***
Entrepreneur parents	0.130	0.117	0.331
Gender	0.914	0.948	-1.807**
Masters	0.500	0.569	-1.830**
Doctorate degree	0.139	0.095	1.786**
Tech only	0.241	0.185	1.784**
Business only	0.139	0.169	-1.089
Family economic status	3.692	3.581	1.370
High Salary	3.495	4.035	-4.647***
Avg. Tenure	5.673	3.976	3.553***
Overseas work exp.	0.179	0.183	-0.121
Number of positions	2.932	3.198	-2.594
High government	0.056	0.041	0.903
Low government	0.194	0.158	1.256
Last job academia	0.140	0.055	3.553***
Ever job academia	0.512	0.569	-1.505
Last job business	0.724	0.869	-4.448***
Student Leader	0.494	0.534	-1.055
GPA Rank	2.150	2.500	-3.449***
Left last job involuntarily	0.028	0.040	-0.544
Ever left job involuntarily	0.104	0.103	0.018

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 10

Categories	**Tsinghua**	**CHNS**	**NBS HH survey**	**NBS HH survey**
Sample	Urban	Rural and Urban	Urban – self-employed	Urban – non. Entrep.
Male	0.89	0.53	0.56	0.50
Age	50.13	41.45	36.2	37.2
Married	0.88	0.98	83.4	84.2
Years of Education	17.1	9.1	9.2	9.4
Household Size	3.40	3.9	--	--
Self-employed	0.26 (0.8% in 1999)	0.14	(4% in 1999)	--
Experienced a layoff	0.13	--	0.26	0.19
Father's Educ.	4.11	--	5.4	5.2
Mother's Educ.	4.89	--	6.0	5.9
Parent Self-Empl.	0.08	--	0.06	0.05
Comm. Party	0.62	--	0.05	0.18

TABLE 11

	MIT				Tsinghua			
School	**Freq.**	**Percent**	**freq. founder**	**% becoming founders**	**Freq.**	**Percent**	**freq. founders**	**% founders**
Engineering	21714	51.28	3483	16.04	1771	69.72	456	25.75
Sciences	9086	21.46	1984	21.84	406	15.98	79	19.46
Management	6365	15.03	1634	25.67	100	3.94	31	31.00
Social Sciences	2838	6.70	265	9.34	163	6.42	27	16.56
Architecture	2339	5.52	487	20.82	100	3.94	27	27.00
Department	**Freq.**	**Percent**	**freq. founder**	**% becoming founders**	**Freq.**	**Percent**	**freq. founders**	**% founders**
Electrical Eng. & Comp. Sci.	7445	19.18	1541	20.70	578	24.62	179	30.97
Civil & Env. Engineering	2122	5.47	456	21.49	458	19.51	84	18.34
School of Management	6331	16.31	1634	25.81	100	3.94	31	31.00
Mechanical Engineering	4124	10.63	767	18.60	545	23.21	142	26.06
Chemical Engineering	4730	12.19	461	9.75	155	6.60	44	28.39
Aero/Astro	2074	5.34	358	17.26	70	2.98	14	20.00
Architecture	1554	4.00	487	31.34	100	4.26	27	27.00
Math/Physics	3877	9.99	651	16.79	187	7.96	35	18.72
Materials	1347	3.47	193	14.33	64	2.73	16	25.00
Biology/Ocean engineering	2704	6.97	315	11.65	16	0.68	3	18.75
Humanities	2293	5.91	146	6.37	138	5.88	22	15.94
Psychology	211	0.54	23	10.90	2	0.09	0	0.00

TABLE 12

Tsinghua	Non-Founders (n=2152)	Founders (n=670)	
Variable	Mean		t-stat
Age	52.829	42.967	12.388***
Master's Degree	0.397	0.552	-7.161***
Doctorate Degree	0.100	0.115	-1.121
Entrepreneur Parents	0.036	0.031	0.614
Privatized	0.000	0.260	--
Gender	0.879	0.933	-3.931***
Family Economic Status	3.834	3.639	4.348***
Recent Salary	2.317	2.045	3.686***
Avg. tenure	8.074	4.813	7.554***
Overseas	0.126	0.212	-5.525***
Number of Pos.	2.115	3.109	-18.605
Ever job high gov.	0.036	0.042	-0.713
Ever job low gov.	0.242	0.176	3.574***
Last job academia	0.166	0.081	5.475***
Ever job academia	0.233	0.207	1.402*
Last job business	0.399	0.687	-13.451***
Student leader	0.674	0.903	-5.314***
MIT	Non-Founders (n=35,870)	Founders (n=7,798)	
Variable	Mean		t-stat
Age	57.69	61.95	-20.196***
Master's Degree	0.321	0.290	5.498***
Doctorate Degree	0.082	0.066	-4.986***
Gender	0.823	0.928	-23.404***

TABLE 13

	Median Age at First Founding				
Decade of Graduation	**1950s**	**1960s**	**1970s**	**1980s**	**1990s**
MIT	40.5	39	35	32	28
Tsinghua	55.5	60	42	36	30

TABLE 14a

Tsinghua Repeat Founders by Decade of Graduation

Decade	1950s	1960s	1970s	1980s	1990s	2000s
Total # firms = 1	17	30	12	89	145	64
% repeat	**32**	**54**	**63**	**58**	**49**	**26.5**
=2	5	20	11	61	91	17
=3	1	7	4	38	29	6
=4	1	6	1	5	12	0
=5	1	1	4	8	4	0
=6	0	1	0	2	2	0
=7	0	0	0	0	1	0
=8	0	0	0	1	1	0
=9	0	0	0	0	0	0
=10	0	0	0	13	0	0
>10	0	0	0	2	0	0
Totals	**25**	**65**	**32**	**219**	**285**	**87**

TABLE 14b
MIT Repeat Founders by Decade of Graduation

)ecade	1950s	1960s	1970s	1980s	1990s	2000s
Total # firms = 1	161	231	238	242	182	19
% repeat	**44.5**	**46.2**	**52.3**	**43.3**	**38.9**	**40.6**
=2	60	85	115	92	69	9
=3	29	47	79	49	27	3
=4	19	28	30	23	9	1
=5	10	14	16	9	6	0
=6	4	7	7	3	0	0
=7	0	5	2	3	3	0
=8	5	2	3	0	0	0
=9	0	5	2	1	0	0
=10	0	2	1	1	1	0
>10	2	3	6	4	1	0
Totals	**290**	**429**	**499**	**427**	**298**	**32**

TABLE 15

Number of Companies Founded by Tsinghua Entrepreneurs

Number of Companies	*Number of Entrepreneurs*	*Percentage*
Founded 1 Company	375	51.9%
Founded More Than 1 Company	348	48.1%
Founded 2 Companies	206	28.5%
Founded 3 Companies	85	11.7%
Founded 4 Companies	25	3.5%
Founded 5 Companies	18	2.5%
Founded more than 5 Companies	14	1.9%

TABLE 16

Median Company Statistics for Repeat Entrepreneurs (Tsinghua)

Firm Rank	1st firms	2nd firms	3rd firms
Median Employment	20	20	36.5
Median Years of Survival	4	3	4
Median Revenues (inflation adj., PPP)	9,369	6,933	54,593
Percentage IPO (%)		3.9	
Lag Between Subsequent Firms	3.44	4	6.67
(median)	9	78	3.5
Observations	223		32

MIT

Panel A – Likelihood of Exit Events and Revenues (in 2001 dollars)

Firm Rank	1st firms (N=556)	2nd firms (N=182)	3rd firms (N=84)	4th firms (N=21)	5th firms and higher (N=36)
Employment	12	15	12	17	30
Median Revenues ('000s USD)	836	1,784	924	1,181	7,274
Percentage IPO	11.2	9.8	12.9	7.0	3.7

Panel B – Lag (from graduation and from the prior firm founding)

Firm Rank	1st firms (N=761)	2nd firms (N=241)	3rd firms (N=150)	4th firms (N=71)	5th firms and higher (N=31)
Median Lag Between Subsequent Firms (years)	11	6	5	5	5

TABLE 17
Revenues

Revenues					
	25th	**50th**	**75th**	**99th**	**Mean**
MIT	53,742.35	465,725	2,953,308	140,000,000	10,100,000
Tsinghua (constant PPP)	345	1,241	6,893	386,014	15,710
Tsinghua (exchange rate)	788	2,836	15,756	882,317	35,909

All revenues exclude financial firms and firms older than 15 years. All revenues are for the most recent year that the firm was in operation. Tsinghua revenues have been converted for the exchange rate and for purchasing power parity (PPP). The former can be thought of as a lower bound while the PPP conversion gives a lower bound. MIT revenues have been adjusted for inflation.

TABLE 18

Primary Idea sources	MIT Data	Tsinghua data
	percentage	percentage
In school-doing outside-funded research	2.40	1.66
In school- graduate thesis	4.64	3.96
In school- in class	1.98	5.88
In school-informal discussion with students	3.41	11.00
In school-other research	2.28	1.92
In school-professional literature	1.73	4.48
In school- visiting scientists, engineers etc	1.77	4.86
In school-working with outside company	3.20	4.86
Other sources-discussions in social/professional conferences	21.54	17.65
Other sources-research conference	2.66	4.48
Other sources-working in the industry	41.44	24.81
Other sources- working in the military (government experience)	4.01	2.94
Other sources- doing outside-funded research	2.07	0.77
Other university- graduate thesis	1.05	1.28
Other university- in class	1.01	1.53
Other university- informal discussion with students	1.43	3.45
Other university- other research	1.26	0.90
Other university- professional literature	1.05	2.05
Other university- working with an outside company	1.05	1.53
Total	100	100
Number of observations	1284	110

TABLE 19
Founding Team / Idea Formation Characteristics (MIT)

Panel A - Team Formation (%)						
Founding Decade	**1950s (N=22)**	**1960s (N=55)**	**1970s (N=108)**	**1980s (N=204)**	**1990s (N=309)**	**2000s (N=90)**
Research	18.2	21.8	7.4	16.2	14.9	20
Work	31.8	34.6	40.7	39.7	39.5	36.7
Extracurricular Activities	0.0	3.6	5.6	2.9	4.9	12.2
Social Activities	36.4	30.9	16.7	27.5	31.4	47.8
Other	13.6	21.8	15.7	11.7	12.6	16.7
Panel B - Source of Idea (%)						
Founding Decade	**1950s (N=20)**	**1960s (N=48)**	**1970s (N=98)**	**1980s (N=186)**	**1990s (N=289)**	**2000s (N=76)**
Idea from Research	25.0	8.3	7.1	10.8	7.9	18.4
Idea from Networking	10.0	14.6	11.2	14.5	15.2	19.7
Idea from Industry	55.0	75.0	70.4	66.1	67.5	57.9
Other	10.0	2.1	11.2	8.6	9.3	3.9
Panel C - Number of Founders						
Founding Decade	**1950s**	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**
Total # of Founders	2.3	2.5	2.2	2.6	2.8	3.3

TABLE 20
Sources of the Team (Percentages)
Note: Numbers on the Diagonal Represent Only 1 Source Indicated. N=901 who reported 1 or 2 team sources. The minority of teams with three or more sources are not represented here.

	Business	Enter-prise Forum	Family	Govt	50K	MIT Contacts	MIT Course	MIT Lab	MIT Living Group	MIT Network-ing	MIT Sociallly	Non-MIT Networking	Other Univ.	Sociallly
Business	**37.34**	0.00	1.57	0.42	0.00	0.42	0.63	0.52	1.15	0.63	0.42	1.88	0.94	0.84
Enterprise Forum		**0.42**	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.10	0.00	0.00
Family			**3.45**	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.42	0.31	0.42	0.21
Govt				**1.36**	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
50K					**0.42**	0.00	0.10	0.21	0.00	0.10	0.00	0.00	0.00	0.00
MIT Contacts						**1.57**	0.21	0.21	0.31	0.10	0.00	0.00	0.00	0.10
MIT Course							**2.41**	1.05	0.31	0.31	0.52	0.10	0.21	0.10
MIT Lab								**3.14**	0.10	0.31	0.10	0.10	0.21	0.00
MIT Living Group									**3.87**	0.10	0.42	0.21	0.21	0.31
MIT Networking										**1.57**	0.00	0.73	0.00	0.00
MIT Socially											**1.36**	0.00	0.31	1.15
Non-MIT Networking												**3.77**	0.31	0.52
Other University													**6.90**	0.10
Socially														**4.60**

TABLE 21
Combinations of Primary (rows) and Secondary (columns) Ideas

**Number from Table 4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
MIT-Doing outside-funded research	0.00	0.06	0.37	0.06	0.43	0.43	0.25	0.37	0.06	0.06	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.25	0.00	0.06	0.31	0.00
MIT-Graduate thesis	0.37	0.19	0.47	0.25	0.00	0.56	0.43	0.56	0.25	0.19	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.06	0.50	0.06
MIT-In class	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.00	0.00	0.06	0.06	0.06	0.06	0.12	0.00	0.00	0.00	0.00	0.06	0.12	0.00	0.00	0.12	0.00
MIT-Informal discussion with students or faculty	0.19	0.25	0.12	0.19	0.31	0.00	0.09	0.06	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.06	0.00	0.37	0.00
MIT-Other	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.25	0.06
MIT-Other research	0.06	0.06	0.00	0.06	0.19	0.12	0.09	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.06	0.31	0.00
MIT-Professional literature	0.00	0.00	0.00	0.00	0.06	0.00	0.06	0.06	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.06	0.00
MIT-Undergraduate Research Opportunity	0.06	0.00	0.06	0.06	0.00	0.06	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.06	0.12	0.06
MIT-Visiting scientists, engineers, or	0.00	0.00	0.06	0.06	0.12	0.06	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.06	0.00
MIT-Working with an outside company	0.12	0.06	0.12	0.06	0.25	0.12	0.00	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.56	0.06	0.06	0.19	0.00
Other Sources-Discussions with	0.00	0.00	0.11	0.11	0.11	0.33	0.33	0.11	0.22	0.11	0.00	0.11	0.00	0.00	0.33	0.11	0.00	0.11	0.22	0.78	0.37	0.06	0.43	0.06

social/professional acquaintances	0	0	9	9	2	1	7	2	5	9	6	2	6	0	1	2	6	9	5	2		2		2
Other Sources-Working in the military or government	0.00	0.00	0.06	0.00	0.19	0.12	0.06	0.06	0.00	0.12	0.06	0.06	0.00	0.00	0.00	0.06	0.00	0.12	0.00	0.62	0.06	0.31	0.99	0.06
Other University-Doing outside-funded research	0.12	0.00	0.12	0.00	0.19	0.06	0.00	0.06	0.00	0.06	0.06	0.37	0.06	0.25	0.25	0.19	0.06	0.19	0.00	0.25	0.00	0.00	0.00	0.00
Other Sources-Working in the industry	0.56	0.62	0.99	0.55	0.42	0.61	0.87	0.55	0.36	0.18	0.56	0.68	0.68	0.50	0.74	0.37	0.81	0.74	0.25	0.24	0.27.36	0.99	17.87	2.36

TABLE 22

	MIT		Tsinghua			
Meeting Channels	**freq.**	**percent**	**cfnd1 only freq.**	**percent**	**overlapping freq.**	**percent**
Family relatives	69	7.98%	52	24.30%	9	7.76%
Classmates	395	45.66%	63	29.44%	39	33.62%
Colleagues	470	54.34%	99	46.26%	68	58.62%
Total	865	100.00%	214	100.00%	116	100.00%

Tsinghua	**cfnd1 only**	**percent**	**cfnd2 only**	**percent**	**cfnd3 only**	**percent**	**cfnd4 only**	**percent**
Relative	52	24.30%	14	9.72%	8	8.51%	6	8.33%
Classmate	63	29.44%	34	23.61%	26	27.66%	14	19.44%
Colleague	99	46.26%	96	66.67%	60	63.83%	52	72.22%
Total	214	100.00%	144	100.00%	94	100.00%	72	100.00%

TABLE 23
MIT

	MIT		Tsinghua	
Source	**Number of Companies**	**% of Total Companies**	**Number of Companies**	**% of Total Companies**
Savings	782	53	141	42
Venture Capital	180	12	25	8
Family / Friends	129	9	48	14
Cash Flow	114	8		
Angel Investor	112	8	22	7
Credit	70	5	28	8
Customers	42	3		
Gov. Federal	25	2	25	8
Gov.-State	11	1		
University	6	0	11	3
Suppliers	6	0	32	10
Total	1477	100	332	100

TABLE 24

	MIT		Tsinghua	
IP author?	**Freq.**	**percentage**	**Freq.**	**percentage**
Yes	578	46.24	105	62.87
No	672	53.76	62	37.13
Total	1250	100	167	100
	MIT		**Tsinghua**	
IP owner?	**Freq.**	**Percentage**	**Freq.**	**Percentage**
Yes	434	53.19	107	59.44
No	382	46.81	73	40.56
Total	816	100	180	100
	MIT		**Tsinghua**	
IP important?	**Freq.**	**Percentage**	**Freq.**	**percentage**
Yes	481	33.83	123	37.85
No	941	66.17	202	62.15
Total	1422	100	325	100
R&D/Revenue Ratio	**MIT**		**Tsinghua**	
Mean	0.09		0.12	
25%ile	0		0	
Median	0		0	
75%ile	0.10		0.10	

	MIT			Tsinghua		
	Mean	**Median**	**Obs.**	**Mean**	**Median**	**Obs.**
Electronics	16.72	10	279	11.09	0	65
Software/Internet	20.16	10	321	18.55	10	65
Law	6.18	0	50	6.24	0	21

&Accounting		

TABLE 25

Panel A: Tsinghua Alumni (entrepreneurs and non-entrepreneurs)	Foreign Patents		Domestic Patents	
Number of Patents per Individual	Freq.	percent	Freq.	percent
0	2924	98.58	2565	86.48
1	18	0.61	163	5.50
2	14	0.47	90	3.03
3	3	0.10	56	1.89
4	3	0.10	24	0.81
5	0	0.00	27	0.91
6 or more	4	0.13	41	1.38
Total	2966	100	2966	100

Panel B								
Firms	MIT		Tsinghua		MIT		Tsinghua	
Number of Patents per Firm	Freq.	percent	Freq.	percent	Firm Age </=15 yrs Freq.	percent	Firm Age</= 15 yrs Freq.	percent
0	1263	74.91	66	20.12	755	78.00	20	7.72
1	112	6.64	33	10.06	73	7.54	31	11.97
2	64	3.80	58	17.68	37	3.82	49	18.92
3	40	2.37	52	15.85	25	2.58	50	19.31
4	20	1.19	56	17.07	11	1.14	52	20.08
5	16	0.95	53	16.16	6	0.62	47	18.15
6 or more	171	10.14	10	3.05	61	6.30	10	3.86
Total	1686	100	328	100	968	100	259	100

TABLE 26
Reported Factors for Tsinghua Alumni Who Did Not Become Entrepreneurs

Panel A – Consideration for Becoming an Entrepreneur		
Never Considered	186	27.2
Not a worthwhile activity	53	7.7
Considered, but did not start the project	446	65.1

Panel B – Factors for Not Becoming an Entrepreneur																	
Rank (1 – 8)	**1**	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**6**	**%**	**7**	**%**	**8**	**%**	**N/A**
Difficult to raise capital	141	31	101	23	80	21	44	14	20	7	10	3	4	1	5	2	627
Difficult to find partners	47	10	114	26	95	25	56	17	31	10	18	6	8	3	5	2	658
Lack of good ideas	171	37	67	15	43	12	26	8	28	9	16	6	17	6	13	4	651
Concept easily copied	6	1	30	7	47	13	60	18	76	25	48	17	36	13	21	7	708
Risk too great	55	12	73	17	61	16	74	23	57	19	19	7	19	7	5	2	669
Family against entrepreneurship	8	2	16	4	12	3	25	8	41	13	91	31	50	17	55	20	734
Cannot leave current job	22	5	19	4	19	5	27	8	31	10	45	15	94	33	56	20	719
Government discouraged entrepreneurship at the time	9	2	17	4	20	5	12	4	20	7	43	15	57	20	122	43	732

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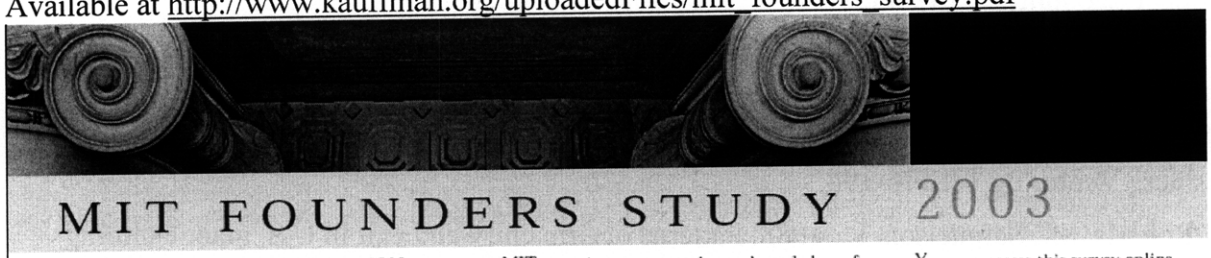
APPENDIX A

MIT Survey Instrument

Available at http://www.kauffman.org/uploadedFiles/mit_founders_survey.pdf



MIT FOUNDERS STUDY 2003

We invite you to participate in the 2003 survey of MIT founders to expand our knowledge of entrepreneurship and enterprise creation. MIT graduates, students, and faculty have founded thousands of companies, and this new survey will contribute valuable insights into the entrepreneurial process and its sources of inspiration and support. We hope that our findings will create a deeper understanding of the factors encouraging discovery, innovation, and economic development and, by so doing, help encourage current and future generations of entrepreneurs by informing the institutions supporting them.

We ask you to help by completing this survey even if you participated in our 1995 survey. We expect that the process will take less than 30 minutes. Please rest assured that our findings will be reported only in the aggregate and that the particular data you provide will be kept strictly confidential. We will be pleased to share our results with you before the end of the calendar year. We look forward to receiving your response by Friday, August 1st.

You may access this survey online by visiting our website at *web.mit.edu/surveys/founders*. If you have questions, contact us by email at *founders-study@mit.edu* or by phone 617-253-3648.

Your name: _____

What is your affiliation with MIT?

- ☐ Alumnus/a Course(s) _____ Degree(s) _____ Year(s) _____
- ☐ Faculty
- ☐ Staff

COMPANIES YOU HAVE FOUNDED

1. How many companies have you founded or co-founded over the course of your lifetime? _____
2. Please list them here, starting with the most recent:

	Company	City	State	Country	Year Founded	Operating Status*	If Closed, Year	Public or Private
A								
B								
C								
D								
E								

☐ Check here if more than five. Feel free to attach a separate page listing those companies.

*Under "Operating Status", please choose from the following three options: • in operation • acquired by another firm • out of operation

If you have founded more than one company, we are interested in learning about the one that you think is the most significant. Pick one, drawing from the criteria listed below, and use that as the focus of this survey.

Company Selected: _____

Headquarters' Location: City/State or City/Country _____

Reason Selected (Mark only one)

- ☐ First
- ☐ Most Recent
- ☐ Largest
- ☐ Most Successful
- ☐ Most Important Technology
- ☐ Other _____

Please answer the questions that follow for the company you have selected:

3. Please tell us your position with the company when it was founded and your current position, if you are still active.

List of Positions	At Company Founding	Current Role
President/CEO	☐	☐
Chairman (if not also CEO)	☐	☐
Chief Operating Officer	☐	☐
Chief Scientist/Chief Technology Officer/Chief of R&D	☐	☐
Chief Finance Officer	☐	☐
Chief Information Officer	☐	☐
Vice President	☐	☐
Outside Director	☐	☐
Consultant or Advisor	☐	☐
Other employee (specify) _____	☐	☐
Not Active	☐	☐

4. If you are no longer still active in this company, are you currently (check as many as apply):

☐ Working in another company that you have founded
☐ Starting a new company
☐ Consulting
☐ Employed elsewhere
☐ Retired
☐ Other

COMPANY PROFILE

5. In which industry would you categorize your company?
(Please mark one primary industry sector and as many secondary sectors as apply.)

Manufacturing	Primary	Secondary
Aerospace		
Drugs, Biotech, Medical Devices		
Chemicals, Materials		
Consumer Products		
Electronics, Computers, Telecommunications Devices		
Machinery		
Other Manufacturing		

Services	Primary	Secondary
Architecture		
Energy, Electric Utilities		
Telecommunications		
Finance		
Management & Finance Consulting		
Publishing, Schools		
Software		
Law, Accounting, Miscellaneous Business Services		
Other		

6. For most recent fiscal year available, what were:

- Total Company Revenues $ _____ Fiscal Year _____
- Total Company Employment _____ Fiscal Year _____

7. What percentage of annual revenues is invested in R&D? _____% In Marketing? _____%

8. Where does your company generate its revenues? Please provide an approximate percentage by region (the total should be 100%).

For US Companies	% of Total
US	
Non U.S.	

If Headquartered Outside U.S.	% of Total
Your Headquarters' Country	
The U.S.	
Rest of the World	

If available, what percentage of US sales is in your headquarters' state? _____%

9. Is your company located in Cambridge or Greater Boston (the area on or within the Route 495 belt)?

☐ Yes ☐ No **If NO skip to question 11.**

10. What is your company's activity, including branches as well as headquarters, in Cambridge or Greater Boston?

	Cambridge	Greater Boston
What percentage of total company employment is in:		
What percentage of total company revenues originates in:		

COMPANY INFORMATION

11. How many people founded the company? _____

Please list all your co-founders and mark their affiliation, if any, with MIT, and the role(s) they served in the company's founding.

Founder Name	Alum	Student	Faculty/Staff	Non MIT	Technology	Finance	Marketing	Other
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	

12. Where did you meet the other founders? (Mark as many as apply)

While at MIT:

- ☐ In Class/Course
- ☐ Doing research/lab (Specify) _____
- ☐ In your residence/living group (Specify) _____
- ☐ In connection with the MIT $50K Entrepreneurship Competition
- ☐ In connection with other extra-curricular activities (Specify) _____
- ☐ Networking
- ☐ Socially
- ☐ Other (Specify) _____

Before coming to or after leaving MIT:

- ☐ At another university (Specify) _____
- ☐ In connection with the MIT Enterprise Forum
- ☐ In connection with MIT Alumni Association activities (Specify) _____
- ☐ Through MIT contacts
- ☐ Working in business
- ☐ Working in government
- ☐ Family connections
- ☐ Networking
- ☐ Socially
- ☐ Other (Specify) _____

13. What was the source of the idea for the product or service leading to the founding of the company? (Please answer even if the idea came from one of your co-founders and not from you.) Mark one primary source and as many secondary sources as apply.

		Primary	Secondary
At MIT	Doing outside-funded research		
	Undergraduate Research Opportunity Program		
	Other research		
	In class		
	Graduate thesis		
	Informal discussion with students or faculty		
	Visiting scientists, engineers, or entrepreneurs		
	Working with an outside company		
	Professional literature		
	Other		
At Another University	Doing outside-funded research		
	Other research		
	In Class		
	Graduate thesis		
	Informal discussions with students or faculty		
	Visiting Scientists, engineers.....		
	Working with an outside company		
	Professional literature		
	Other		
	Please Name the University Here:		
Other Sources	Working in the industry		
	Working in the military or government		
	Research conference		
	Discussions with social/professional acquaintance(s)		
	Other		

14. Was intellectual property (patented or copyrighted material) a critical factor in the company formation?
☐ Yes ☐ No

15. Were you an inventor or author of the intellectual property? ☐ Yes ☐ No

16. If yes, is the patent or other intellectual property owned by you or one of the founding team? ☐ Yes ☐ No
If not, did you license (or get an assignment of) its use from any of these?

☐ From MIT
☐ From another university
(Specify) _____
☐ From another company
☐ From a government lab
☐ From an individual inventor

17. Prior to starting the company, did you receive financial help to demonstrate feasibility and/or develop a prototype? ☐ Yes ☐ No
If so, how much was this? $ _____
Did this help come from any of the following sources (check as many as are appropriate):

☐ From a university (Specify) _____
☐ Federal defense research (DARPA/DOD)
☐ Other federal research grant (NSF/NIH/DoE)
☐ SBIR
☐ State government programs
☐ Business community initiatives
☐ Friends, family
☐ Angel investors
☐ Other _____

Early Funding

18. How much capital did you raise to get your company off the ground? $_____

19. Roughly what percentage came from each of the following sources during the start-up phase (roughly defined as within the first year)

Funding Source	% (do not exceed 100% total)
Founders' personal savings	
Founders' credit card or borrowing	
Founders' families or friends	
Venture capital	
Company cash flow	
Commercial bank(s)	

Funding Source (continued)	% (do not exceed 100% total)
Angel investor(s)	
* University	
Government: federal	
Government: state	
Customers	
Suppliers	

* Name of University _____

ROLE OF MIT

20. Which of these factors in your connection with MIT, if any, played a role in the founding of your company?
Check all that were relevant.

☐ Fellow students
☐ Faculty or staff
Anyone in particular? _____
☐ Research work
☐ Contact with entrepreneurial network
☐ Specific offices, groups, or activities
○ Entrepreneurship Center
○ Enterprise Forum
○ Venture Mentoring Service
○ $50K Entrepreneurship Competition
○ Technology Licensing Office
○ Alumni Regional Club
○ Other _____

The entrepreneurial environment

21. Was MIT's entrepreneurial environment a factor in your choice to attend MIT or to work at MIT? ☐ Yes ☐ No
22. Did the reputational benefit of your association with MIT help you to acquire funding? ☐ Yes ☐ No
Did it enhance your credibility with clients and suppliers? ☐ Yes ☐ No
23. Does your company currently have or anticipate having an ongoing connection with MIT? ☐ Yes ☐ No
(Check all that apply)

☐ Recruiting new employees
☐ Licensing technology
☐ Funding research
☐ Joint research with MIT faculty and/or staff
☐ Faculty Advisors or Directors
☐ Specific offices, groups, or activities
○ Entrepreneurship Center
○ Enterprise Forum
○ Venture Mentoring Service
○ $50K Entrepreneurship Competition
○ Technology Licensing Office
○ Alumni Regional Club
○ Other _____

KEY LOCATION AND SUCCESS FACTORS

24. Did you start your company where you were living at the time? ☐ Yes ☐ No
If yes, were you living there because (check all that apply):

☐ You grew up there
☐ You had attended a school or university there
☐ You were employed there
☐ Other (please specify) _____

25. What factors influenced the location of your company?

	Decisive	Important	Less Important	Not Important
Access to venture capital and other funding				
State and local government assistance programs				
Access to MIT				
Proximity to key research facilities or key researcher				
Access to other major universities				
Access to skilled professional workers (engineers, managers)				
Access to skilled (blue-collar) labor				
Access to unskilled labor				
Proximity to major markets				
Favorable regulatory environment				
Favorable tax climate				
Low business costs				
Quality of life				
Good network of suppliers				
Network of contacts				
Low-cost land and rental space				
Available land for building				
Ample and reasonably priced housing				
That's where I lived				
Other factors				

Skip Questions 26-28 if you are not currently active with the company

26. When you plan for an expansion, what factors will help determine where it occurs?

	Decisive	Important	Less Important	Not Important
Access to venture capital and other funding				
State and local government assistance programs				
Access to MIT				
Proximity to key research facilities or key researcher				
Access to other major universities				
Access to skilled professional workers (engineers, managers)				
Access to skilled (blue-collar) labor				
Access to unskilled labor				
Proximity to major markets				
Favorable regulatory environment				
Favorable tax climate				
Low business costs				
Quality of life				
Network of suppliers				
Network of contacts				
Low-cost land and rental space				
Available land for building				
Ample and reasonably priced housing				
Proximity to company headquarters or other existing company operations				
Other factors				

27. Do you plan a major expansion in the next two years? ☐ Yes ☐ No

28. What factors are critical in giving your company a continuing competitive edge?

	Most Important	Important	Less Important	Not Important
Access to capital				
Government support programs				
Innovation/new technology				
Niche product				
Time-to-Market				
Superior performance				
Market image/brand recognition				
Dominant market position				
Customer service/responsiveness				
Employee enthusiasm/creativity				
Management expertise				
Competitive cost structure				
Offshore outsourcing				
Other (please specify) _____				

COMMENTS

Please share your stories and your thoughts about your entrepreneurial experiences, your connections with MIT (past and current), your lessons learned: any comments of your choosing. Feel free to attach additional pages.

AN APPRECIATION AND AN INVITATION

We are grateful for your participation in the MIT Founders Study 2003. We hope to share our preliminary findings before the end of the year.

We invite your continued involvement in our ongoing research on entrepreneurial activity. We hope that you will be willing to participate in follow-on studies related to additional companies you have founded or on specific aspects of the entrepreneurial enterprise. Please let us know if you are so willing.

☐ Yes, I am willing to be contacted for follow-on studies

☐ Email Address (if available):_____

CONFIDENTIALITY AND RELEASE OF INFORMATION

Your privacy is our highest priority. The information you have provided will be reported only in the aggregate. From time to time, we are asked by MIT administrative offices and the news media for the names of MIT-associated founders, their companies, and the industries and technologies with which they are associated. We would like your permission to release that information when so requested. Please check below ONLY if we do not have your permission.

☐ Do not release my name or the name of my company to MIT offices.

☐ Do not release my name or the name of my company to the news media.

Please return the survey in the enclosed envelope pre-addressed to the MIT Founders Survey 2003, 77 Massachusetts Avenue, Cambridge MA 02139.

You may also fax it to 617-258-8690. Let us know if you would prefer to complete the survey through a telephone interview or if you have any questions by calling the MIT Founders Project at 617-253-3648.

We thank you for your participation!

PSB 03-05-0426

APPENDIX B: Tsinghua Survey Instrument

Tsinghua University – MIT Survey

Massachusetts Institute of Technology

Dear _insert name here___,

This research survey carried out jointly by Tsinghua University and MIT in the U.S. seeks to better understand what people do with an education from a research university and the process of entrepreneurship. The survey takes approximately 30 minutes to complete.

You should know that:

- participation is voluntary
- confidentiality and/or anonymity are assured
- please fill out the survey based on your own situation
- For all Tsinghua alumni, please fill out the "Tsinghua Alumni Biographical Survey"
- For Tsinghua alumni, who own enterprise, please fill out "Tsinghua Founders Survey"
- To answer questions with "□," please mark the answer with an "x".
- To answer questions with "___" please fill in the English letter for the corresponding answer.
- For numbers needed in the survey, please use Arabic numbers.

If you would like to fill in the survey online, please go to http://tsinghua.org.cn or http://mit.edu/tsinghuasurvey.

We thank you very much for your cooperation. We are also very grateful to Charles Zhang, founder and CEO of Sohu.com, for making this survey possible.

Tsinghua Alumni Biographical Survey:

Gender: M F (circle one) Year of Birth: _____

Size of Birth Place: □ Metropolis □ Medium City □ Small city □ Village

Before attending college, in which city did you primarily live in? _____ (Please clearly indicated the province)

Married? □ Yes □ No Number of Children: ___ Ages: Oldest) ___; Youngest) ____

Communist party member? □ Yes □ No If yes, which year did you join? _____

Please list the universities you attended, educational degrees, and the subject(s):

Degree	Year of Graduation	University	Department	Major
Bachelor's				
Master's				
PhD				

With regard to your academic performance, your rank in the class were: a) top 10% b) top 10-25% c) top 25-50% d) other

When you were an undergraduate or a graduate student, your highest position in a student organization:
_____ (Please indicate the name of the school, department, and/or class)

Do you have patents? □ Yes □ No If yes, how many? __ How many are foreign patents? __

Describe your family's economic status within the Chinese society when you were in college? _____
Upper 10% 2) Upper 10-25% 3) Upper 25-50% 4) Lower 50-25% 5) Lower 25%

Your father's highest degree is__? Your mother's highest degree is__?
1) Masters degree or higher 2) Undergraduate 3) High School 4) Middle School 5) Primary or lower

Please list the job characteristics of your parents when you were in the last year of your high school:
Father ___ Mother: ____
Business administrator b) Government official c) Researcher or educator
Occupational: d1) Factory worker d2) Farmer d3) Military service d4) other

Please indicate whether the following groups of people have experiences in founding firms in the past.

Your Parents	Your Close Relatives	Former/Current Neighbors	Former Colleagues/Classmates
□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No

How many companies have you founded (not including State-Owned Enterprises (SOEs))? ____ Of those, how many were successful? ___

How many companies have you privatized or bought? ____

Do you have plans to found new companies in the future? □ No □ Yes, in the next 1-2 years □ Yes, in the next 3-5 years □ Yes, at some point.

If you have not founded a company please indicate the reason why not ____ (write the #)
1) Never considered it 2) Don't view it as a worthwhile activity. 3) Thought about it, but did not start the project
12a. If you chose #3, Please rank all that apply: give value 1 to the most important factor; 2 to the second most important factor and so on) Please leave blank any item that does not apply.
a) ____ Funding is too difficult to find; b) ____ Cofounders are too difficult to find; c) ____ I couldn't find a good enough idea; d) ____ It is too easy for someone to copy the idea; e) ____ It is too risky; f) ____ Opposition from family members; g) ___ My work unit did not allow me to leave; h) ____ Government policy was not encouraging at the moment
Please indicate your previous job responsibilities: 1 = Have held, 0 = Have not held.

General Management	Tech. Management	R & D	Sales/ Marketing	Finance/ Accounting	Advisory Board/ Board of Directors	Banks	Government

How much do you think the Chinese economy will grow in the next 5 years? ___% average growth rate per year

14a. Please describe the main jobs you have held since graduation, starting with the first job. If possible, attach a resume.

Job	**A (first job after graduation)**	**B**	**C (most recent)**
Type of organization: a) Business b) Government c) Academia d) Non-profit			
If in business, indicate the industry.			
Number of years in this position			
Did you leave this organization voluntarily or involuntarily?			
Ending yearly salary **			

** Including bonuses. Unit: 10,000 RMB . a) 0-2 b) 2-5 c) 5-10 d) 10-20 e) 20-50 f) more than 50

14b. If you worked in the government, what was the highest position you held. ___ (Please indicate the level: province/ministry, district/department, or country/bureau)

If you do not have overseas experience, please skip to the last section on Page 4. If you have overseas experience, please continue to finish this section.

If you had overseas experience please describe it below:

Government-funded study abroad	Self-funded study abroad	Visiting scholar	Business trip
□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No

If you studied abroad, in which year did you start? ___ How many years total? ___
If you went abroad as a visiting scholar or on a business trip, how many trips did you make? ____

Have you taken the TOEFL? □ Yes □ No If yes, what was your highest score? ___ (Perfect score at the time: ___)

Have you taken the GRE? □ Yes □ No If yes, what was your highest score (as %)? Logic: ___% Language: ___ %

Do you have overseas working experience? □ No □ Yes, full-time □ Yes, part-time If yes, how many years? ___

If no, please skip to question "27". If yes, please continue answering the following questions.

Please mark all the organizations in which you had overseas work experiences, including internships.

Investment Bank	Venture Capital	Consulting Firm	Startups	Large Corporate Lab	University Lab
□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No

18b. While overseas, the main city you worked in was _____ (Indicate country, province/state, city)

If you worked for a startup overseas, which category is most applicable to your experience in the startup: ____
a) Cofounder; b) Early employee; c) Joined after 1 year of its founding; d) Joined after 2 years of its founding

How would you categorize the overseas startup firm's performance? ___
a) Too early to tell; b) VC funding and was quite successful at IPO (or acquired at a good price); c) No VC funding and not successful; d) No VC funding but very successful; e) VC funding but no IPO yet; f) VC funding but failed at IPO (or acquired at a low price)

Please mark all the job functions you held when you worked overseas.

General Management	Tech. Management	R&D	Sales/ Marketing	Finance/ Accounting	Advisory Board/ Board of Directors
□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No

Were your jobs overseas related to the Greater China Region? □ Yes, very related □ Yes, somewhat related □ No
In your most recent overseas job, to what degree did your position maximize your potential? Please choose a number between 1 and 10. ___ (1=not at all; 10=maximum)

Please choose a number between 1 and 10 to evaluate how much Chinese people working abroad have been discriminated against? ___ (1= not at all; 10 = all the time)

While overseas, were you active in community activities or social gatherings? ___
a) Rarely participated; b) Participate sometimes; c) Participate often; d) Participate frequently

If you selected b/c/d, please indicate the type of activity. ___
1) Primarily hosted by Chinese; 2) Primarily hosted by non-Chinese; 3) Mostly hosted by Chinese; 4) Mostly hosted by non-Chinese; 5) 50-50 hosted by Chinese and non-Chinese

While abroad, did you publish academic papers in international academic journals? □ Yes □ No
If "Yes", how many were in the top 10 journals in your field? __

If you are willing, would you be able to found your own company overseas? □ No; □ Yes, with great difficulty; □ Yes, with some difficulty; □ Yes, with no difficulty

Which of the following items best describes your situation while abroad? ___
a) single; b) spouse was in China; c) spouse was overseas, but did not study abroad; d) spouse studied abroad but did not have full-time job; e) spouse had a full-time job abroad

Please choose a number from 1 to 10 to evaluate your foreign language capability. 1 = have difficulty; 10 = fluent
A) Speaking ___; B) Listening ____; C) Writing____

While overseas, how was your communication with China:

30a. How many times did you return to China in the past 2 years? ___ If you have already returned, describe the last 2 years abroad.

30b. In the past year, how many phone calls did you make to your parents or close relatives? __ If you have already returned, describe the last year abroad.

30c. How many contacts did you make with the following people in China in the past year: If you have already returned, describe the last year abroad.
1) Government official ___; 2) Scholar/ Academic Institution ___; 3) Business (company) ____;

Intent to return to China: a) already returned (Indicate year ____); b) plan to return in 1-2 years; c) plan to return in 3-5 years; d) have not made plans to return

If you have already returned to China, which of the following best describes your situation:
□ Returned with a group of friends; □ Returned alone by invitation; □ Returned alone without being invited

If you have returned to China, did you bring any technology back with you? □ Yes □ No
If "Yes", which following item best describes the technology? __
a) State of the art in the world; b) Did not exist in China but had existed abroad for sometime; c) Mature technology abroad but new to China; d) China had similar but this technology was more advanced; e) Mature in China but this technology was more advanced; e) Not an advanced technology but fits China's situation

If you have already returned to China, did you bring any new business models? □ Yes; □ No

Select a number from 1 to 10 to indicate your satisfaction with your abroad academic degree: ___
(1=not satisfied, 10=most satisfied)

If you have founded a new company or bought or managed a previously state-owned enterprise, please continue to the "Tsinghua Founders Survey." Otherwise, please skip to the last page.

Tsinghua Founders Survey

Please list your companies here, starting with the most recent one that you founded (Company A)

Company	Number of cofounders	Company address (City)	Number of employees	How company was founded & year *
A (latest firm)				
C (first firm)				

* How company was founded: a) founded b) bought c) privatized

Company	Publicly traded?	In operation?	If closed/acquired, which year?	Industry **
A (latest firm)	□ Yes □ No	□ Yes □ No		
C (first firm)	□ Yes □ No	□ Yes □ No		

** Industry: a) Internet; b) Aerospace; c) Drugs; d) Biotech; e) Medical Devices; f) Chemicals; g) Materials; h) Consumer Products; i)Electronics, Computers, Telecommunications Devices; j) Machinery; k) Other Manufacturing; l) Architecture; m) Energy; n) Electric Utilities; o) Telecommunications; p) Finance; q) Management & Finance Consulting; r) Publishing, Schools; s) Software; t) Law, Accounting, Miscellaneous Business Services

Please answer the remaining following questions about your first company (Company A)

Were the products and services to be provided by your new business available on the market 3 years ago?

□ No □ Yes, but only a few □ Yes, but not too many □ Yes, almost everywhere

Percentage of sales in various regions:

If your company is in China, ___% in province, ___ % in other provinces, ___ % international

If your company is overseas, ___ % in country, ___ % in China, ___ % other countries

Please describe the characteristics of Company A in the last 2 years (If the company closed or has been purchased, please answer for the last 2 years of operation)

	Number of employees	Profit/ Revenues (%)	R&D spending/ Revenues (%)	Marketing spending/ Revenues (Unit: 10,000 RMB)	% of profit reinvested
Last year*					
Two years ago**					

If the company closed or has been purchased, answer for the last year.

** If the company closed or has been purchased, answer for the two years before.

Please evaluate how important each of the following factors in creating your business on a scale of 1-5. (1=most important, 2=of second importance, etc)

a) ___ Speed/Time to market; b) ___ Intellectual Property protection; c) ___ Partnerships with other firms;
d) ___ Sponsorship from the government; e) ___ Access to a large amount of capital; f) ___ Other;

Was intellectual property (patented or copyrighted material) a critical factor in the company formation? □ Yes □ No
If "Yes", how many patents does your firm have? ____ How many were granted outside of China?___
If "Yes", were you an inventor or author of the intellectual property? □ Yes □ No

Please indicate the source of the idea for the product or service leading to the founding of the company? Please select the most important source. (Please answer even if the idea came from one of your co-founders and not from you.)
7a. If the primary source of the idea was at Tsinghua please indicate one:
□ Research, conference, or Grad Thesis □ In class □ Informal discussion with students/faculty/campus visitors
□ Working with an outside company □ Professional literature
7b. If the primary source of the idea was at another university, please indicate one:
□ Research, conference, or Grad Thesis □ In class □ Informal discussion with students/faculty/campus visitors
□ Working with an outside company □ Professional literature
7c. If the primary source of the idea was from other sources, please indicate one:
□ working in the industry □working in the military /government □ Discussions with social/professional acquaintances.

Does your company have stock options? □ Yes □ No, no plan to start □ No, but plan to start n the next 2-3 years

What is the founding capital of your company? _____ (Unit: 10,000 RMB)

Entrepreneurship is difficult; besides a new and innovative product, mobilizing social relationships is also needed to get a company off the ground. The following questions pertain to social relationships.

Indicate major funding sources by type, amount, and involvement in management.

Source of funding	Government	Tsinghua Alumni	Cofounder	Chinese Bank	Other company	Relative
Amount*						
On Board of Directors						

*(Unit: 10,000 RMB) a) 0; b) 1-10; c) 10-50; d) 50-100; e) 100-500; f) over 500

10b. Company's revenues last year: __ a) none; b) 1-10; c) 10-50; d) 50-100; e) 400-500; f) over 500 (10,000 RMB)

Did your company ask for angel investor funding? □ Yes □ No
If yes, how many did you contact? ___ How many of them invested? ___ Total investment: ____ (10,000 RMB)
On board of directors? □ Yes □ No

Did your company ask for venture capital (VC) funding? □ Yes □ No
If yes, how many did you contact? ___ How many of them invested? ___ Total investment: ____ (10,000 RMB)
On board of directors? □ Yes □ No

If no, because:
Did not need additional financing? □ Yes □ No
Funding not available? □ Yes □ No
Not aware of their existence? □ Yes □ No

Did your company form the following? (can pick more than one) □ Advisory Board □ Board of Directors

Please tell us more about your 4 most important co-founders, if any. *Roles include R&D, Sales & Marketing, Finance, Purchasing, Manufacture, and General management.

Co-founder	Role in the startup *	Previous job role *	Age at founding	Previously founded another company?
A				□ Yes □ No
B				□ Yes □ No
C				□ Yes □ No
D				□ Yes □ No
E Yourself				□ Yes □ No

This question is related to team building among cofounders and is important for us to understand entrepreneurship. Please fill out the information seriously, thanks! Please indicate the relationship between the listed cofounders with a check mark.
We only focus on the most important 5 cofounders (A-E). You are still (E) if there are less than 5 cofounders.

	E-A	E-B	E-C	E-D	A-B	A-C	A-D	B-C	B-D	C-D
Relative										
Classmate										
Alumni										
Previous Colleague										
Born in same city										

How many of the cofounders had industry experience in the same industry as your start-up? _____

Is your company's market/technology related to your previous work experience? □ No; □ A little; □ Moderate; □ A lot

Select a number from 1 to 10 to indicate the relationship with the following people during the first year of your business venture? (1=no relationship; 10=very strong relationship)
a) First Customers ____ b) Government regulators ____ c) Banks ____ d) First suppliers ____

In the past year, if you could obtain additional funding, how much would your company need to achieve optimal efficiency? ____ (Unit: 10,000 RMB)

If your company was founded after 2004, please only fill in the columns for 2004, 2005 and 2006.

Time	Year1 ____	Year 2	Year 3	2004	2005	2006*
Revenues (10,000 RMB) (0 if the firm did not have revenues)						

Alliance formed for product development?	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No

* If the company has closed, provide data for the last year the firm was open.

Please put a check mark to indicate the relationship with the following categories of people involved in your business:

	School Friend	Fellow Alumni in the same industry	Social circle	Co-Worker	Family Member
Investors					
Initial Employees					
Government regulators in charge of your industry					

Thank you very much for your assistance in completing this survey. If you have any questions or suggestions for this survey, please email tisghua.survey@gmail.com. If you would like a copy of the survey results of this research, please leave an e-mail or postal address.
E-mail:
Postal:
If the stamped, addressed envelope for returning the questionnaire has been misplaced, please return to:Tsinghua University Alumni Association
北京市海淀区清华科技园创新大厦，清华大学校友总会 李志华；邮政编码：100084