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Student startups and local economic development

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Student Startups and Local Economic Development

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Abstract

Earlier research on the role of universities in creating local economic development almost exclusively covers licensing and start-ups by faculty and staff. Our hypothesis is that the major impact by universities instead is in the form of startups created by former students. We review the evidence on student spin-off activity and provide new case study data. It turns out that this activity is probably order of magnitudes larger than faculty spin-offs, at least in terms of number of startups. Maybe as much as 80 percent of all student spin-offs are and remain locally situated and a dominant fraction of these spin offs are located extremely close to their parent university. The recent transformation of university goals and practices toward increasing spinoff rates and new firm creation by faculty and researchers thus might be called to question.

Introduction

The last thirty years has seen an increasing rate of spin-offs from university research: the Association of University Technology Managers (AUTM) which collects quantitative data on licensing activities at U.S. universities and research institutions report 3,376 spin-offs between 1980 and 2000, and another 2,885 spin-offs between 2001 and 2007. The total number of yearly spin-offs has risen from approximately 59 in 1991 reported by 98 universities, to 366 spin-offs from 141 universities in 2000, and to 502 spin-offs from 155 universities by 2007. This acceleration is not confined to the U.S. There is a concomitant increase in other countries across the world. An increasing fraction of academics are engaging in entrepreneurial activities (Thursby and Thursby, 2007) and more companies are started based on research at universities than these numbers reveal since not all spin-offs are disclosed to universities and faculty may also start up businesses that are not based on university intellectual property (IP)¹. The dramatic increase in the rate of university spinoffs over the past decades is attributed to several reasons: the germination of biomedical research in the 1970's, the passage of the Bayh-Dole act in 1980, increased financing of research by industry, change in university guidelines and behavior, and changes in the scientific ethos of faculty and researchers (Mowery et al., 2004).

Most of past research and empirical work on stimulating university spinoffs focus on the role of university policies, government regulation (in particular the Bayh-Dole act of 1980), the organization of technology licensing and transfer activities, and researcher incentives. For

¹ AUTM counts firms based on university IP disclosed to universities' technology licensing office (TLO.) Subscribing members of AUTM reports these data to the AUTM. Markman et al (2008) estimate that 58 percent of faculty reports their patent to their TLO. If this also goes for start-ups, faculty spin-offs may be twice that reported. Allen and Norling (1991) found that 16.2 percent of faculty in science, engineering, business and medicine were involved in starting companies but only 4.4 percent, or roughly one fourth, did so based on their academic research. Fini et al (2009) show that among faculty, about two third of businesses started by academics are not based on patented inventions. The number of faculty spin-offs may thus be as much as four times as high. Our analysis of data from MIT show that it may even be up to 10 times higher, although that is probably the upper bound since MIT is such a unique institutions.

recent reviews of this literature see Rothaermel et al. (2008), Siegel et al. (2007), and Djokovic and Souitaris (2008).

Patenting and licensing of faculty inventions to firms and spinoffs by university faculty remain the center of analysis in most of the recent literature. Various faculty incentives have sometimes been found to affect their decision to commercialize inventions through startups (see e.g. Lockett and Wright, 2005; Friedman and Silberman, 2003; Louis et al., 1989; Di Gregorio and Shane, 2003; Markman et al., 2009; Belenzon and Schankerman, 2009; Lach and Schankerman, 2008). However, some of these findings are not consistent with each other. In addition to incentive structures, a variety of input metrics such as faculty quality and federal and industrial R&D spending positively affect the number of university spinoffs (see e.g. O'Shea et al., 2005; Zucker et al., 1998; Powers and McDougall, 2005). Moreover, characteristics of Technology Licensing Offices such as the age of the TLO, and TLO staff bonuses have also been subject of research (Markman et al., 2009; Belenzon and Schankerman, 2009; Lockett and Wright, 2005). In most empirical works weak or insignificant effects of TLO characteristics have been reported. Establishing a TLO is positively correlated with an increase in patenting, licensing and spinoffs but the causality is unclear.

The empirical evidence of earlier research exclusively covers licensing and start-ups by faculty and staff. Existing empirical work (in particular all the work based on AUTM data) does not cover firms started by students because these are typically not using IP based on university funding.² So, if a group of students get together (before or after graduating) to start a business this is not typically recorded as a university spin-off.³ Our hypothesis is that the majority of local entrepreneurial economic development affected by universities is in the form of startups created

² Students may on occasion be involved in startups through research projects and these may thus be registered.

³ Sometimes the line is blurred, for example Google was started by two Stanford Ph.D. students where the basic idea was laid out in Larry Page's dissertation. Stanford could not register ownership of the IP as it was in the open domain. But since the students relied heavily on Stanford computers in an early phase, the university was awarded shares of the company in return and most researchers consider Google a "university spin-off."

by former students. If this hypothesis is confirmed then the recent transformation of university goals and practices toward increasing spinoff rates and new firm creation by faculty and researchers might be called to question. In the remainder of this paper we will review what little evidence there is of student spin-off activity. It turns out that this activity is probably order of magnitudes larger than faculty spin-offs, at least in terms of number of startups. We also conduct original research; several secondary datasets are re-analyzed and we add some primary interview and case data from a few universities.⁴ We treat students as the unit of analysis and ask “What role do students play in stimulating local economic development through entrepreneurship?”

Local and Regional Impact of University Spin-Offs

University spin-offs seem to create primarily local economic development, although the evidence here is not systematic. In 1999 AUTM reported that 82 percent of firms formed from university licenses operated in the state where the university was located. By 2007 this number had dropped to 72 percent. And a study by Clayman and Holbrook (2003) find that 80 percent of surviving Canadian spin-offs operate in the same region as the university from which they originated. Using a much smaller geographical footprint as a point of evaluation, Roberts (1991) find that spin-offs from MIT, Cambridge tend to be located in Cambridge, whereas spin-offs from MIT's Lincoln Labs (in Lexington, MA) tend to be located in Lexington.

We performed some complementary analysis on the local concentration of university spin-offs using data from Ludwig Maximilians Universität (LMU), Germany, and from MIT. LMU spun off 96 companies between 1977 and 2009. Approximately 80 percent of these spin-off companies are located within only 20 kilometers of LMU. A similar investigation of 76 spin-offs

⁴ Detailed case studies have been assembled on Chalmers Tekniska Högskola and Högskolan i Halmstad (both in Sweden), Ludwig-Maximilian University (Germany), Penn State, Massachusetts Institute of Technology, University of Waterloo (Canada), and Université de Nice Côte d'Azur (France).

from MIT between 1980 and 1996 (listed in Shane, 2004, Table 2.2) reveal that approximately 50 percent are located within 20 kilometers of MIT and a little over 70 percent are located less than 100 kilometers from MIT. More generally, Egelin, Gottschalk and Rammer (2004) find that 66 percent of academic spin-offs in Germany locate within 50 kilometers from their university. These data reinforces the suggestion of very local effects.

One would expect primarily local effects of university spin-offs for several reasons. If the inventor is to be engaged in the spin-off less than full time then the inventor would want to start up close to her main employment location (Zucker, Darby and Brewer, 1998). Also, the inventor may want to use the labs of the university after spin-off to engage in additional research to support the spin-off (Hsu and Bernstein, 1997). Further, the inventor may want to exploit local social networks developed over time by the inventor to support the spin-off. Finally, all else equal, the inventor may prefer not to move households even if leaving her job at the university as such is costly both socially and economically. However, moving may be useful if local conditions are not ideal for the spin-off.

To examine more precisely the issue of causality one can look towards Sweden which undertook a conscious spatial decentralization of its higher education system beginning in 1987. Eleven new universities were created and 14 colleges were upgraded in status to a total of 36 universities. This comes close to a natural experiment and Andersson, Quigley, and Wilhelmsson (2004; 2009) use this exogenous shock to estimate the effect of increased university employment and student matriculation on local productivity growth and patenting. The authors find large increases in local productivity around the new universities and a greater impact on productivity growth than the old established universities. The elasticity is higher with respect to the number of researchers employed than the number of students graduated. The effects are very local; about 75 percent of the effect occurs within 100 kilometers of the municipality containing the new institution. In their 2009 paper the authors employ IV estimation

and test their exogeneity assumption, finding good instruments and that the assumption holds. They also establish positive effects of the number of university researchers employed on local patenting activity finding strong effects. When they compare the economic effects of increased university investment in pre-existing universities (in older, denser, urban regions) with equivalent investments in the new institutions (in less dense, rural regions) the results suggests that the decentralization policy has lead to an increase in aggregate output and aggregate creativity in Sweden.

To summarize this section, we discover that a dominant fraction of spin-offs are located extremely close to their parent, within 50 kilometers. This is close enough to allow person-to-person contact even in densely populated cities. Inferring causality for correlation is not recommended. However, the papers by Andersson et al. (2004; 2009) indicate clear causal effects of increased investments at universities in personnel and matriculation on local labor productivity growth and patenting activity. Interesting, such growth is much faster in “structurally weak” regions where the new universities were created, and slower per input in the older established institutions located in “structurally strong” regions.

Student/Alumni Start-Ups

We contend that the majority of local entrepreneurial economic development affected by universities is in the form of start-ups created by former students, and that start-ups by university faculty and researchers constitute a minority of the local economic impact simply because they are very few. Our claim is based on two points. The first point is that students are in much greater numbers than faculty. A rule of thumb would be a ratio of 30 graduated students per year per faculty. If, as indicate in an MBA alumni survey that we conducted at the University of Toronto, there are on the order of 10 percent of students which create start-ups in the first 3 years after graduating, we obtain one student start-up per faculty per year. Since a faculty member teaches over approximately 25 years it stands to reason that students’ start-ups greatly

outnumber start-ups by the average faculty. If each faculty member starts one business in their life-time the ratio is 25:1 in favor of students, if more plausibly one in four faculty members starts one business in their life-time the ratio is 100:1 start-ups in favor of students.

There are no general data on the rate by which students start up new businesses upon graduation, but there are several university-specific alumni surveys which will give indications of the magnitude. Recent alumni surveys have been conducted on Harvard MBAs (Lerner and Malmeider, 2007) Stanford MBAs (Lazear, 2005), and students from Tsinghua University⁵ in China (Eesley, Roberts and Yang, 2009,) Halmstad University in Sweden (Eriksson, 1996) and MIT (Eesley and Roberts, 2009; Hsu, Roberts and Eesley, 2007). The percentage of students from these programs which start businesses are approximately 5 percent at Harvard business school (1997-2004 students), 24 percent from MIT, 24 percent from Stanford business school and Tsinghua, respectively, and finally 36 percent from a program at Halmstad University.

In Roberts and Eesley's (2009) report, 23.5 percent of the alumni indicated that they had founded at least one company.⁶ A special extract of these data made by Charles Eesley revealed 388 firms started by former students in 1980 growing to 710 in 1995 and to 1,089 started in 2000, subsequently to decline to 313 started in 2003.⁷ These numbers indicate an enormous response to the dot-com boom, both up and down. In comparison, the number of TLO-registered spin-offs by MIT faculty and staff were 2 in 1980, growing to 14 in 1995 and 23 in 2006. (Note that the number of registered spin-offs from MIT is leading among all U.S. universities).

⁵ Tsinghua University, Beijing, is one of the most selective universities in China, with a focus on engineering.

⁶ There were two different alumni surveys. The figure is computed based on the first survey where there, however, is no data on the time of founding. New firms are those that employed 10 or more individuals. A second figure of 18 percent reported by Hsu et al., (2007) is based on a follow-up survey reporting businesses started with known founding dates. As well, duplicates started by several students are removed from this number.

⁷ With students in leading positions. We thank Charles Eesley and Ed Roberts for generously providing the data and their time. These data exclude all MIT faculty spinoffs. Eesley further removed duplicates in cases a company was founded by more than one alumni and we count all firms founded. The raw response numbers were scaled up by a factor of 9.476 to account for survey non-responses as in Roberts and Eesley (2009).

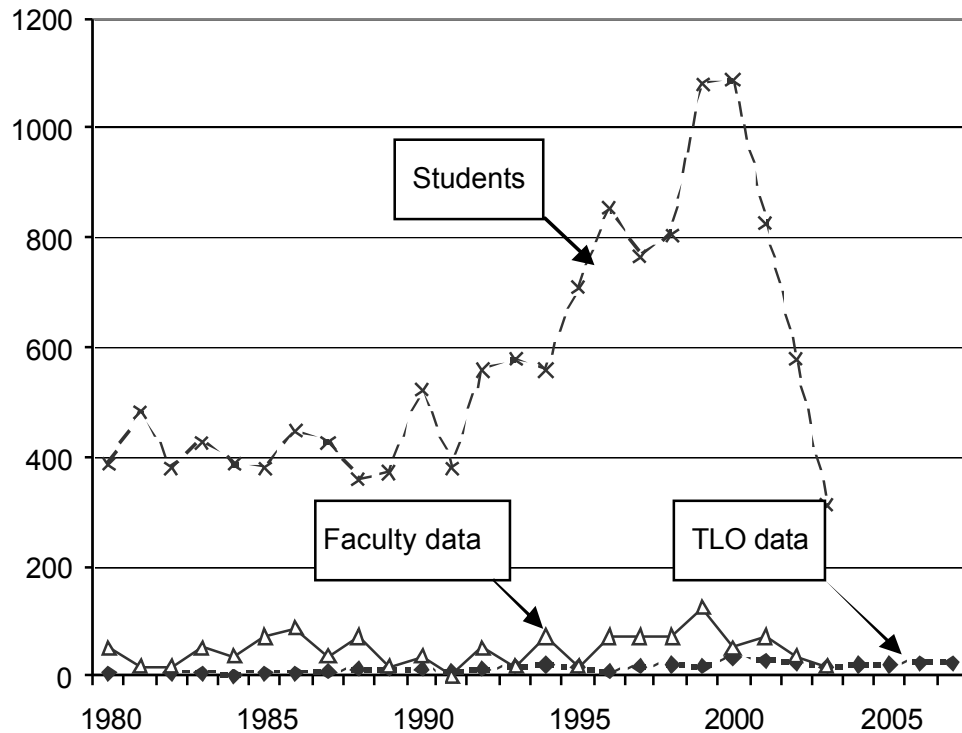
The cumulative student spin-offs at MIT thus outnumbered cumulative faculty spin-offs by a ratio of 48:1 between 1980 and 2003 (Figure 1). Should one accept that the number of unregistered faculty spin-offs is somewhere between 30-45 percent (Markman et al. 2008; Audretsch et al. 2005) the ratio is still on the order of 20-25:1. Using instead the data on students that stayed and became MIT faculty (survey extract by Charles Eesley, and making several additional assumptions: see notes to Figure 1) we obtain a ratio of 12:1. Consequently, under any reasonable assumption the number of student start-ups is at least one order of magnitude larger than faculty start-ups.

Almost all student founders (89 percent) from MIT started their companies where they were living at the time (Roberts and Eesley, 2009). The largest fraction (65 percent) indicated that they were living there because this was where they had been employed, and 15 percent indicated that that's where they attended university (often MIT). When asked what factors influenced the location of their companies, the most common responses (in order) were: (1) where the founders lived, (2) network of contacts, (3) quality of life, (4) proximity to major markets, and (5) access to skilled professional workers.

It is therefore not surprising that the state benefiting most from jobs from MIT alumni is Massachusetts with 6,900 active MIT alumni firms and one million jobs. The 6,900 alumni firms generate worldwide sales of about \$164 billion — 26 percent of the sales of all Massachusetts companies — a truly astounding proportion (Roberts and Eesley, 2009).⁸

⁸ However, there has been a shift towards locating in California with about 22 percent of MIT graduates starting their companies there in the 1990s, growing from 10 percent in the 1950s, while still leaving about 26 percent locating in Massachusetts. California has thus benefitted greatly from MIT alumni with 4,100 alumni firms and 526,000 jobs.

Figure 1. Number of Faculty Spin-offs and Student Start-ups from MIT between 1980 and 2007.



Sources: AUTM, Eesley and Roberts (2009).

Notes: TLO data (black diamonds) as reported by the MIT TLO to AUTM. Student and faculty data are from Eesley and Roberts (2009). Faculty data computed as follows: The number of current MIT faculty responding to Eesley and Roberts (2009) survey who are MIT student alumni reported starting 66 companies during 1980-2003. Each start-up is multiplied by the product of the inverses of the two survey non-response rates = 2.425×3.906 . To approximate the number of spin-offs by all MIT faculty we compute the fraction of MIT faculty in the mechanical and electrical engineering departments in 2000 who were MIT alumni (53 percent). This gives an additional scale-up factor of $(1 + 0.47/0.53)$.

The role of MIT alumni for local economic growth has been increasing over time. Each successive MIT graduating class generates proportionally more entrepreneurs. Roberts and

Eesley (2009) estimate that 2,900 currently active companies were founded during the 1980s and as many as 9,950 companies were founded during the 1990s, of which 5,900 are still active. More than 5,800 companies were created between 2000 and 2006. Alumni of more recent cohorts are also starting their first companies sooner and at earlier ages. The median age of first-time entrepreneurs gradually has declined from about age 40 (1950s) to about age 30 (1990s). Correspondingly, the average time lag between graduation and first firm founding has dropped from approximately 18 years (1950s) to as low as four years (1990s), although data truncation artificially deflates the latter figure.

A critical influence on these start-ups is the effect of “positive feedback” arising from early role models and successes. In particular, (Roberts and Eesley, 2009) show that while 17 percent of those who eventually formed companies chose MIT to study for its entrepreneurial environment in the 1950s, 42 percent of those 1990s graduates who formed companies claim they were attracted to MIT by its reputed entrepreneurial environment. Student-run activities (mostly many different clubs) are pointed to as the major reason for the vast number of student spin-offs. Importantly, student-run activities initiated already in the 1950s and have grown organically and slowly. On the other hand, faculty generate a fraction of start-ups and are more important in terms of stimulating students’ start-ups through their research and openness to entrepreneurship. And the TLO office took a very non-interventionist role. Further, MIT did not provide any great deal of courses on entrepreneurship. In fact, begun in 1961, only one course in entrepreneurship was being taught at MIT until 1990. While there has been a late growth in a variety of support activities and courses in entrepreneurship at MIT since the mid 1990’s, these cannot be said to have had any impact on the trend that got started already in the 1950s.

Students from MIT may have been exceptionally well endowed with favorable local conditions. There has been a large amount of applied engineering research done at MIT, an early development of the venture capital industry in Boston, and a large supply of potential co-

founders and employees. Nevertheless, we have been able to find an antithesis where none of these conditions exist(ed) and where a large fraction of engineering students still manage to start up new businesses, albeit maybe of smaller average size.

The antithesis to MIT is “Högskolan i Halmstad” in Sweden and a short background is required to appreciate the data. Halmstad has close to 90,000 inhabitants. The local economy is a mixture of different small-scale operations with no venture capital, research labs, or research-driven businesses. Instead, trade and services are important due to seasonal tourism. The largest private company employs 600, while 75 percent of inhabitants are employed in companies with 10 or less employees.

A small teachers' college was created in Halmstad in 1973 from which the university was formed in 1983 through a general university reform; it is one of the youngest universities in Sweden. In the mid 1980s it was focussed on teacher's education and shorter degree programmes. Not until 1997 was the university granted the rights to employ Full Professors, prior to that teaching staff had lower status positions. And the first Ph.D. was not conferred until 1999. Nevertheless, by 2008 Högskolan i Halmstad had some 50 degree programmes, 5,000 full-time (11,500 total) students, approximately 40 professors and a research budget of 88 MSEK (8 mill USD). Thus, it graduates students in numbers 55 percent of Chalmers University of Technology in Göteborg, but has an R&D budget only 6 percent to that of Chalmers.

One of the first new programmes created in 1979 was “Innovation Engineering”. It received the nickname the “Inventor program” and it quickly attracted students from across the country, many with prior work experience. The program aimed at combining broad engineering knowledge with business skills. A Mechatronics programme was started next, followed by Computer Engineering.

The percentage of alumni starting new businesses from the Innovation Engineering and Computer Engineering programs was estimated through a survey in 1992 to be 36 percent and 21 percent, respectively (Eriksson, 1996). Since many start-ups were team-based the fraction of unique spin-offs was somewhat lower, 28 percent and 16 percent, respectively. To explain the large rate of start-ups from the "Inventor program" Eriksson (1996) points out that in that program students' thesis projects are geared to develop a technical idea into a product, usually in co-operation with an established local company. Further, Eriksson argues that Halmstad University experienced large institutional changes which ended up creating a supportive environment for entrepreneurship. The program's closeness to industry and the students' independence and greater maturity are further explanations.

Even the research laboratories at Halmstad University produce considerably more student than faculty spin-offs. In a study of 15 spin-offs from the Center for Research on Embedded Systems, Berggren and Lindholm-Dahlstrand (2008) found that 12 (80 percent) were formed by former students and only 3 by research staff. Twelve of these firms (80 percent) maintain head office in Halmstad. The first wave of student-entrepreneurs (1988-1996) "were inspired by the unique Innovation Engineering programme and the spirit of new settlement that surrounded the university at the time" (ibid, p. 50). A second generation of entrepreneurs started after 2000 as more resources were given to the university's incubator and venture capital became available from Högskolan i Halmstad. Also, some of the first generation of student entrepreneurs returned to the university, became discussion partners, network providers, and in some cases provided financing for ventures in the second wave (ibid, p. 50-51).

This illuminating case provides great hope for universities which lack the ecosystem that MIT has developed for itself over many decades. The case shows that even in situations with great local resource constraints there appears to be actions that a university can take to create local economic development, primarily through its graduating students. The role of university

policies and TLO activities may have had some impact, but most important at Halmstad, and similar to MIT, was the educational programs' industry orientation and spirit of entrepreneurialism. The case also reinforces the lesson from MIT of the importance of peers (entrepreneurs returning to the university) influencing students' decisions to start up businesses. Importantly, many of the spin-offs remained close to their alma mater, just as in the case of MIT, even though local economic conditions may not have been ideal.

There is a more formal econometric study that indicates the role of student's peers in improving the quality of spin-offs. Lerner and Malmeider (2007) use allocation of students to sections in the Harvard MBA program as an instrument for peer effects, claiming assignment to sections is random.⁹ They find that a one standard deviation increase in the share of peers with pre-HBS entrepreneurial background in a section decreases the share of the section going into an entrepreneurial role after graduation from 5 percent to 4 percent. This effect is driven by the diminishing rate of unsuccessful entrepreneurs after graduation: students in sections with more pre-HBS entrepreneurs are less likely to start unsuccessful firms. Lerner and Malmeider (2007) argue that these results are consistent with intra-section learning, where the close ties between students in a section lead to an enhanced understanding of the merits of proposed business ideas. Because the authors do not analyze individual but section-level data, an alternative interpretation is that entrepreneurs start again after obtaining their MBA, but with better ideas.¹⁰ Better ideas could be obtained through coursework, for example, rather than from peers.

⁹ Among Harvard MBAs, approximately 4 percent self-reported to be entrepreneurs (or intending to become) in the MBA program exit survey, varying over the sample years 1997-2004 from a low of approximately 2.5 percent in 2002 to a peak of approximately 10 percent in 2000. The share of successful entrepreneurs was approximately between ½ to one percent over the years and 5 percent of each section, on average, had worked previously as an entrepreneur. They define a *successful* business as one that (a) went public, (b) was acquired for greater than \$5 million, or (c) in October 2007 or at the time of the sale of the company had at least 50 employees or \$5 million in annual revenues.

¹⁰ This point was raised by David Robinson.

Returning us from peer effects and local norms to the role of university policies, Franklin, Wright and Lockett (2001) interview policy-setters and administrators at universities in the U.K. and distinguish between academic and “surrogate” (external) entrepreneurs. Universities creating the most start-ups are claimed to be those that have the most favourable policies towards enlisting surrogate entrepreneurs. Our inclination is to extend the authors’ definition to encompass students as surrogate entrepreneurs. Students may be more flexible in adopting business attire than the university inventor, certainly have lower opportunity costs in doing so, and are in reasonably good supply so that a talent market is possible to develop. The drawbacks of using students as surrogate entrepreneurs are that students may not have the technical expertise and may still be too “green” to be able to carry a business forward effectively. Such drawbacks may be solved if an effective talent market is developed and the inventor remains with the business to complement students’ lack of technical expertise. We will illustrate this point with another case.

Chalmers Tekniska Högskola, a Polytechnique/Institute of Technology located in Göteborg with 500,000 inhabitants, was founded in 1829 through a donation from a business person. It has always had close interaction with local industry. Large local employers such as Volvo, SKF, and Ericsson typically hire considerable number of engineers from Chalmers every year. The region has almost twice as many university spin-offs among high-tech firms as the country as a whole and experiences a disproportionate impact of Chalmers compared to other regions with universities (Lindholm-Dahlstrand, 1999). Chalmers has had a steady stream of spin-offs with the first recorded in 1946, 13 ventures recorded in 1980, growing to 22 in 1985 and declining to 10 in 1994 (Wallmark, 1997).

Chalmers went through radical changes in their innovation ecosystem during 1994-2007, precipitated by several events. First, in 1994 Chalmers became private, only the second of two

Swedish universities at that time.¹¹ Chalmers appointed a new chair in Innovation at its fledgling incubator in 1993. His first task was to create a modest seed financing fund at Chalmers by appropriating 20 million SEK (approx. 2 mill. US \$) from the 1994 government privatization loan. Two additional early-stage venture capital funds were subsequently created, reaching 300 million SEK and 115 million SEK, respectively, before closing. These were the first venture capital pools with university investment in Sweden. A new building for the incubator was opened in 1999. However, the most radical impact on spin-offs from Chalmers was the Entrepreneurship School (E-school) founded in 1997, the first of its kind in Sweden.

The idea was to pair high-quality Chalmers undergraduate students with inventions from Chalmers' laboratories to create spin-offs. The E-school was designed to combine formal lectures with the task of creating real companies; now a two-year International Master Program. The first intake contained 12 students and in steady state E-school admits 20 students each year from approximately 100 applicants. Applicants are screened through a three-stage process, where those that are not open to new ideas, with low self-efficacy, low stamina and creativity are screened out. A dominating fraction of applicants have an undergraduate degree from Chalmers.

A key feature of the program is that students do *not* bring their own venture idea. Instead, the projects are promising inventions developed by faculty and staff at Chalmers, and to a small but increasing degree by inventors from outside Chalmers. A double-sided competitive selection process clears the market. A contract is signed where the inventor is left with a third ownership rights, the students in the project obtain a third conditional on continuing

¹¹ This came about as a challenge/offer from the newly ruling conservative party to privatise one of Sweden's Institutes of Technology. Chalmers bid won and it received a loan of approximately U.S. \$166 million to jump-start structural changes, to be repaid by 2009. This loan turned out to be instrumental for spinoff activities, as we will see. The change in legal status allowed Chalmers to accumulate capital from its entrepreneurial activities, which became an important incentive (Jacob, Lundquist and Hellsmark, 2003). Privatizing also allowed Chalmers, among other things, to set market wages, although that opportunity has been less often used, and to locally determine program offers, which have been a big boon.

the project after graduation, and Chalmers obtains the remaining third. Each project's expenses (approximately 200,000-300,000 SEK for patent work, legal and other) are paid by Chalmers. The inventor agrees in writing to provide reasonable efforts (typically two days a month). After finishing E-School approximately half the students continue in the newly incorporated businesses in a leading position, and many take the next step to the incubator. Approximately 80 percent of the businesses remain in the region. The students often return to Chalmers as guest speakers, providing contract research (surprisingly more in absolute terms than from the region's larger firms) and their start-ups provide many opportunities for undergraduate theses work. The E-school produced two start-ups in its first year of operations, increasing to six in 2007.

Moving away from the case of Chalmers, but staying in Sweden, Baltzopoulos and Broström, (2009) are able to statistically estimate the effect of studying at a particular university on the probability that a student locates his/her startup in the region of the university as opposed to another region. Seventy-one percent of the entrepreneurs graduating from university start their business in the region where they were born. If the university was in the same region as they were born this probability increases to 87 percent. However, if the university where they studied was located in another region than where they were born the probability to locate in the region where they were born decreases to 26 percent. Further, for those who moved to study at a university in another region, 51 percent start up the business in the same region as the university, 22 percent move to another region altogether, and as previously reported 26 percent move back home to start their business. The university thus serves as a strong magnet to start-ups by alumni.

One might ask why students are more likely to locate close to their alma mater. There are probably many reasons. Studying spin-offs started by Ph.D. students, post-docs and former research assistants, Heblich and Slavtchev (2009) find that the likelihood of these being located

in the region of the parent university increases with the number of professors at the parent university in the specific academic discipline, but not with the number of professors at other universities in the region in the specific academic discipline. The degree to which the advisor of the students had R&D collaboration with local industry also affected the probability of locating locally. Because the data is cross-sectional the authors cannot eliminate common unmeasured causes. However, in the analysis comparing the effect of the number of professors from the parent university with the number of professors from other universities in the region, regional conditions are held constant. The results suggest strong effects of ties between professors and students as an explanation for why students' start-ups remain close to their alma mater.

Entrepreneurship Education

Since students and university alumni constitute the majority of university spin offs, it should be asked "How can universities stimulate student start ups?" Teaching Entrepreneurship is one way of stimulating such startups. We review some of the emerging literatures which attempt to investigate the relationship between entrepreneurship education and student startups.

Teaching entrepreneurship in academic institutions started in 1947 when Myles Mace taught the first entrepreneurship course in the United States at Harvard Business School (Katz, 2003). Entrepreneurship education started to become a force in business schools in the early 1970s when University of Southern California launched the first MBA concentration in entrepreneurship in 1971, and the first undergraduate concentration in 1972 (Kuratko, 2005). In the early 1980s, 300 universities had courses in entrepreneurship education in their curriculum. By the early 1990s, over 1,050 universities in United States were reporting courses in entrepreneurship education (Solomon, Weaver, & Fernald, 1994). Today, entrepreneurship education has expanded to more than 2,200 course at over 1,600 U.S. schools (Kuratko, 2005).

The logic of entrepreneurship education is more aligned with the aims of economic development than with the aim of providing advanced education (McMullan and Long, 1987). However, the link between entrepreneurship education and entrepreneurial activity is not straightforward. Entrepreneurs do not necessarily set up their companies directly upon graduation. Even though the average time lag between graduation and starting a business for MIT alumni has dropped from 18 years in the 50's to four years in the 90's (Roberts and Eesley, 2009), the multiplicity of reasons for engaging in entrepreneurship makes it difficult to measure the effect of entrepreneurship education on entrepreneurial activity.

Recently researchers have begun to investigate the effects of entrepreneurship education. However, this work is still very preliminary. Most attempts only evaluate the impact of entrepreneurship programs on students' stated intentions to start a business. None of the studies we found clearly evaluated the impact on actual start ups. Some researchers propose that entrepreneurship education affects students' opinion about entrepreneurship and their perception of starting a new business (Rasmussen and Sorheim, 2006). Bird (1988) postulated that starting a new business is driven by entrepreneurial intentions. This led to the use of "intention models" in evaluating entrepreneurship education research.

Research on entrepreneurial intentions draws on psychology (Ajzen, 1987; 1991; Baggozi et al., 1989). Intentions are argued to be the best predictor of planned behaviour, particularly when the behaviour is considered rare and hard to observe, or involves unpredictable time lags (Ajzen, 1991; Madden, Ellen and Ajzen, 1992). Since starting a new business is a rare and hard to observe behaviour it is exactly the type of planned behaviour for which intention models are well suited (Bird, 1988; Katz and Gartner, 1988).

A variety of intention models have been developed. Maybe the most notable one is Ajzen's (1991) theory of planned behaviour, which identifies three attitudinal antecedents that

drive intentions. The first is the *attitude towards the behaviour* and refers to individual's favourable / unfavourable perception of the behaviour in question. The second predictor is *subjective norms*, a social factor that refers to individual's perceived social pressure to engage or not engage in the behaviour. The third antecedent is *perceived behavioural control* which refers to perceived ease or difficulty of performing the behaviour and mirrors individual's past experience, perceived impediments and obstacles toward the behaviour. The theory of planned behaviour predicts that the greater the positive attitude and subjective norm toward behaviour, and the greater the perceived behavioural control, the greater should be an individual's intention to perform the behaviour. An intention model specific to the field of entrepreneurship is conceptualized by Shapero (1975, 1982). In Shapero's model, intentions to start a new business are driven by perceptions of desirability, feasibility, and a propensity to act upon an opportunity. Perceived desirability refers to personal attractiveness of starting a business. Perceived feasibility is the perception of personal capability of starting a business. Propensity to act refers to personal determination to act on one's decision.

Some empirical studies argue that there is a positive impact of entrepreneurship courses/programs at universities on students' start-up decisions (e.g. Clouse, 1990; Clark et al., 1984) as well as the perceived attractiveness and perceived feasibility of starting a new business (e.g. Tkachev and Kolvereid, 1999; Fayolle and Lassas-Clerc, 2006).¹² But these studies rarely involve control groups, pre-test-post-test settings, or control for existing predisposition towards entrepreneurship. Three exceptions are Peterman and Kennedy (2003), Souitaris et al. (2007), and Oosterbeek et al. (2008).

¹² Clark, Davis and Harnish (1984) found that 76 percent of individuals who started their business subsequent to completing a traditional entrepreneurship course rated the course as having a "large" or "very large" effect on their decision to start, while only 4.3 percent felt that the course had little or no effect on the decision. Hornaday and Vesper (1982) found that students who elected to take a single course in entrepreneurship were much more likely to subsequently start their own business (21.3 percent were full-time self-employed) than control group who had not taken the course (14.2 percent were full-time self-employed). Vesper and McMullan (1997) show that entrepreneurship courses help alumni to make better decisions in the start-up process.

Peterman and Kennedy (2003) and Souitaris et al. (2007) investigate the effect of a five month enterprise education program, and an elective entrepreneurship course for science and engineering students, respectively, on perceptions towards entrepreneurship. Both adopted a pre-test, post-test control group design to measure changes in students' perceived desirability and perceived feasibility of starting a new business. Both found a significant increase in both perceived desirability and feasibility of starting a business for the group exposed to the entrepreneurship course, whereas the control group's perceived desirability and feasibility remained unchanged. Souitaris et al. (2007) also find that the change in desirability, feasibility, and control affected intentions. However, the results of these studies should be interpreted with caution. First, treatment was not randomized meaning that students self select into the courses. Even though prior attitudes are measured, unmeasured attitudes may be correlated with the treatment effect. Second, only the effects on intentions are tested, not the impact on observed behavior.

In a carefully executed study, Oosterbeek et al.(2008) analyses the impact of a compulsory entrepreneurship program on entrepreneurial competencies and intentions using an instrumental variable approach in a difference-in-difference framework. They exploit the fact that the program was offered to students at one location of a school but not to students at another location of the same school by comparing differences in pre-post measures at both locations. Self selection of students into different locations is controlled by including as an instrument the relative distance from the campus to the location of the students' place of living prior to enrolling in postsecondary education. They find two surprising results which stand in sharp contrast to previous studies. First, the effect of the entrepreneurship program on students' self-assessed entrepreneurial skills is not significant. Second, there is a significant negative effect on students' entrepreneurial intentions. They argue that the results might be related to the content of the entrepreneurship program which enabled students to obtain a more realistic perspective of

themselves as well as an entrepreneurship career in general. In a recent study by Weber et al. (2009), results are similar to Oosterbeek's et al. (2008). They report a decline in students' entrepreneurial propensity after taking a compulsory entrepreneurship course. To explain the results they use a Bayesian learning model in which the entrepreneurship program generates signals that help students to evaluate their own aptitude for an entrepreneurial career. Importantly, the model distinguishes between two types of students, "entrepreneurs" or "employees," whose beliefs about their actual type and consequently about their entrepreneurial abilities are updated during the entrepreneurship program. The results from Weber et al. (2009) and Oosterbeek's et al. (2008) make it clear that it is important to control for self-selection. Prior results reporting positive impacts may be entirely consistent with the latter two studies reporting negative impacts since it might be that those with unmeasured positive prior attitudes self-select into entrepreneurship programs and self-report large gains in attitudes, while those with prior neutral or sceptical views select not to take the course, or, if it is compulsory, self-report no change (or decreases) in posterior attitudes. Thus, one conclusion might be that entrepreneurship programs often preaches to the choir.

The relation between entrepreneurship education and actual start ups is still not clear. Perhaps this is due to the significant time lag between the intention and the actual start up activity which dilutes the causal relationship between them. Souitaris et al. (2007) tried to compensate for this by measuring several actions (such as raising capital) as proxies for starting up. They found no link between these actions and change in intentions. As previously reported, Lerner and Malmeider (2007) find that among HBS MBAs, a one standard deviation increase in the share of section peers with pre-HBS entrepreneurial background decreases the share of the section going into an entrepreneurial role after graduation from 5 percent to 4 percent, but increases the rate of successful start-ups. They argue that these results are consistent with intra-section learning. An alternative interpretation is that entrepreneurs start

again after obtaining their MBA, but with better ideas. Whether or not entrepreneurship education induces more, or better, business start ups is an avenue for future research.

Conclusions

There has been an increased trend in the number of spin-offs generated by universities at the aggregate. This has been driven by, or associated with, an increase in university research activities, an increase in privately protected ownership of research at universities, and an increase in licensing of the research for profit. Whatever is accomplished in terms of increased number of spin-offs disproportionately favor local development. Maybe as much as 80 percent of all university spin-offs are and remain locally situated and a dominant fraction of these spin offs are located extremely close to their parent university.

Given the importance of startups for local economic development, we show that student start-ups outnumber faculty spin-offs by at least an order of magnitude and a majority of those start-ups are located close to the university even if the local environment lacks important resources. The importance of universities for creating local economic development through startups may therefore be considerably underestimated by looking exclusively at faculty spin-offs where absolute numbers are much smaller and where mobility may be higher. In terms of gross economic impact student start-ups thus appear much more important. We know very little about the factors that cause student start-up rates to grow. Two case studies indicate that at these Universities much is due to student-run activities and the development of positive local norms among students and faculty over time. The evidence is less clear that dedicated entrepreneurship courses and programs do anything to affect start-up rates – what we know is that they affect students' intentions to start businesses. However, sometimes such courses reduce students' intentions to start businesses, which may indicate that students get better calibrated on the vagaries of starting up businesses.

Research on the role of students in creating local entrepreneurial activity is lacking although it appears to be a very important phenomena. We don't understand the degree to which universities are able to cause local economic development, as opposed to respond to economic development. And we would like to know a lot more about what drives students to create start-ups. Finally, the recent transformation of university goals and practices toward increasing spinoff rates by faculty may have missed the target since the majority of startups are created by students rather than faculty.

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