DISCUSSION PAPER SERIES

IZA

IZA DP No. 2992

A Study of Academic Entrepreneurs Using Venture Capital Data

Junfu Zhang

August 2007

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

A Study of Academic Entrepreneurs Using Venture Capital Data

Junfu Zhang
Clark University
and IZA

Discussion Paper No. 2992
August 2007

IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

IZA Discussion Paper No. 2992
August 2007

ABSTRACT

A Study of Academic Entrepreneurs Using Venture Capital Data*

Academic entrepreneurship has become an increasingly important channel through which universities contribute to economic development. This paper studies academic entrepreneurs using a comprehensive venture capital database. I find that about two-thirds of the academic entrepreneurs locate their businesses in the same state as their universities. National academy membership and number of faculty awards, measures of a university's research quality, are the most significant variables in explaining the number of academic entrepreneurs from a university. In contrast, the abundance of venture capital near the university has no significant effect on academic entrepreneurship.

JEL Classification: M13

Keywords: academic entrepreneur, university spin-off, venture capital

Corresponding author:

Junfu Zhang
Department of Economics
Clark University
950 Main Street
Worcester, MA 01610
USA
E-mail: juzhang@clarku.edu

* I would like to thank Nikesh Patel, whose careful and patient work on data coding has been tremendously helpful. This paper has benefited from the comments by Jon Haveman, Martin Kenney, Young-Choon Kim, Josh Lerner, Ting Lu, David Neumark, Xue Song, Michael Teitz, Rob Valletta, Brandon Wall, Peyton Young, and seminar participants at the Public Policy Institute of California, the Center for Globalization and Information Technology at the University of California at Berkeley, the Technology Transfer Society 26th Annual Conference in Albany, New York, the 26th Annual Research Conference of the Association for Public Policy Analysis and Management (APPAM) in Atlanta, Georgia, and the Department of Economics at California State University, Hayward.

1. Introduction

This paper studies business founders who have worked at universities. I call these founders academic entrepreneurs, and their firms university spin-offs (USO). I seek to answer the following questions: What is the academic background of these entrepreneurs? What industries do they enter? Do they locate their businesses close to their universities? And most importantly, which types of universities tend to generate academic entrepreneurs?

Entrepreneurship among academics is by no means a new phenomenon. Professorial entrepreneurs played an important role in creating the U.S. biotechnology industry (Kenney, 1986a, 1986b). Today's biotech industry leaders such as Genentech, Amgen, Biogen Idec, and Chiron were all founded or co-founded by university professors.[1] The information technology industries, though more famous for college-dropout entrepreneurs such as Bill Gates, Steve Jobs, and Michael Dell, also provide many examples of academic entrepreneurs: The legendary personal computer software pioneer Gary Kildall, whose CP/M operating system dominated the personal computer industry in the early years, was once an instructor at the Naval Postgraduate School in Monterey, California. Silicon Valley's most famous serial entrepreneur Jim Clark, the founder of Silicon Graphics, Netscape, Healtheon, myCFO, and Shutterfly.com, started his career as a professor at UC Santa Cruz and later Stanford University. Michael Mauldin, a computer scientist at Carnegie Mellon University, founded Lycos, one of the leading Internet search engines.[2]

Academic entrepreneurs caught scholarly attention primarily in two closely related contexts. First, academic entrepreneurs are viewed as important players in the process of technology transfer from university to industry. A great deal of knowledge created at universities is tacit and uncodifiable, and the dissemination of such knowledge requires direct interpersonal contact. For this reason, moving people is believed to be the most effective way to move knowledge (Allen, 1984). Thus the movement of university

[1] Biogen Idec was formed by a merger between Biogen and IDEC Pharmaceuticals, both originally founded by academic entrepreneurs. Two of Biogen's founders, Walter Gilbert and Phillip Sharp, later won the Nobel Prize.

[2] It is well known that popular Internet search engines Yahoo! and Google both grew out of Stanford. But they were founded by students instead of university employees and thus not considered as university spin-offs by the definition used here.

employees to industry creates an important channel for technology transfer (Samson and Gurdon, 1993; Zucker et al., 2002).[3] Understanding academic entrepreneurship and university spin-offs is therefore an important part of the research agenda on technology transfer.

Second, studying academic entrepreneurs helps us understand the role of research universities in regional economic development. It is well recognized that universities such as Stanford and MIT played a crucial role in the development of regional high-tech economies, partly through spinning off technology companies (Saxenian, 1994; Zhang, 2003). A growing literature has studied the link between academic entrepreneurship and regional development. Audretsch and Stephan (1996) find that when biotech companies are founded by university-based scientists, their founders tend to be local. Recent research by Zucker and Darby and coauthors (e.g., Zucker, Darby, Armstrong, 1998; Zucker, Darby, Brewer, 1998) show that "star scientists" have a significant impact on the timing and location of the formation of biotechnology companies. Shane (2004) is a comprehensive study of academic entrepreneurship primarily based on data from MIT, often considered one of the most successful research institutions in spawning technology companies. Feldman (1994), on the other hand, studies why a top research university such as Johns Hopkins contributes little to the local economy through academic entrepreneurship and knowledge spillovers.

Given the value of studying academic entrepreneurs, scholars resort to various sources of data to conduct research in this area. Depending on the data at hand, researchers often invoke very different definitions of academic entrepreneurship and university spin-offs. (See Pirnay et al., 2003 for a typology of university spin-offs.) Klofsten and Jones-Evans (2000) use a very broad definition of academic entrepreneurship that covers not only new firm formation but also consulting and patent-seeking activities of academics. In Stuart and Ding (2004), an academic entrepreneur may only serve on the scientific advisory board of a startup.[4] In several studies, Scott Shane and co-authors investigate "university spin-offs" as start-ups exploiting university

[3] As quoted by Zucker et al. (2002), former Stanford president Donald Kennedy once observed that "technology transfer is the movement of ideas in people."

[4] In an early study of life scientists, Louis et al. (1989) even considered engaging in externally funded research and earning supplemental income as academic entrepreneurship.

inventions but not necessarily founded by university employees (e.g., Shane and Stuart, 2002; Di Gregorio and Shane, 2003; and Nerkar and Shane, 2003).[5] These studies, though related to this work, do not address exactly the same questions.[6]

When defining university spin-offs as firms founded by academic entrepreneurs affiliated with a university, researchers apparently face a data constraint. As a result, they often focus on a small number of universities and rely on case studies or small-scale survey data. McQueen and Wallmark (1982) study spin-off companies from the Chalmers University of Technology in Sweden. Smilor et al. (1990) examine technology start-ups from the University of Texas at Austin. Using personal interviews, Steffensen et al. (2000) analyze six spin-off companies from the University of New Mexico. Kenney and Goe (2004) use survey and Internet data to compare "professorial entrepreneurship" at UC Berkeley and Stanford.

Lowe and Gonzalez-Brambila (2005) and Toole and Czarnitzki (2005) are perhaps the only studies that use a definition of academic entrepreneurs similar to mine and rely on systematic analysis of relatively large databases. Lowe and Gonzalez-Brambila identify 150 "faculty entrepreneurs" in 15 academic institutions and investigate whether entrepreneurial activities affect their research productivity. Toole and Czarnitzki identify 337 academic entrepreneurs by matching the National Institute of Health (NIH) researcher database with data from the U.S. Small Business Innovation Research (SBIR) program. They find that firms linked to academic scientists show a better performance in terms of receiving follow-on venture capital investment, completing SBIR program, and filing patent applications.

In this paper, I employ a comprehensive venture capital database to study academic entrepreneurs. This database tracks all venture-backed start-ups in the United States and has detailed firm-level information. In addition, it contains biographical information about a large number of start-up founders, which makes it possible to identify whether a founder has ever worked for a university. By focusing on venture-backed firms, I am excluding a large proportion of new businesses founded by academic

[5] Data on companies founded to exploit MIT intellectual property during 1980-1996 shows that about one third of them have the university inventor as the lead entrepreneurs (Shane, 2004, pp. 6-7).
[6] There is also literature that studies spin-offs from existing companies that pays more attention to the process of business creation rather than technology transfer. See, for example, Klepper (2001) and Gompers et al. (2005).

scientists.[7] However, venture-backed start-ups often possess the greatest growth potential and may have a much greater effect on the economy than their share implies. In addition, the richness of the data, enhanced by information from various other sources, allows one to study academic entrepreneurs across industries and universities, which previous studies were unable to do.

I find that entrepreneurial activities among university employees concentrate in biotechnology and information technology industries. About two-thirds of the venture-backed university spin-offs are located in the same state as the universities. National academy membership and total faculty awards, measures of a university's research quality, are the most significant variables in explaining the number of spin-offs at the university level. Although I focus on venture-backed start-ups, the abundance of local venture capital has no significant effect on the number of spin-offs from the university, which is rather surprising.

The rest of the paper is organized as follows: Section 2 describes the venture capital data used in this study. Section 3 presents some descriptive statistics, including the specialty, industry, business location, and academic affiliation of venture-backed academic entrepreneurs. Section 4 analyzes why some universities generate more venture-backed entrepreneurs than others. And finally, section 5 offers some concluding remarks.

2. Data

VentureOne, a leading venture capital research company based in San Francisco, provided the data used in this study. Founded in 1987, VentureOne has been continuously tracking equity investment in the United States and abroad. It collects data by regularly surveying venture capital firms for recent funding activities and portfolio updates, gathering information through direct contacts at venture-backed companies, and scouring various secondary sources such as company press releases and IPO prospectuses

[7] According to the survey conducted by Association of University Technology Managers (2005, pp. 28), 85 (18.6%) of 458 start-ups licensing technology from U.S. research institutions (including research hospitals and research institutes) received venture capital financing. Data on companies founded to exploit MIT intellectual property during 1980-1996 indicates that venture capitalists and angel investor groups helped finance 30% of these companies (Shane, 2004, pp. 236).

(VentureOne, 2001). VentureOne intends to capture all the venture-backed companies in the United States and their early-stage financing events.[8]

For each deal, VentureOne keeps a record of its size, stage of financing, closing date, the venture capital firms involved, and detailed information about the firm that receives the money, including its address, founding year, industry, and so on. In addition, VentureOne tracks the venture-backed company and updates the information about its employment, business status, ownership status, etc. VentureOne claims that they have "the most comprehensive database on venture backed companies."[9] While VentureOne's database is maintained for commercial purposes, its rich information has attracted many academic researchers. Some recent empirical work, such as Gompers and Lerner (2000), Cochrane (2005), Gompers et al. (2005), and Zhang (2003, 2007), has used VentureOne data.

The version of the data used in this study covers venture capital deals completed in the United States from the first quarter of 1992 through the fourth quarter of 2001. It includes 22,479 rounds of financing, which involved 11,029 firms. Among these firms, 83.5% were founded in or after 1990. VentureOne categorizes venture-backed firms into 16 "industry segments." Table 1 presents venture capital investment in each industry during 1992-2001. On the top of the list are all Internet-related industries, including communication, software, consumer/business services, and information services. Together, these four industries account for 71.3% of the total venture capital investment over the decade. Venture capital investment also tends to concentrate geographically. As shown in Table 2, California alone received 44.1% of the U.S. total; Massachusetts, a distant second, received about 10% of the U.S. total. The top ten states together absorbed 82.5% of the U.S. venture capital investment.[10]

---

[8] VentureOne defines a venture capital firm as "a professional, institutional venture capital limited partnership that generally manages over $20 million in assets and invests in privately held companies" (VentureOne, 2000). Once a company receives some investment from venture capital firms, it becomes a "venture-backed company" and enters the VentureOne database. Once in the database, VentureOne tracks the company's financing from all sources, including bank loans and IPO. While I do not count bank loans or money raised through an IPO as venture capital, I do include equity investment made by non-VC corporations or "angel investors" as venture capital in my calculations.

[9] See http://www.ventureone.com/products/venturesource.html (accessed on January 18, 2007).

[10] To put this into perspective, in 2004, 55.5% of the U.S. GDP came from the top ten states.

VentureOne also provided a separate data set containing information about venture-backed firm founders. However, the founder data are incomplete: Founder information is available for 5,972 of the 11,029 venture-backed firms.[11] Because many firms are co-founded by more than one individual, I end up with a total of 10,530 individual founders.

The availability of founder information is not entirely random, which stems from VentureOne's database management practice. A firm enters VentureOne's database once it receives equity investment from a venture capital firm. VentureOne regularly updates the information about the venture-backed firm until it ceases operation, is acquired, or goes public.[12] Therefore, VentureOne will follow some firms longer than others. VentureOne is more likely to obtain a firm's founder information if the firm has been followed longer. VentureOne also appears to be more likely to capture founder information for firms founded in the late 1990s, possibly because these firms tend to reveal a lot of company and founder information at their websites. For example, among firms with founder information available, 20.5% were founded before 1995; for the rest, 62.4% were founded before 1995. Indeed, firms with founder information tend to be privately held, and are less likely to be out of business, to be acquired, or to complete an initial public offering (IPO), which is consistent with the fact that they are younger. In subsequent work, I will focus on firms with founder information. As long as this sample selection is independent of whether or not a founder is an academic entrepreneur, my results will not be biased.

For each founder, there is a data field containing brief biographical information of the person. It describes the founder's working experiences, which, in most cases, not only specifies the companies or institutions a founder worked for but also includes the position held. Because VentureOne did not code founders' biographical information, I started by carefully reading this field. In particular, I constructed a variable to indicate whether an individual previously worked for a university or college.[13] If so, values are assigned to a

---

[11] For an additional 387 firms, some non-biographical information about the founder is available, but these data are not useful to identify academic entrepreneurs.

[12] For VentureOne's research methodology, see http://www.ventureone.com/ii/research.html (accessed on January 18, 2007).

[13] Some founders' bio indicated a working experience at some research lab or research center that may or may not belong to a university. I search the Internet to investigate whether the lab or research center is

set of variables including the name of the institution, the job position (if indicated), the person's specialty (if identifiable), and the state where the institution is located. For a small group of people who had worked at more than one academic institution, only the latest academic position is counted.

An academic entrepreneur's specialty is not always identifiable in the data. For example, an entrepreneur's biographical sketch could read like this: "professor, Johns Hopkins University." In this case, the "specialty" field is left blank. Most cases provide more information, for example: "professor, Department of Computer Science, Carnegie Mellon University," or simply "professor of chemistry, Stanford University," which clearly indicates this person's specialty.

The firm data and the founder data share a common variable, "EntityID," by which I can match a firm with its founder when founder information is available. Using this rich data set, I can characterize academic entrepreneurs along many dimensions with simple descriptive statistics.

3. Descriptive Statistics on Academic Entrepreneurs

This section describes the specialties and academic affiliations of academic entrepreneurs and summarizes the industry and business locations of the university spin-offs they founded.

Among the 10,530 venture-backed firm founders in the VentureOne data, 903 had worked for academic institutions, which account for 8.6% of the total.[14] These 903 individuals founded or co-founded 704 venture-backed firms, and 35 of them founded more than one firm.

3.1 Positions in academic institutions

associated with some university. If it is (e.g., Lincoln Laboratory of MIT), the founder is counted as an academic entrepreneurs. Otherwise (e.g., Lawrence Livermore National Laboratory), the founder is not considered an academic entrepreneur.

[14] There are 23 entrepreneurs whose biographical information contains university names, but they were "research assistants," "Ph.D. students," or "post-doc fellows" and did not hold formal job positions at universities. I excluded these founders from the group of academic entrepreneurs. One might argue that post-doc founders should be counted as academic entrepreneurs. However, because VentureOne often collects founders' biographical information from secondary sources such as company websites where a post-doc experience may not be significant enough to be mentioned, it is possible that the database fails to identify many post-doc founders. In that case, it makes more sense to exclude them all. Given that the number of post-doc founders is so small, it does not matter how I treat them.

Table 3 summarizes the positions these academic entrepreneurs held at universities. Note that these could reflect either current or former posts. The VentureOne data do not indicate whether a firm founder has or has not given up his or her position in a university. Ample anecdotal evidence suggests that professors usually retain their academic positions when they start firms; yet non-tenure track employees may have to quit if they choose to be entrepreneurs.

As Table 3 shows, nearly two thirds of the entrepreneurs from universities are professors. Most people in this group are self-identified as professors. A few of them are "dean" or "chairman" of some academic departments, which are undoubtedly also professors. So these entrepreneurs are categorized into the professor group instead of the executive group.

The second largest group (close to 16% of the total) is research scientists at universities. These individuals usually identified themselves as researchers at university laboratories. It is likely that they did not hold tenure track positions and it is impossible to tell from the data whether they also do some teaching.

The third group identify themselves as "directors." This group overlaps with some of the other groups. For example, the director of a research lab is likely to be a professor or a research scientist; on the other hand, the director of the department of continuing education in a university could be an executive. Instead of using subjective judgment to assign these people to other groups, they are analyzed as a separate group.

The professor and research scientist groups constitute 78.2% of all entrepreneurs with a prior university affiliation. The proportion rises to 86.1% when directors are included. This implies that around 80% of these entrepreneurs held research positions at academic institutions. Most likely, they started new businesses in order to commercialize their own research findings.

The executive and the lecturer/instructor positions are also self-identified, with the latter likely to be non-tenure track temporary teaching jobs. Finally, all other positions are combined into the "other" group, which includes technicians, programmers, and other staff members in various academic or administrative departments at universities.

Among the 903 academic entrepreneurs, 669 have identifiable specialties. Table 4 describes the distribution of these individuals by specialty. As Table 1 shows, venture capital investment is overwhelmingly concentrated in high-tech industries. So it is not surprising that most of the academic entrepreneurs have an engineering or science background. More than 45% (304) specialize in engineering, among which 186 could be identified as experts in computer science or electrical engineering. Another 44% of academic entrepreneurs specialize in medical sciences, biological sciences, or chemistry. Obviously, computer industries and medical/biological industries attracted most of the academics.

While anecdotal evidence suggests that in the 1990s many business students considered entrepreneurship a desirable career track, the data show that business professors also followed the trend. In fact, they form the largest non-scientist/engineer group among academic entrepreneurs. The “other” group represents a wide range of specialties, including for example architecture, economics, physics, psychology, and statistics. Social sciences and humanities are under-represented, with fewer than ten of the academic entrepreneurs from such disciplines. Of course, academics in social sciences and humanities may not be so much less entrepreneurial as this difference implies. It is quite possible that many of them also start businesses, but they are not backed by venture capital and thus not captured in the VentureOne data.

3.2 Distribution across industries

Table 5 presents the distribution of all entrepreneurs and academic entrepreneurs across industries. Overall there are 10,530 entrepreneurs in this version of the VentureOne data. More than three-fourths of these entrepreneurs (8,033 or 76.3% of the total) are in the software, consumer/business services, communication, and information services industries. In contrast, Table 1 indicates that only 64.2% of venture-backed companies belong to these four industries. This discrepancy stems from two facts: First, founder information is available for a higher proportion of companies in these industries; and, second, an average company in these industries has more co-founders.

The 903 academic entrepreneurs constitute 8.6% of the total number of entrepreneurs. The percentage of academic entrepreneurs varies substantially across industries. While more than 40% of the entrepreneurs in the biopharmaceutical industry have worked for universities, only 3.1% of the firm founders in the consumer/business services industry are academic entrepreneurs. Each of the four largest industries has a below-average proportion of academic entrepreneurs.

The biopharmaceutical industry has the largest number of academic entrepreneurs. The second largest group of academic entrepreneurs is in the software industry. Together, these two industries account for more than half of the 903 academic entrepreneurs. In terms of the total number of entrepreneurs, the software industry is almost five times as large as the biopharmaceutical industry (2,963 vs. 618). However, the biopharmaceutical industry attracted more academic entrepreneurs than the software industry (252 vs. 226). In fact, the proportion of academic entrepreneurs in the software industry is below average.

The biopharmaceutical industry truly stands out in that 40.8% of the venture-backed entrepreneurs in this industry are from universities. If we look at companies founded by academic entrepreneurs, the proportion is even more striking: 51.3% (182 out of 355) of the venture-backed biopharmaceutical companies are university spin-offs. Other major industries (with more than 100 entrepreneurs in the sample) over-represented by academic entrepreneurs include the medical information service (17.9%) and medical device (14.7%) industries.

Academic entrepreneurs have such a high tendency to start businesses in the biopharmaceutical industry that it calls for some explanation. A few possible reasons may account for this phenomenon.

1) *Marketability of technology*. In general, whether an inventor benefits from his/her invention depends on whether it is easily marketable. If there is ready market demand for the technology, such as in the case of Nobel’s dynamite, the inventor will see the economic value right away and try to capture it. On the other hand, if there is no immediate market value, such as in the cases of the personal computer and Internet, the inventor often misses the chance to reap the economic benefit. In these situations, it usually takes one or several entrepreneurs rather than the inventor to bring the technology to the market, and it is the entrepreneurs who are financially rewarded. For example, personal computers hardly found any buyers when the technology first became available. IBM, Hewlett-Packard, and DEC all missed the chance to first mass-market personal

computers, although they were in a better position than anybody else. It took Steve Jobs, not the inventor, to found the Apple Computer to establish the enormous PC market.

In the case of biotech and medical research, applications in the healthcare industry have long become well known. Biotechnology did not create its own demand; it helps serve the multi-billion-dollar market that already exists for medicinal drugs.[15] Since the market awaits technological breakthroughs, it is very likely that the inventors themselves (professors) will see the economic value of biotechnology and seek to realize it. While existing market demand for more effective drugs is salient, biotechnology may have some other not-so-obvious applications. If some of those applications are carried out in the future, it is likely that non-academic entrepreneurs, rather than university professors, will make it happen.

2) *Diffusion of technology*. Biotechnology is sophisticated, not easily codifiable, and well protected by patent law. All these features determine that the diffusion of biotechnology is relatively slow. And therefore, for a long time, only the inventor of a new technology (very likely a university researcher) and others involved in making the technological breakthrough are in a position to commercialize it. This is in sharp contrast to the situation in other technology industries. For example, during the Internet boom, the core technology of many dot-coms, such as Amazon.com and eBay, was no more than an innovation in usability. Such ideas can be understood and imitated by many people outside the academic world, which is not the case with complex biotech products.

3) *Asymmetric information and signaling*. Most startups in biotech will remain unprofitable over a long horizon.[16] It first takes years to develop a viable biotech product; and then many of these products are subject to a lengthy approval process by the Food and Drug Administration (FDA).[17] Therefore, investment in biotech is highly risky. Related to this risk is an asymmetric information problem between entrepreneurs and investors: Entrepreneurs know more than investors about just how risky a proposed

---

[15] In 2005, the U.S. spent approximately $2 trillion — 16.0% of its GDP — on health care, of which $200.7 billion goes to purchase prescription drugs. See http://www.cms.hhs.gov/NationalHealthExpendData/downloads/tables.pdf (accessed on January 18, 2007).

[16] For example, I examined the 72 biotech firms that were included in the NASDAQ Biotech Index as of December 2002. Their median founding year was 1990, and by 2002, their average age was 12.6 years. Yet, even among these most successful biotech firms, only 12 were making a profit in 2002. Only 25 had enough total revenue to cover R&D expenditure and 31 spent more than 200% of total revenue on R&D.

[17] The median duration of successful clinical trials is six years (Zhang and Patel, 2005, p. 13).

project might be and it is extremely difficult for investors to acquire the knowledge to fully evaluate the blueprint of a biotech start-up.[18] In this situation of asymmetric information, venture capitalists must base their investment decisions partly on their faith in the entrepreneurs. On the other side, entrepreneurs want to send signals to investors revealing the long-term value of their ideas. Naturally, a record of outstanding work in hard science will be the most convincing evidence that the entrepreneur knows the true value of the proposed idea and has the ability to implement it. At the same time, venture capitalists know they will earn their money back by selling a start-up to the public through an IPO even before the firm becomes profitable. But how do they convince the public that a currently unprofitable start-up is valuable? Again, an established scientist will be a very important selling point. If this is how venture capitalists evaluate proposals of biotech start-ups, prominent scientists (mostly university professors) have a much better chance than others to pass the screening process.

3.3 Academic location vs. business location

An important question regarding academic entrepreneurs is whether they locate their businesses close to their academic institutions. In other words, to what extent is knowledge transfer through entrepreneurship a local phenomenon? This question concerns not only researchers, but also state and local policymakers.

By merging the entrepreneur data with the firm data, I can describe the distribution of academic entrepreneurs by their academic and business locations (Table 6). Among the 903 academic entrepreneurs, 60 were previously employed at foreign institutions, including universities in Britain, Canada, Germany, Israel, and other countries. VentureOne data only include foreign researchers who founded firms in the United States; it is not designed to capture U.S. researchers if they started businesses overseas. Thus it is impossible to measure the net flow of academic entrepreneurs between the United States and the rest of the world.

Among the 843 academic entrepreneurs from U.S. institutions, 571 (just over two-thirds) located their businesses in the same state as their academic affiliations. That is,

[18] See, for example, Leland and Pyle (1977) for a formal discussion of the informational asymmetries between entrepreneurs and investors.

less than one third of academic entrepreneurs moved to other states. Thus technology transfer through academic entrepreneurs is, largely, a local phenomenon.[19]

Table 6 captures the net flow of academic entrepreneurs at the state level. California is clearly the "winner." In my sample, 244 California university employees founded venture-backed firms; yet 364 academic entrepreneurs had businesses in California. Whereas 27 academic entrepreneurs left California, 147 moved into California, resulting in a net gain of 120 academic entrepreneurs (and a net gain of 95 university spin-offs, not shown in Table 6). This is not surprising because the dataset covers the period between 1992 and 2001, during which time the Internet revolution was the primary driver of the venture capital investment, and California was the main destination of this "digital rush." Besides California, other significant winners include Washington (+8), Virginia (+8), Arizona (+5), Texas (+4), Minnesota (+4), and Oregon (+4). Obviously, all these "winning" states are nowhere near comparable to California.

Since my data only include venture-backed firms, one might think that entrepreneurs must be chasing money and that being rich in venture capital guarantees a net gain of academic entrepreneurs. This is hardly true. For example, Massachusetts is number two in terms of total venture capital investment and its academic institutions produce 168 venture-backed entrepreneurs. However, compared with California, Massachusetts has a fairly low retention rate. Forty-nine, or 29.2% of the 168 entrepreneurs chose to leave Massachusetts. At the same time, 45 academic entrepreneurs moved to Massachusetts from other states, resulting in a net loss of four academic entrepreneurs. New York, the number three state in total venture capital investment, did even worse with a net loss of 21 academic entrepreneurs. Other states that experienced a major loss include Illinois (-10), Arkansas (-9), Pennsylvania (-9), Missouri (-8) and Indiana (-7).

Arizona and Arkansas are two extreme cases. Arizona produced no academic entrepreneurs but ended up with five, all of whom came from other states. On the contrary, universities in Arkansas generated nine academic entrepreneurs, but none of

[19] The annual survey by the Association of University Technology Managers (2005, p. 28) shows that 74.5% of 462 start-up companies that formed in 2004 through licensing technology from U.S. research institutions were located in the same state as the institution.

them chose to stay in Arkansas and no one came from other states, leaving Arkansas with no venture-backed university spin-offs.

3.4 Academic affiliations

Table 7 lists top academic institutions by the number of academic entrepreneurs and the number of venture-backed firms they founded. The number of entrepreneurs and the number of spin-offs do not agree because an entrepreneur may found more than one firm and a firm may (usually) have more than one founder.

It is not surprising that Stanford and MIT overwhelmingly outperform other universities. The important role of these two academic institutions in the development of Silicon Valley and the Boston region is well documented in the literature (see, for example, Etzkowitz, 2002; Gibbons, 2000; Saxenian, 1994). While Harvard and UC Berkeley are often considered different from their respective neighbors in terms of their relationship with industry (Etzkowitz, 2002; Kenney and Goe, 2004), they have also generated many academic entrepreneurs. In fact, they spun off more venture-backed firms than any other institutions except Stanford and MIT.

One common feature of the institutions listed in Table 7 is that they are all top research universities. No liberal arts college or teaching university makes the list. Even in the whole sample, no more than five entrepreneurs are from institutions that specialize in teaching. This suggests that it is the research at these institutions that spurred entrepreneurial activity and attracted venture capital investment.

4. Why Do Some Universities Generate More Entrepreneurs than Others?

Why do some universities have more academic entrepreneurs and spin off more firms than others? While this is recognized as an important question, not much work has been done on the subject due to the limitation of data. Di Gregorio and Shane (2003) try to explain why some universities attract more start-ups to exploit their intellectual property than others. In their study, start-ups are not necessarily founded by university employees. Kenney and Goes (2004) use survey and Internet data to explore why the departments of electrical engineering and computer science at Stanford produce more professor entrepreneurs than their counterparts at UC Berkeley. Focus on two universities prevents them from conducting a multivariate analysis. This nationwide VentureOne database allows me to perform a statistical study of academic entrepreneurs and investigate the factors that determine inter-university differences.

4.1 Multivariate analysis

I used the VentureOne data to construct the dependent variable: the number of academic entrepreneurs (or spin-offs) from a university. Table 8 is a list of all the explanatory variables used in the analysis. Many of the variables were constructed using data from The Center for Studies in the Humanities and Social Sciences at the University of Florida.[20] The Center conducts an annual ranking of top research universities in the United States starting from 2000. For this purpose, they collect and maintain data on universities from various sources. Using these data, I constructed several university-level variables that are postulated to be related to academic entrepreneurship. These include measures of faculty quality (national academy membership, total faculty awards), research budget (total expenditure on research, research expenditure on science and engineering), advanced training (doctorial degrees awarded, number of post-docs), and whether the school is private.[21]

The Center at the University of Florida has data for 616 universities. However, many variables are missing, especially for minor universities. There are a total of 150 universities for which every variable is available. I used this subset of universities to match the VentureOne data. In particular, the number of academic entrepreneurs and the number of university spin-offs are generated from the VentureOne data for each of the 150 universities. These numbers are greater than zero for 98 universities. I assign zeros to the rest of them.

I also used VentureOne data to construct variables that measure the availability of venture capital. Since I focused on venture-backed firms only, it is natural to hypothesize that local abundance of venture capital is a significant determinant of academic entrepreneurs. Thus I calculated total local venture capital investment during 1992-2001. For each venture capital deal, VentureOne gives the zip code of the venture-backed firm. The zip codes of universities were gathered by Internet search. These data were merged

[20] Data downloaded from http://thecenter.ufl.edu/, on October 22, 2003.

[21] The Center also has data on undergraduate quality (median SAT scores, number of merit/achievement scholars), total enrollment, size of endowment, annual giving by alumni and others, etc. But such information is not particularly relevant for the purpose here.

with the U.S. Census Bureau's ZIP Code Tabulation Area (ZCTA) files[22] to assign latitude-longitude coordinates to the zip codes, which were then used to calculate the distance between any two zip code areas.[23] For each academic institution, I computed the total venture capital investment within 50 miles during 1992-2001 (Local-VC 50). Since it is unclear *a priori* what degree of proximity to venture capital investment will have an effect, I also computed total investment within 25 miles, 75 miles, and 100 miles for robustness check. Another venture capital variable is the number of venture capital firms located in the university's state (State-VC-Firms). This was constructed based on the directory of venture capital firms published by VentureOne (VentureOne Corporation, 2000).

In addition, university policy could also be a relevant factor in explaining the number of academic entrepreneurs. Universities with policies supporting entrepreneurial activities will likely generate more spin-off companies. For example, Di Gregorio and Shane (2003) included a set of policy variables to explain why some universities have attracted more start-ups to license their technologies than others. They found that some of the policies, such as inventor's share of royalties and whether the university can make equity investment, do have significant effects. I constructed two variables to control for the policy effect: the age of the university's Office of Technology Transfer (OTT) and the total number of patents granted to the university during 1969-2000.[24] The former is acquired through the Association of University Technology Managers (AUTM) and, when not available from AUTM, directly from OTT offices through e-mail or phone call; the later is downloaded from the U.S. Patent and Trademark Office.[25] All major research universities today have an OTT office to help their faculty with patent application and other commercialization activities. Yet the opening dates of these OTT offices vary a lot. While MIT had such an office in 1940, Princeton did not establish one until 1987. One suspects that those universities with a long tradition of facilitating entrepreneurial activities among faculty members should generate more academic entrepreneurs. The

[22] Data downloaded from http://www.census.gov/geo/www/gazetteer/places2k.html on January 20, 2004.
[23] The distance (D) between two points (longitude1, latitutde1) and (longitude2, latitutde2) on the earth is calculated using the formula D = R*arccos [cos(longitude1-longitude2)*cos(latitude1)*cos(latitude2) + sin(latitude1)*sin(latitude2)], where R is the radius of the earth (3961 miles). See the derivation of this formula at http://www.cs.cmu.edu/~mws/lld.html (accessed on March 12, 2004).
[24] Young-Choon Kim has helped with obtaining the data to construct these two variables.
[25] Data downloaded from ftp://ftp.uspto.gov/pub/taf/ on November 9, 2005.

number of patents is an indicator of both how applied a university's research is and whether its faculty actively seek to commercialize their inventions. Thus universities with a large number of patents are expected to have more academic entrepreneurs.

The variables measuring university quality are highly correlated with each other: A university with a distinguished faculty is very likely to spend a lot on research and train a large number of doctoral students and post-docs. Likewise, the measures of venture capital abundance are also correlated with each other. Table 9 presents the pair-wise correlation between all the dependent and independent variables. Notice that all the correlation coefficients are positive. The number of academic entrepreneurs and the number of university spin-offs have a correlation coefficient of 0.997. Thus there should not be a big difference using either one as the dependent variable. The national academy membership and the number of faculty awards have a correlation coefficient of 0.818; the correlation between total research expenditure and research spending on science and engineering is 0.983. All these suggest that there is a potential multi-collinearity problem if all the explanatory variables are included in a single regression.

Therefore, as a preliminary test, I start by running simple OLS to regress a university's number of academic entrepreneurs on each of the explanatory variable listed in Table 8, to examine which variable has the highest explanatory power (results in Table 10). Not surprisingly, in separate regressions, all university characteristics are significant and positively correlated with the number of entrepreneurs from a university. That is, no matter which measure is used, a university of higher quality, closer to VC investment, or highly active in commercializing inventions tends to generate more venture-backed academic entrepreneurs. This is true even if I exclude the four outliers (Stanford, MIT, Harvard, and UC Berkeley) from the single-variable regressions.

However, the goodness of fit (measured by R^2) varies a lot among these regressions. The two university characteristics that are most closely related with the number of academic entrepreneurs are national academy membership and total faculty awards. This suggests that the number of a university's academic entrepreneurs has more to do with its faculty quality than its research budget or advanced training. The regression on national academy membership (using the full sample) has an R^2 higher than 0.8. That is, this variable alone explains more than 80% of the variation in the number of academic entrepreneurs across universities. Besides these two faculty quality measures, the number of post-doc appointees explains more of the variation in the dependent variable than other university characteristics. This also is a good indicator of quality of research. In the regression using the full sample, total number of patents also has a high R^2. Yet its R^2 becomes substantially smaller once the four outliers are excluded.

Single-variable OLS regressions also show that total venture capital investment within 50 miles is significantly and positively correlated with a university's number of academic entrepreneurs. That is, a university in an area with a higher total venture capital investment does generate more venture-backed entrepreneurs, although as Table 6 shows, not all the spin-offs are located in the same state as the university. I also tried alternative measures of local VC investment and find that the smaller the geographic region is defined, the higher degree of correlation is observed between a university's number of entrepreneurs and local venture capital investment. While total venture capital investment within a 100-mile circle explains only 17% of the variations in academic entrepreneurs, the total within a 25-mile circle explains 48%. The number of venture capital firms at the state level ─ an even bigger geographic region ─ shows a much weaker correlation with the number of academic entrepreneurs. All these results seem to confirm the well-known notion that venture capital investment is a local phenomenon (see, for example, Gompers and Lerner, 1999; Sorenson and Stuart, 2001).

As one uses smaller and smaller geographic definitions, one needs to be more and more cautious about how to interpret the coefficient of the venture capital variable. Apparently, if many academic entrepreneurs stay close to the university,[26] more venture-backed academic entrepreneurs necessarily result in more venture capital investment locally. But in that case, a positive coefficient does not represent a positive effect of venture capital on academic entrepreneurship. From this point on, the analysis will use VC investment within 50 miles and total number of VC firms at the state level to measure the availability of VC locally, and use other VC measures only for sensitivity analysis.

Table 11 presents the results from multivariate regression analysis. Again, because the independent variables are highly correlated, I tried various specifications. I first used the venture capital measures as independent variables, then added different

[26] This is likely the case especially when professorial entrepreneurs want to retain their academic positions.

university characteristics one by one, and finally pooled all the explanatory variables in a single regression (Models 1-9). Whether a university is private or not is included in all the specifications as a control variable. Because there are many zeros in the dependent variable, I have run both OLS and Tobit regressions.[27] These two specifications give qualitatively similar results. Table 11 presents only the results from Tobit regressions.

In each of the nine regressions in Table 11, total venture capital investment within 50 miles has a positive and statistically significant coefficient. The number of VC firms at the state level, when included in the regression together with local VC investment, is never statistically significant. When the national academy membership is added to the regression in Model (2), it has a positive and statistically significant coefficient, and it raises the R^2 of the regression substantially. As university characteristics are added to the regression one by one, the coefficient of the national academy membership hardly changes and remains statistically significant. A comparison between models (3)-(9) and model (2) reveals that adding a group of university characteristics hardly adds any explanatory power to the simpler specification of model (2), which includes only one university characteristic—the national academy membership. Moreover, adding other university characteristics causes very little change to the magnitude of the significant coefficients in model 2. In other words, the national academy membership variable alone essentially captures all the explanatory power of the university characteristics in these regressions. In all these specifications, only one other university characteristic, number of patents, has a positive coefficient that is statistically significant (at the 10% level).

The coefficient of post-docs is statistically significant in some specifications but has the wrong sign. Sensitivity analysis showed that the significance of the post-doc variable derived from a single outlier, Harvard. This is because Harvard, with an extremely large medical school, consistently appoints many more post-docs than its

[27] Since the dependent variables are nonnegative integers, I also tried negative binomial regressions as a robustness check. Given the large number of zeros in the dependent variable, the zero-inflated negative binomial model seems appropriate. However, this model requires the specification of an extra equation determining whether the count is zero. If I want to add variables to the main equation one by one, how to re-specify the ancillary equation becomes a rather arbitrary decision. Thus I simply run the ordinary negative binomial regression on the full sample and on a truncated sample dropping all the zeros. These negative binomial regressions yield results qualitatively similar to those from the Tobit regressions, although dropping all the zeros generally gives more precise estimates (with smaller standard errors) than running the negative binomial regressions on the full sample.

peers.[28] For example, in 1998, the combined number of post-docs at Stanford and MIT was less than half of the number at Harvard, but each of them has many more academic entrepreneurs than Harvard.

Further sensitivity analysis evaluated the robustness of the results. As shown in Table 7, Stanford, MIT, Harvard, and UC Berkeley greatly outperformed all other schools. This raises the question of whether or not these four outliers alone drive some of the regression results. Table 12 presents the regression results based on a restricted sample that excludes these four observations.

When I exclude the four outliers, local venture capital investment is no longer statistically significant. In fact, neither of the two measures of venture capital availability is statistically significant in any of the regressions with other university characteristics included as independent variables (models (2)-(9) in Table 12). This suggests that the significance of the venture capital variables is derived from the four outliers, all of which have access to a rich supply of capital locally. National academy membership and total faculty awards, both measuring the quality of the faculty, are the only two variables that consistently have statistically significant coefficients. None of the other university characteristics, including the number of patents, is statistically significant. These results in Table 12 clearly suggest that venture-backed academic entrepreneurs tend to come from universities with a first-class faculty doing high-quality research. More importantly, these results show that their entrepreneurial activities are not significantly influenced by venture capital investment near the universities, which is surprising given that I am focusing exclusively on venture-backed academic entrepreneurs.

Table 13 presents more results from sensitivity analysis. Since national academy membership and total faculty awards both measure the quality of faculty and are highly correlated, only one is included in the regression. As Models (1) and (2) show, each of the two variables, when included in the regression separately, is statistically significant. Moreover, their coefficients and standard errors are almost identical, further proving the high level of collinearity between these two variables. For the same reason, one may doubt that the two measures of research expenditure, total research expenditure and

---

[28] As Harvard's website shows, it has 10,647 medical school faculty, compared to only 2,497 non-medical faculty (http://www.news.harvard.edu/glance/, accessed on January 18, 2007).

research spending on science and engineering, are highly collinear and that neither one is statistically significant only because both are included in a single regression. The same logic applies to the two measures of advanced training (number of doctoral degrees awarded, total number of post-docs) and the two measures of commercialization (age of OTT office and number of patents). Thus one variable in each pair is dropped from the regression to see whether the other becomes statistically significant. As the rest of Table 13 shows, dropping these variables hardly affects the coefficient of national academy membership or the coefficient of total faculty awards. They are still statistically significant when included in the regression separately. In fact, when national academy membership is excluded, total faculty awards is always the only university characteristic that has a statistically significant coefficient. When total faculty awards is excluded, national academy membership and total number of doctoral degree awarded are always statistically significant. Overall, the results in Table 13 again show that the quality of research at a university affects the number of venture-backed entrepreneurs from the university and that the availability of venture capital in the local area is not an important factor.

Alternative measures of local venture capital investment yielded similar results. Even total investment within 25 miles, the measure most likely to be endogenously related to the number of venture-backed entrepreneurs, does not have a statistically significant coefficient when the four outliers are excluded. I repeated the same set of regression analysis using the number of university spin-offs as the dependent variable. The results are qualitatively similar and not reported here.

4.2 Further discussion

The regression analysis shows that entrepreneurial activities among academics are closely related to the most distinguished faculty members in universities. So why do universities with outstanding scientists tend to generate more venture-backed entrepreneurs? One possible explanation could be that a strong reputation in scientific research is a selling point that venture capitalists need, as mentioned earlier. Thus venture capitalists are more willing to invest in start-ups founded by scientists from top research universities. And national academy membership and total faculty awards are simply two important indicators of a school's quality of research.

Another possible reason is that outstanding scientists or their associates themselves are engaged in entrepreneurial activities once they see the commercial value of their research findings. It is important to understand that nowadays universities in the United States are anything but "ivory towers" in which scholars hide away to solve problems that are irrelevant to the real world. Thanks to pioneering figures such as MIT's Vannevar Bush and Stanford's Frederick Terman, today's university-industry relationship is extensive, productive, and mutually beneficial. Industrial consulting has become a part of life for many university professors, and collaboration between university research labs and industry is common. Even today's most prestigious academic scholars would not consider entrepreneurial activities in the business world unacceptable.[29] In fact, many universities even encourage such activities. For example, the University of Georgia, Georgia Tech, and other universities in the state formed a partnership with the local government and industry, called the Georgia Research Alliance. The partnership helps these universities recruit "eminent scholars" to Georgia. These scientists are expected to work as professors and entrepreneurs. They are even offered incubator space (Herper, 2002).

A casual search of the Internet reveals that even among today's most distinguished scientists, starting a firm is not uncommon. Table 14 presents a partial list of Nobel Prize winners who were also entrepreneurs. Among the 36 U.S. Nobel Laureates who won the prize in chemistry or medicine between 1993 and 2005, 13 had founded at least 14 firms.[30]

One may suspect that these Nobel Laureates' entrepreneurial activities came after their prizes. It is reasonable to believe that these scientists' research productivity had peaked long before they won the prize. Thus it must be attractive for them to move into

[29] Indeed, Lowe and Gonzalez-Brambila (2005) show that faculty entrepreneurs tend to be more productive in terms of publication than their peers who have never started businesses. That is, successful scientists are more likely to start businesses than less successful ones.

[30] One of the Nobel Laureates, Robert Grubbs, apparently founded more than one firm although I was unable to name all of them. The entrepreneurial activities are by no means limited to the Nobel Laureates from the U.S. For example, I found at least three Laureates from other countries also started businesses: Arvid Carlsson from Sweden (Nobel Prize in Medicine in 2000, founded Carlsson Research in 1998); Christiane Nüsslein-Volhard from Germany (Nobel Prize in Medicine in 1995, founded ARTEMIS Pharmaceuticals GmbHn (later acquired by Exelixis) in 1997); and Michael Smith from Canada (Nobel Prize in Chemistry in 1993, founded Zymos (now ZymoGenetics) in 1981). Although Michael Smith was associated with University of British Columbia in Canada when he won the Nobel Prize, the company he co-founded was actually located in the United States (Seattle, WA).

industry after the prize so that they could capitalize on their Nobel Prize fame. However, I found that most of these Nobel Laureates (10 out of 13) founded their firms before their prizes. At least for those people, their entrepreneurial activity was not triggered by the Nobel Prize.

Furthermore, I found that several of these Nobel Laureates even mentioned their entrepreneurial activities in their speeches/autobiographies submitted to the Nobel Prize archive, suggesting that they take their entrepreneurial achievement seriously. Thus, it is unlikely that these great scientists merely lent their names to, but spent little time on, their businesses. Given the list in Table 14, it is not surprising that the number of a university's academic entrepreneurs is most closely related to its number of distinguished scientists.

It is unexpected that the statistical significance of local venture capital variables is not robust. However, this is not puzzling. As Table 6 shows, not all of the academic entrepreneurs stayed close to their academic institutions. In fact, about one third of them ended up in different states, suggesting that the availability of venture capital locally is not a decisive factor that lures academics to industry. Moreover, consider an area like Boston, which houses several universities in my sample, including Brandeis, Boston College, Boston University, Harvard, MIT, Northeastern, Tufts, and others. The number of spin-offs varies a great deal among these universities, although they have access to roughly the same local venture capital resources. The San Francisco Bay area is another example. Stanford, UC Berkeley, UC Davis, and UC Santa Cruz all enjoy the proximity to the abundance of local venture capital, but show very different performance in terms of generating entrepreneurs. All these examples provide the intuition as to why very little variation of academic entrepreneurs is attributable to local venture capital.

It is worth noting that the results of this study are consistent with the findings in previous work, such as Zucker, Darby, and Armstrong, (1998), Zucker, Darby, and Brewer (1998), and Di Gregorio and Shane (2003). Zucker, Darby, and co-authors showed that "star scientists," as defined by a distinguished publication record, play a significant role in determining the location and timing of biotech firm formation. Similarly, Di Gregorio and Shane (2003) found that the number of new firms licensing a university’s inventions is correlated with the intellectual eminence of the university, measured by its academic rating score in the Gourman Reports.

Both Zucker, Darby, and Brewer (1998) and Di Gregorio and Shane (2003) included venture capital variables in their empirical studies. Zucker, Darby, and Brewer found that local venture capital has no significant effects (or has significantly negative effects in some regressions) on the number of biotech firms in a region. Di Gregorio and Shane showed that the number of start-ups using university technology is not significantly correlated with the availability of venture capital locally. My result is in line with these findings. One may argue that this paper’s conclusion about the role of venture capital is even stronger, because neither of the previous studies is limited to venture-backed firms. What is shown here is that even venture-backed academic entrepreneurs are not attracted to industry by venture capital. It seems that some schools generated more venture-backed spin-offs only because they have done high quality research suitable for commercialization.

Some other relevant factors at the university level, such as salient entrepreneurial successes and particular university culture, are hard to measure, but their importance is evident. For example, the data show that Carnegie Mellon University did particularly well in generating start-ups. The impressive performance of Carnegie Mellon is most likely inspired by the early financial success of Lycos. Lycos is an Internet search engine developed by Michael Mauldin, a research scientist at Carnegie Mellon’s School of Computer Science. The company was incorporated in June 1995. On April 2, 1996, even before the public offerings of Yahoo! and Excite, Lycos was launched on the NASDAQ. It ended the day with a market value of nearly $300 million (Lewis, 1996). That instant wealth creation must have inspired many other researchers at Carnegie Mellon to follow suit. From the VentureOne data, I could identify at least 15 of the 24 entrepreneurs from Carnegie Mellon as computer scientists. Also, I found that 18 out of the 19 Carnegie Mellon spin-offs were founded after May 1996. That is, almost all these founders had witnessed Lycos and Michael Mauldin’s miraculous wealth creation before they started their own ventures.

Culture also matters. Two of the outliers, Stanford and MIT, have a long tradition of supporting academic entrepreneurship. This is an important reason why they greatly outperformed other universities. At MIT, the tradition traces back to Vannevar Bush, a professor in the 1920s who co-founded Raytheon, a major U.S. defense contractor. Bush was primarily responsible for creating a business friendly culture at MIT. His student, Frederick Terman, later transmitted the culture to Stanford (Etzkowitz, 2002). In his various capacities (professor, dean of engineering, provost, and vice-president), Terman always encouraged entrepreneurial activities among faculty members and students at Stanford. The entrepreneurial culture has now been so deep-rooted at Stanford that the university even offers entrepreneurship seminars to faculty.

On the other hand, a culture that expects academic scientists to keep an arm's length from the business world may have discouraged entrepreneurial activities on some campuses. An obvious under-performer among the top research universities (in Table 7) is the Johns Hopkins University. Johns Hopkins has one of the world's best medical schools and its annual research budget is often greater than Stanford and MIT's combined budget, but it has only 6 spin-offs in the data. As Feldman (1994) and Feldman and Desrochers (2003) documented, Johns Hopkins lags similar institutions along a variety of measures of technology transfer, including patents granted and patent licensing royalties in addition to firm formation. They relate this outcome to the emphasis on basic scientific research in Johns Hopkins' founding mission, the long-lasting culture of seeking "truth for its own sake," and the lack of successful commercialization attempts in the early years that further enhanced this culture.

5. Conclusions

The university, as the producer and distributor of knowledge, is a major force of technological innovation and thus an important driver of economic growth (Rosenberg and Nelson, 1994). University technology becomes incorporated into industrial practices through various channels. Entrepreneurial activities by academics constitute one particular form of technology transfer, which have not been thoroughly studied due to the limited availability of data. This paper examines venture-backed academic entrepreneurs using a large venture capital data set. I used the biographical information about start-up founders to identify whether an entrepreneur has had a university affiliation. Combining this rich venture capital data set with ancillary data sources, I was able to do a comprehensive study of academic entrepreneurs. My major findings include the following:

First, academic entrepreneurs are common. Close to 9% of venture-backed entrepreneurs have worked at academic institutions. A majority of these people specialize in engineering, and most of them start businesses in life science industries or information technology industries.

Second, to a great extent, technology transfer through academic entrepreneurs is a local phenomenon. About two-thirds of the venture-backed academic entrepreneurs locate their businesses in the same states as the academic institutions they served. Many conceivable factors could explain why entrepreneurs stay where they are when they found firms, including the value of local networks and the feasibility of an informal start on a part-time basis (Cooper and Folta, 2000). It is unclear what motivates academic entrepreneurs to move to other states. Anecdotal evidence suggests that venture capital firms could lure entrepreneurs away. Yet the data suggest that venture capital is not a sufficient determinant, because states rich in venture capital, such as Massachusetts and New York, have both experienced net losses of academic entrepreneurs.

Third, the number of venture-backed academic entrepreneurs from a university is primarily explained by the number of distinguished scientists at the university. An overwhelming majority of the venture-backed academic entrepreneurs are from the top-tier research universities, and very few are from teaching universities or colleges, which suggests that it is high-quality research that drives academic entrepreneurship. A multivariate regression analysis further confirms that better research universities tend to generate more spin-offs. Moreover, a university's national academy membership and total faculty awards are the two most significant variables in explaining its number of academic entrepreneurs. Other university characteristics, such as total research expenditure, research expenditure on science and engineering, doctoral degrees appointed, and post-doc appointees, have no significant effects on the number of spin-offs once the regression includes the national academy membership and/or total faculty awards.

Fourth, local abundance of venture capital does not play a significant role in explaining venture-backed academic entrepreneurs once I drop the four outliers from the regressions. Although previous research has shown similar findings, I still find this result striking because this analysis focuses exclusively on venture-backed entrepreneurs.

The significance of the national academy membership and total faculty awards suggests that quality research is the decisive factor in explaining venture-backed academic entrepreneurs. However, this finding is open to alternative interpretations. For example, it might be the reputation of these distinguished scientists instead of the true quality of their research that has attracted venture capital to universities. Further investigation along this line seems warranted.

Although it is uncertain what the national academy membership and total faculty awards exactly measure, I find it surprising that these variables show more explanatory power than the venture capital variables. My analysis shows that even if the study covers venture-backed firms only, the availability of venture capital plays a minor role in explaining the number of academic entrepreneurs from a university. I consider this finding the most important one in this paper.

A limitation of this paper is its focus on venture-backed academic entrepreneurs, which only represent a subset of all academic entrepreneurs. However, it is likely that these entrepreneurs are the most prominent and that their ventures tend to have a larger effect on economic growth. The rich information in the data set permits a comprehensive study of academic entrepreneurs across disciplines and across universities, which previous studies have not been able to do. I believe this is a fruitful starting point that invites further investigation.

References

Allen, Thomas J., 1984, Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R&D Organization, MIT Press, Cambridge, MA.

Association of University Technology Managers, 2005, "AUTM U.S. Licensing Survey: FY 2004," available at http://www.autm.net/events/File/FY04%20Licensing%20Survey/04AUTM-USLicSrvy-public.pdf (accessed on December 28, 2005).

Audretsch, David B., and Paula E. Stephan, 1996, "Company Science Locational Links: The Case of Biotechnology," *American Economic Review* 86, 641–652.

Cochrane, John H., 2005, "The Risk and Return of Venture Capital," *Journal of Financial Economics*, *75*, 3-52.

Cooper, Arnold and Timothy Folta, 2000, "Entrepreneurship and High-technology Clusters," in Donald L. Sexton and Hans Landstrom (eds.), *The Blackwell Handbook of Entrepreneurship*, Blackwell Business, Malden, MA.

Di Gregorio, Dante and Scott Shane, 2003, "Why Do Some Universities Generate More Start-Ups Than Others?" *Research Policy* 32, 209-227.

Etzkowitz, Henry, 2002, *MIT and the Rise of Entrepreneurial Science*, Routledge, London.

Feldman, Maryann, 1994, "The University and Economic Development: The case of Johns Hopkins University and Baltimore," *Economic Development Quarterly* 8, 67-76.

Feldman, Maryann and Pierre Desrochers, 2003, "Research Universities and Local Economic Development: Lessons from the History of the Johns Hopkins University," *Industry and Innovation* 10, 5-24.

Gibbons, James F., 2000, "The Role of Stanford University: A Dean's View," in Lee, Chong-Moon, William F. Miller, Marguerite Gong Hancock, and Henry S. Rowen (eds.), *The Silicon Valley Edge*, Stanford University Press, Stanford, pp. 200-217.

Gompers, Paul and Josh Lerner, 1999, *The Venture Capital Cycle*, Cambridge, MA: MIT Press.

Gompers, Paul and Josh Lerner, 2000, "Money Chasing Deals? The Impact of Fund Inflows on Private Equity Valuations," *Journal of Financial Economics* 55, 281-325.

Gompers, Paul, Josh Lerner, and David Scharfstein, 2005, "Entrepreneurial Spawning: Public Corporations and the Genesis of New Ventures, 1986-1999," *Journal of Finance* 60, 577-614.

Herper, Matthew, "Biotech Topples the Ivory Tower," *Forbes*, May 13, 2002.

Kenny, Martin, 1986a, "Schumpeterian Innovation and Entrepreneurs in Capitalism: A Case Study of the U.S. Biotechnology Industry," *Research Policy* 15, 21-31.

Kenny, Martin, 1986b, *Biotechnology: The University-Industrial Complex*, New Haven, CT: Yale University Press.

Kenney, Martin and W. Richard Goe, 2004, “The Role of Social Embeddedness in Professorial Entrepreneurship: A Comparison of Electrical Engineering and Computer Science at UC Berkeley and Stanford,” *Research Policy* 33, 691-707.

Klepper, Steven, 2001, “Employee Start-ups in High- Tech Industries,” *Industrial and Corporate Change* 10, 639-674.

Klofsten, Magnus and Dylan Jones-Evans, 2000, “Comparing Academic Entrepreneurship in Europe — The Case of Sweden and Ireland,” *Small Business Economics* 14, 299-309.

Leland, Hayne E. and David H. Pyle, 1977, “Informational Asymmetries, Financial Structure, and Financial Intermediation,” *Journal of Finance* 32, 371-387.

Lewis, Peter H., “Yet Again, Wall Street Is Charmed by the Internet,” *New York Times*, April 3, 1996.

Louis, Karen Seashore, David Blumenthal, Michael E. Gluck, and Michael A. Soto, 1989, “Entrepreneurs in Academe: An Exploration of Behaviors among Life Scientists," *Administrative Science Quarterly* 34, 110-131.

Lowe, Robert and Claudia Gonzalez-Brambila, 2005, “Faculty Entrepreneurs and Research Productivity,” mimeo, Carnegie Mellon University.

McQueen, Douglas H., and J. Torkel Wallmark, 1982, “Spin-off Companies from Chalmers University of Technology,” *Technovation* 1, 305-315.

Nerkar, Atul and Scott Shane, 2003, “When Do Start-ups That Exploit Patented Academic Knowledge Survive?” *International Journal of Industrial Organization* 21, 1391-1410.

Pirnay, Fabrice, Bernard Surlemont, and Frederic Nlemvo, 2003, “Toward a Typology of University Spin-offs,” *Small Business Economics* 21, 355-369.

Roberts, Edward B., 1991, *Entrepreneurs in High Technology: Lessons from MIT and Beyond*, Oxford University Press, Oxford.

Rogers, Everett M., 1986, “The Role of the Research University in the Spin-off of High Technology Companies,” *Technovation* 4, 169-181.

Rosenberg, Nathan and Richard R. Nelson, 1994, “American Research Universities and Technical Advance in Industry,” *Research Policy* 23, 323-348.

Samson, Karel J. and Michael A. Gurdon, 1993, “University Scientists as Entrepreneurs: A Special Case of Technology Transfer and High-Tech Venturing,” *Technovation* 13, 63-71.

Saxenian, AnnaLee, 1994, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Harvard University Press, Cambridge.

Shane, Scott, 2004, *Academic Entrepreneurship: University Spinoffs and Wealth Creation*, Edward Elgar, Northampton, MA.

Shane, Scott and Toby Stuart, 2002, “Organizational Endowments and the Performance of University Start-ups,” *Management Science* 48, 154-170.

Smilor, Raymond W., David V. Gibson, and Glenn B. Dietrich, 1990, "University Spin-out Companies: Technology Start-ups from UT-Austin," *Journal of Business Venturing* 5, 63-76.

Sorenson, Olav and Toby Stuart, 2001, "Syndication Networks and the Spatial Distribution of Venture Capital," *American Journal of Sociology* 106, 1546-1590.

Stuart, Toby and Waverly Ding, 2004, "When Do Scientists Become Entrepreneurs? The Social Structural Antecedents of Commercial Activity in the Academic Life Sciences," mimeo, Columbia Business School, Columbia University.

Steffensen, Morten, Everett M. Rogers, and Kristen Speakman, 2000, "Spin-offs from Research Centers at a Research University," *Journal of Business Venturing* 15, 93-111.

Toole, Andrew A. and Dirk Czarnitzki, 2005, "Biomedical Academic Entrepreneurship Through the SBIR Program," NBER Working Paper 11450.

VentureOne Corporation, 2000, *The VentureOne Venture Capital Sourcebook*, San Francisco, California.

VentureOne Corporation, 2001, *Venture Capital Industry Report*, San Francisco, California.

Zucker, Lynne G., Michael R. Darby, and Jeff S. Armstrong, J., 1998, "Geographically Localized Knowledge: Spillovers or Markets?" *Economic Inquiry* 36, 65-86.

Zucker, Lynne G., Michael R. Darby, and Marilynn B. Brewer, 1998, "Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises," *American Economic Review* 88, 290-306.

Zucker, Lynne G., Michael R. Darby, and Maximo Torero, 2002, "Labor Mobility from Academe to Commerce," *Journal of Labor Economics* 20, 629-660.

Zhang, Junfu, 2003, *High-Tech Start-Ups and Industry Dynamics in Silicon Valley*, Public Policy Institute of California, San Francisco, California.

Zhang, Junfu, 2007, "Access to Venture Capital and the Performance of High-Tech Start-Ups in Silicon Valley," *Economic Development Quarterly*, forthcoming.

Zhang, Junfu and Nikesh Patel, 2005, *The Dynamics of California's Biotechnology Industry*, Public Policy Institute of California, San Francisco, California.

Table 1: Venture Capital Investment by Industry, 1992-2001

Industry	Number of VC-Backed Companies	Number of VC Deals	VC Raised, ($ million)*	Percentage of U.S. Total, %
Communication	1,381	2,984	49,502.21	23.31
Consumer/Business Services	2,060	4,051	41,240.49	19.42
Software	2,672	5,542	40,917.12	19.27
Information Services	972	1,958	19,687.36	9.27
Biopharmaceutical	689	1,664	13,606.89	6.41
Retailing	390	784	9,242.43	4.35
Medical Devices	626	1,470	8,903.98	4.19
Semiconductor	431	913	8,330.73	3.92
Electronics	619	988	6,608.62	3.11
Medical Information Services	336	723	5,669.59	2.67
Healthcare	341	643	4,607.45	2.17
Consumer/Business Products	251	399	2,111.29	0.99
Advance/Special Material and Chemical	76	142	641.64	0.30
Energy	34	58	580.15	0.27
Agriculture	34	45	209.05	0.10
Other	117	115	463.30	0.22
Total	11,029	22,479	212,322.30	100

* In 1996 dollars (converted using GDP deflator).

Table 2: Top Ten States by Venture Capital Investment, 1992-2001

State	Number of VC-Backed Companies	Number of VC Deals	VC Raised ($m)*	Percentage of U.S. Total, %
California	4,302	9,856	93,655.50	44.11
Massachusetts	1,170	2,612	22,196.60	10.45
New York	610	1,179	11,129.79	5.24
Texas	598	1,145	12,008.25	5.66
Washington	347	787	6,881.90	3.24
Colorado	316	703	8,468.45	3.99
Virginia	323	673	5,632.51	2.65
Pennsylvania	359	657	5,466.01	2.57
Georgia	304	602	4,563.52	2.15
New Jersey	263	501	5,197.80	2.45

* In 1996 dollars (converted using GDP deflator).

Table 3: Positions That Entrepreneurs Ever Held in Academic Institutions

Position	Number of Individuals	Percentage of Total, %
Professor	563	62.35
Research Scientist	143	15.84
Director	71	7.86
Executive	69	7.64
Lecturer / Instructor	17	1.88
Other	40	4.43
Total	839*	100

* Position is unidentifiable for some of the 903 academic entrepreneurs.

Table 4: Distribution of Entrepreneurs by Specialty

Academic Discipline	Number of Entrepreneurs	Percentage of Total, %
Engineering	304	45.44
Medical sciences	175	26.16
Bioscience	96	14.35
Business	29	4.33
Chemistry	23	3.44
Other	42	6.28
Total	669*	100

* Specialty is unidentifiable for some of the 903 academic entrepreneurs.

Table 5: Venture Backed Entrepreneurs by Industry

Industry	Number of Entrepreneurs in Sample	Number of Academic Entrepreneurs	Percentage of Industry (row) Total, %
Advance/Special Material and Chemical	39	11	28.21
Agriculture	11	0	0
Biopharmaceutical	618	252	40.78
Communication	1,441	95	6.59
Consumer/Business Products	71	9	12.68
Consumer/Business Services	2,470	76	3.08
Electronics	280	23	8.21
Energy	12	1	8.33
Healthcare	139	11	7.91
Information Services	1,159	44	3.80
Medical Devices	346	51	14.74
Medical Information Services	302	54	17.88
Retailing	228	4	1.75
Semiconductor	442	44	9.95
Software	2,963	226	7.63
Other	9	2	22.22
Total	10,530	903	8.58

Table 6: Distribution of Academic Entrepreneurs by Academic/Business Location

State	By Academic Location				By Business Location		
	Entrepreneurs Moved out	Entrepreneurs Stayed	Total (a)	Net Gain (b) – (a)	Total (b)	Entrepreneurs Stayed	Entrepreneurs Moved in
California	27	217	244	120	364	217	147
Massachusetts	49	119	168	-4	164	119	45
New York	32	24	56	-21	35	24	11
Pennsylvania	17	24	41	-9	32	24	8
North Carolina	10	30	40	-1	39	30	9
Illinois	14	20	34	-10	24	20	4
Texas	12	19	31	4	35	19	16
Georgia	6	15	21	2	23	15	8
Washington	2	16	18	8	26	16	10
Colorado	4	11	15	2	17	11	6
Connecticut	6	8	14	1	15	8	7
Maryland	9	4	13	-2	11	4	7
Michigan	4	9	13	-2	11	9	2
Missouri	8	3	11	-8	3	3	0
Wisconsin	4	7	11	-4	7	7	0
Arkansas	9	0	9	-9	0	0	0
Indiana	7	2	9	-7	2	2	0
Minnesota	1	8	9	4	13	8	5
Ohio	5	4	9	-3	6	4	2
Rode Island	4	5	9	-3	6	5	1
New Jersey	4	4	8	3	11	4	7
Utah	4	4	8	-4	4	4	0
Virginia	4	4	8	8	16	4	12
New Mexico	2	4	6	0	6	4	2
Tennessee	4	2	6	-3	3	2	1
Florida	4	1	5	0	5	1	4
Alabama	2	1	3	1	4	1	3
Washington, DC	3	0	3	-3	0	0	0
Kentucky	2	1	3	-2	1	1	0
Louisiana	3	0	3	-3	0	0	0
West Virginia	3	0	3	-3	0	0	0
Iowa	2	0	2	0	2	0	2
Oklahoma	1	1	2	-1	1	1	0
Oregon	1	1	2	4	6	1	5
Delaware	0	1	1	0	1	1	0
Hawaii	1	0	1	-1	0	0	0
Kansas	1	0	1	-1	0	0	0
Nebraska	0	1	1	0	1	1	0
New Hampshire	0	1	1	2	3	1	2
Vermont	1	0	1	-1	0	0	0
Arizona	0	0	0	5	5	0	5
Nevada	0	0	0	1	1	0	1
Total	272	571	843	60*	903	571	332

* Net gains do not add up to zero because 60 entrepreneurs are associated with foreign institutions.

Table 7: Top Universities by Number of VC-Backed Entrepreneurs and Spin-offs

Institution	Entrepreneurs	Spin-offs	Institution	Entrepreneurs	Spin-offs
Stanford	96	91	U Colorado	10	7
MIT	85	76	UIUC	10	6
Harvard	58	53	Brown	9	6
UC Berkeley	38	37	UW-Madison	9	6
CMU	24	19	U Minnesota	8	8
UCSF	20	17	Washington U	8	5
UC San Diego	17	17	Cornell	7	8
Duke	17	14	Northwestern	7	8
U Washington	16	13	Johns Hopkins	7	6
CalTech	15	15	U Arizona	7	6
Columbia	14	12	UCSB	7	6
Michigan	13	13	Princeton	6	5
Yale	13	12	UPenn	6	5
Chicago	13	10	U Pittsburgh	6	4
UT-Austin	12	14	UC Davis	5	6
Boston U	12	10	Purdue	5	5
NYU	12	10	Maryland	5	5
Georgia Tech	11	9	Wake Forest	5	5
USC	11	8	U New Mexico	5	4
UCLA	10	11	Emory	5	3
NC State	10	10			

Table 8: University Characteristic Variables [a]

Variable Name	Description	Mean	Standard Dev.	No. of Obs.
NAM99	National academy membership in 1999 [b]	19.8	40.1	150
Awards99_01	Total faculty awards during 1999-2001 [c]	37.5	37.3	150
Total-Exp91_00	Total research expenditure during 1991-2000	$1.33 billion	1.24	150
SciEng-Exp00	Research expenditure on science and engineering in 2000	$0.13 billion	0.12	150
Doctors98_01	Total doctoral degrees awarded in 1998 and 2000-01	0.68 thousand	0.53	150
Post-Doc98	Number of post-doc appointees in 1998	0.22 thousand	0.35	150
Private	= 1 if private and = 0 otherwise	0.35	0.48	150
Local-VC 50	Total venture capital investment within 50 miles during 1992-2001	$2.27 billion	10.7	150
State-VC-Firms	Number of venture capital firms located in the state	49.0	82.2	150
OTT-Age	The age of the Office of Technology Transfer	19.2	12.3	136
Patents 69_00	Total number of patents assigned to the university during 1969-2000 [d]	1.69 hundred	2.7	128

[a] Since most of the firms in the VentureOne data were founded in the 1990s, it is desirable to use the explanatory variables in the same period or earlier. However, not all the variables are available in early years. Some of the variables, such as the national academy membership, are available for several years but not addable over time. So I chose the one in the earliest year. This hardly affects the results because university characteristics are fairly stable over time. For example, I run regressions using national academy membership in 1999, 2000, and 2001, and the differences are negligible.

[b] This includes membership in the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), or the Institute of Medicine (IOM). All three academies are private, nonprofit organizations and serve as advisors to the federal government on science, technology, and medicine. Their members are nominated and elected by active members and all get life terms. National academy membership is one of the highest honors that academic faculty can receive.

[c] This refers to awards from 24 prominent grant and fellowship programs in the arts, humanities, science, engineering, and health fields, including Fulbright American Scholars, Guggenheim Fellows, MacArthur Foundation Fellows, NIH MERIT and Outstanding Investigators, National Medal of Science, National Medal of Technology, NSF CAREER awards, etc.

[d] For some multi-campus universities such as the University of California, the University of Texas, and the State University of New York, the patent data are aggregated and not available at the campus level, which creates some missing data at the campus level.

Table 9: Pair-wise Correlation of Dependent and Independent Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) No. of Entrepreneurs	1												
(2) No. of Spinoffs	0.9971	1											
(3) NAM99	0.9042	0.9069	1										
(4) Awards99_01	0.6835	0.6811	0.8182	1									
(5) Total-Exp91_00	0.5602	0.5551	0.6372	0.8502	1								
(6) SciEng_Exp00	0.5492	0.5441	0.6209	0.8613	0.9832	1							
(7) Doctors98_01	0.5197	0.519	0.6123	0.8009	0.7714	0.7958	1						
(8) Post-Doc_98	0.6482	0.6467	0.7767	0.7914	0.7093	0.7022	0.5893	1					
(9) Private	0.0863	0.0809	0.1795	0.0564	-0.0614	-0.0465	-0.0706	0.0821	1				
(10) Local_VC 50	0.5926	0.606	0.5699	0.3887	0.1689	0.1693	0.2209	0.3366	0.2622	1			
(11) State-VC-Firms	0.1772	0.1847	0.3274	0.1776	0.0927	0.111	0.1213	0.2179	0.1167	0.5166	1		
(12) OTT_Age	0.3551	0.3481	0.3862	0.3669	0.4524	0.4515	0.3993	0.2788	-0.0407	0.1223	0.1765	1	
(13) Patents 69_00	0.7313	0.7275	0.747	0.6123	0.6584	0.6583	0.5881	0.4117	0.1336	0.3462	0.2742	0.6198	1

Table 10: Single-Variable OLS Regressions

[Dependent variable: number of academic entrepreneurs from a university]

	Independent Variables										
	NAM99	Awards 99_01	Total-Exp91_00	SciEng-Exp00	Doctors 98_01	Post-Doc98	Private	Local-VC 50	State-VC-Firms	OTT-Age	Patents 69_00
	Full Sample										
OLS coefficient	0.27***	0.21***	4.77***	46.9***	11.2***	21.4***	5.93***	0.67***	0.05***	0.37***	3.43***
	(0.01)	(0.02)	(0.70)	(7.17)	(1.66)	(2.27)	(2.02)	(0.07)	(0.01)	(0.08)	(0.29)
R^2	0.813	0.435	0.239	0.224	0.236	0.374	0.055	0.351	0.108	0.126	0.535
No. of Obs.	150	150	150	150	150	150	150	150	150	136	128
	Excluding Stanford, MIT, Harvard, and UC Berkeley										
OLS coefficient	0.16***	0.10***	2.21***	22.7***	4.89***	13.4***	2.05***	0.09*	0.01***	0.09***	1.34***
	(0.01)	(0.01)	(0.25)	(2.55)	(0.65)	(1.43)	(0.77)	(0.05)	(0.004)	(0.03)	(0.19)
R^2	0.566	0.498	0.345	0.355	0.284	0.380	0.047	0.022	0.051	0.048	0.288
No. of Obs.	146	146	146	146	146	146	146	146	146	132	125

Every OLS regression included a constant term, although not reported here in the table.

Standard errors are in parentheses. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 11: Tobit Regressions Using the Full Sample
[Dependent variable: number of academic entrepreneurs from a university]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-3.34**	-2.79***	-2.21**	-2.60**	-2.63	-3.44***	-3.12**	-3.65**	-2.96*
	(1.50)	(0.76)	(1.03)	(1.08)	(1.11)	(1.27)	(1.24)	(1.51)	(1.50)
Local-VC 50	0.69***	0.16**	0.015**	0.17***	0.17**	0.17***	0.15**	0.17**	0.45***
	(0.12)	(0.06)	(0.06)	(0.007)	(0.07)	(0.07)	(0.07)	(0.07)	(0.09)
State-VC-Firms	0.009	-0.009	-0.009	-0.009	-0.009	-0.01	-0.009	-0.008	-0.01
	(0.02)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.013)
NAM99		0.28***	0.29***	0.29***	0.29***	0.29***	0.31***	0.31***	0.25***
		(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)
Awards99_01			-0.02	-0.05	-0.04	-0.07*	-0.05	-0.05	-0.04
			(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)
Total-Exp91_00				0.89	1.16	0.22	0.56	0.061	-0.37
				(0.73)	(2.08)	(2.18)	(2.14)	(2.18)	(2.20)
SciEng-Exp00					-3.07	3.92	1.02	-2.02	1.08
					(22.8)	(23.3)	(22.9)	(23.8)	(25.6)
Doctors98_01						2.84	2.11	1.90	2.56
						(2.03)	(2.01)	(2.08)	(2.38)
Post-Doc98							-5.08**	-4.76*	-2.55
							(2.49)	(2.53)	(2.96)
OTT-Age								0.06	-0.03
								(0.05)	(0.06)
Patents 69_00									0.008*
									(0.005)
Private	2.97	0.46	0.37	0.59	0.60	1.29	1.12	1.68	-0.39
	(2.29)	(1.17)	(1.16)	(1.17)	(1.18)	(1.27)	(1.25)	(1.34)	(1.47)
Pseudo R^2	0.057	0.222	0.223	0.224	0.225	0.227	0.231	0.234	0.259
No. of Obs.	150	150	150	150	150	150	150	136	115

Note: Standard errors are in parentheses. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 12: Tobit Regressions Using the Limited Sample
[Dependent variable: number of academic entrepreneurs from a university]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	0.44	-0.064	-2.08***	-2.29***	-2.40***	-2.92***	-2.93***	-2.78***	-2.86***
	(0.70)	(0.50)	(0.66)	(0.69)	(0.70)	(0.80)	(0.80)	(0.95)	(1.08)
Local-VC 50	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.08
	(0.08)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.08)
State-VC-Firms	0.014**	-0.001	0.002	0.002	0.003	0.003	0.003	0.004	0.008
	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.009)
NAM99		0.18***	0.09***	0.08***	0.08***	0.08***	0.08***	0.08**	0.04
		(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Awards99_01			0.07***	0.06**	0.07***	0.05*	0.05	0.05	0.07*
			(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Total-Exp91_00				0.46	1.62	0.96	0.97	1.04	0.78
				(0.47)	(1.29)	(1.36)	(1.36)	(1.39)	(1.58)
SciEng-Exp00					-13.8	-8.75	-9.82	-10.6	-9.08
					(14.3)	(14.7)	(15.3)	(15.9)	(19.3)
Doctors98_01						1.88	1.97	1.83	1.16
						(1.24)	(1.29)	(1.34)	(1.72)
Post-Doc98							0.91	0.28	-0.31
							(3.65)	(3.70)	(4.34)
OTT-Age								0.007	0.002
								(0.03)	(0.04)
Patents 69_00									0.002
									(0.004)
Private	2.08	0.52	1.05	1.19	1.27*	1.67**	1.67**	2.03**	1.65
	(1.11)	(0.76)	(0.75)	(0.76)	(0.76)	(0.81)	(0.81)	(0.87)	(1.07)
Pseudo R^2	0.015	0.143	0.161	0.162	0.163	0.167	0.167	0.162	0.147
No. of Obs.	146	146	146	146	146	146	146	132	112

Four outliers, Stanford, MIT, Harvard, and UC Berkeley, are excluded from the regressions.

Note: Standard errors are in parentheses. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 13: Tobit Regressions Using the Limited Sample: Sensitivity Analysis
[Dependent variable: number of academic entrepreneurs from a university]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	-2.78**	-3.15***	-2.99***	-3.46***	-2.99***	-3.47***	-3.00***	-3.47***	-3.00***	-3.49***
	(1.10)	(1.07)	(0.93)	(0.88)	(0.93)	(0.89)	(0.93)	(0.89)	(0.93)	(0.89)
Local-VC 50	0.11	0.07	0.09	0.05	0.08	0.07	0.08	0.08	0.09	0.08
	(0.08)	(0.08)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
NAM99	0.10***		0.10***		0.010***		0.10***		0.11***	
	(0.03)		(0.03)		(0.03)		(0.03)		(0.03)	
Awards99_01		0.10***		0.10***		0.10***		0.09***		0.10***
		(0.03)		(0.03)		(0.03)		(0.03)		(0.03)
Patents 69_00	-0.0003	0.004	0.0001	0.004	0.00005	0.005	0.00007	0.005	-0.0007	0.005
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
SciEng-Exp00	3.92	-14.9	2.98	-15.8	3.14	-16.3	1.68	-4.61	4.92	-3.20
	(18.4)	(18.8)	(17.9)	(18.3)	(17.9)	(18.4)	(8.09)	(8.21)	(5.98)	(6.77)
Doctors98_01	3.01**	0.73	3.26**	1.02	3.25**	1.26	3.24**	1.48	3.17**	1.39
	(1.46)	(1.69)	(1.41)	(1.62)	(1.41)	(1.61)	(1.41)	(1.58)	(1.40)	(1.55)
Post-Doc98	1.55	0.15	2.46	0.96	2.43	1.51	2.49	1.31		
	(4.32)	(4.36)	(4.26)	(4.31)	(4.25)	(4.29)	(4.20)	(4.29)		
Total-Exp91_00	-0.11	1.17	-0.14	1.15	-0.14	1.09				
	(1.53)	(1.56)	(1.51)	(1.53)	(1.51)	(1.53)				
State-VC-Firms	0.002	0.01	-0.001	0.007						
	(0.009)	(0.009)	(0.008)	(0.008)						
OTT-Age	0.001	-0.001								
	(0.04)	(0.04)								
Private	1.95*	1.79*	1.74*	1.64	1.72*	1.85*	1.73*	1.83*	1.77*	1.85*
	(1.09)	(1.08)	(1.02)	(1.00)	(1.00)	(0.98)	(0.99)	(0.98)	(0.99)	(0.98)
Pseudo R^2	0.141	0.145	0.144	0.148	0.144	0.147	0.144	0.146	0.143	0.146
No. of Obs.	112	112	125	125	125	125	125	125	125	125

Four outliers, Stanford, MIT, Harvard, and UC Berkeley, are excluded from the regressions.

Note: Standard errors are in parentheses. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 14: A Partial List of Nobel Laureates as Entrepreneurs, 1993-2005

Name	Affiliation	Nobel Prize	Firm Founded	Founding Year
H. Robert Horvitz	MIT	Medicine, 2002	NemaPharm (acquired by Sequana Therapeutics) and Idun Pharmaceuticals (merged with Apoptech)	1990, 1993
Leland Hartwell	Fred Hutchison	Medicine, 2001	Rosetta Inpharmatics (bought by Merck)	1996
K. Barry Sharpless	Scripps	Chemistry, 2001	Coelecanth (bought by Lexicon Genetics)	1996
Alan Heeger	UCSB	Chemistry, 2000	Uniax Corporation (acquried by DuPont)	1990
Paul Greengard	Rockefeller U	Medicine, 2000	Intra-Cellular Therapies	2002
Eric Kandel	Columbia	Medicine, 2000	Memory Pharmaceuticals	1998
John Pople	Northwestern	Chemistry, 1998	Gaussian	1987
Ferid Murad	UT-Houston	Medicine, 1998	Molecular Geriatrics Corporation (Acquired by Hemoxymed)	1992
Stanley B. Prusiner	UCSF	Medicine, 1997	InPro Biotechnology	2001
Richard E. Smalley	Rice	Chemistry, 1996	Carbon Nanotechnologies	2000
Alfred G. Gilman	UT-Dallas	Medicine, 1994	Regeneron Pharmaceuticals	1988
Phillip Sharp	MIT	Medicine, 1993	Biogen	1978
Robert H. Grubbs *	CalTech	Chemistry, 2005	Materia	1997

Source: Author's search on the Internet.

* It is claimed that Robert Grubbs has founded four companies although I was unable to identify all of them. See, for example, http://www.neurionpharma.com/news0702grubbs.htm (accessed on January 18, 2007).