How Do Financial, Institutional, and Human Capital Factors Affect University Start-ups?

WORKING PAPER

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Abstract

The art of enabling new start-ups is on the rise, but only minimal research has been conducted in this arena. Because university start-ups contribute to the economy of the locale where they operate, they have become an important sector of the economy. This paper seeks to examine how sponsored research expenditure, entrepreneurship culture, and certain human capital factors affect number of university start-ups.

1. Introduction

Besides number of publications, citations and patent applications, the number university start-ups resulting from research efforts within university science and engineering laboratories is also a way of demonstrating the impact of research. University start-ups are gaining popularity for a few reasons one might envisage. Starting a company based on academic research: (1) adds to the relevance of the research, especially if the company is sustained in the long haul; (2) appears to complement research publications because start-up companies can also serve as conduits for information dissemination; (3) highlights the tenacity, talent and entrepreneurial prowess of the academic who spearheads the start-up; and (4) positively impacts the economy of the region where it is located by bolstering employment and by simply doing business (Vincett, 2010). Academic entrepreneurship can be defined as “the involvement of academic scientists and organizations in commercially relevant activities in different forms, including industry-university collaborations, university-based venture funds, university-based incubator firms, start-ups by academics, and double appointments of faculty members in firms and academic departments” (Pilegaard et al., 2010). There is an explosive growth in academic entrepreneurship, and universities are not only attempting to foster the entrepreneurship culture on their campuses, they are becoming sophisticated in the spin-out process – finding ways to make profit as well.

Progress in Academic Entrepreneurship

Research shows that universities are now negotiating equity deals in their spin-off companies. In an investigation of 124 research universities, Feldman et al. found that 1978 was the earliest date reported for an equity deal negotiated by a university, but by 2000, 70% of universities took equity in companies licensing their technologies - a jump from 1992 where university-equity participation was only 40% (Feldman et al., 2002).

The number of patents filed and licenses issued by universities, as well as new products introduced into the marketplace by university spin-offs, are also good metrics for examining progress in academic entrepreneurship. Data show that academic entrepreneurship has become a legitimate vehicle for starting viable and sustainable companies. According to the Association of University Technology Managers (AUTM,
2008), before 1980, the aggregate number of patents per year obtained by U.S. universities was under 250 and discoveries were rarely commercialized for public use. In contrast, 11,089 new patents were filed and a total of 5,329 new licenses (and options) were executed in 2004. In 2000, the association reported that licensed technologies from U.S. universities led to the introduction of 347 new commercial products to the marketplace (AUTM, 2000). In 2002 and 2008, the number of new commercial products introduced to the marketplace was 569 and 648, respectively. In 2002, AUTM reported that of 26,086 active license agreements, about 23 percent were linked with product sales by licensees. By the end of the 2008 fiscal year, 3,381 university start-up companies were still operating with a total sponsored research expenditure of $51.47 billion. Another interesting piece of the AUTM finding was that 72 percent of new companies formed operated from their institutions' home state, suggesting that university-based spin-off companies tend to be making important economic contributions in their home-states; however, when a cumulative effect of all these spin-offs is considered, a national economic contribution due to their business activities emerges.

One observer reported a huge impact on the national economy in terms of the employment of 1.1 million people and the generation of $232 billion in world-wide annual sales directly linked to spin-off companies from just one university - Massachusetts Institute of Technology (MIT) (BankBoston, 1997). MIT’s performance is atypical: its record number of spin-off companies and economic contribution can be traced back in the university’s long history of academic entrepreneurship since World War II. So, for a more representative U.S. university, Steffensen et al. investigated the nature of spin-off companies from the University of New Mexico (UNM) and found that six spin-off companies from UNM had some type of association with the university’s research centers, and had employed a total of 108 people in and around Albuquerque, New Mexico, the home of UNM (Steffensen et al., 2000). Whatever the economic impact – global or local, there is evidence that academic entrepreneurship is on the rise.

**Contribution to Literature**

Despite many inspiring stories of university spin-offs, including the Cisplatin cancer treatment drug company from Michigan State University and Gatorade from the University of Florida, it is surprising that there is little research specifically directed towards university-start-ups or towards academic entrepreneurship in general. With minimal research to guide “academic entrepreneurs,” it appears some universities may have taken a hit or miss approach as there have been discouraging stories of failed university spin-off companies as well (Sigurdson & Reddy, 1995). For example, Riley reported that some universities have maintained a culture of loading up their licensing portfolios with untested start-ups and small, privately-held companies (Riley, 1998). One obvious reason for this behavior is to reap the financial benefit of issuing technology licenses and selling the companies or company stocks. Because academic entrepreneurship is now gaining traction, it is now imperative, more than ever, to understand how to create new university-based start-ups; identify the “entrepreneurship mix” needed to be successful; determine factors that lead to a successful start-up; and so on and so forth.

To shed light on this, Powers and McDougall investigated the effects of particular resource-based factors on the performance of universities in terms of (1) the number of start-up companies formed and (2) the number of newly public companies to which a
university had previously licensed a technology (Powers & McDougall, 2005). The authors examined industry research and development (R&D) and venture capital munificence (financial factors), faculty quality (human resource factor), and patent portfolio importance and age of the university’s technological transfer office, TTO (organizational resource factors). While the authors’ work clearly advanced the knowledge in the field, it is our belief that there are other influencers of university entrepreneurship performance.

We are interested in studying the success of universities as a new venture creation vehicle by measuring the number of university start-ups and determining how this number is affected by the level of total sponsored research expenditure (financial factor), university entrepreneurship culture (institutional factor), and three human capital factors, including the presence of a full-time entrepreneur/business manager; i.e., someone other than the founding faculty member with the original idea, graduate students, and university research center-type personnel in the start-up. The human capital factors in this study are often excluded in the study of university start-ups, because contrary to popular notion in academic entrepreneurship, which mainly emphasizes founding faculty and venture capitalist, we envisage that five different categories of people, instead of the aforementioned two, form the core university start-up team. These five are: the venture capitalist that funds the start-up, the faculty who usually initiates the idea to start a company, entrepreneurs (or business managers) whose duty is to run the business affair of the start-up, graduate students working with the founding faculty, and university research center-type personnel.

We are certainly not making the case of the “more the merrier” sort of approach because in practice, just throwing more personnel at a problem does not necessarily improve the team efficacy. In fact, it could make it worse by turning the whole endeavor into a premature bureaucracy. Rather, we are suggesting that having sufficient level of research and administrative support will ensure more new venture creation, and that if the sufficient level and in the right combination is not there, then the number of start-ups will fall off, may be even dramatically. We reasoned that human capital within an organization can be viewed as a diversified portfolio of “stocks” and “bonds”, plus idiosyncratic risk (Chen et al., 2006), meaning that the optimal level and the right combination of personnel are desirable. The contribution of faculty is important especially since he/she usually spearheads the start-up. Powers and McDougall (2005) showed a positive correlation between the quality of faculty and the number of university start-ups. Their results indicate that human capital, among other things, has a significant effect on university start-ups, but, again, they only considered one human capital – faculty. Venture capitalists primarily fund start-ups, but when they participate in the start-up process, they could make meaningful contributions as core members of the start-up team (Bower, 2003). So, their role in the start-up process is well known to be crucial.

2. Theory and hypotheses development

2.1. Total sponsored research expenditures

It is common knowledge that obtaining financial capital is vital for conducting academic research. However, because many university spin-offs often rely on university’s scientific and engineering research activities, this implies that funding and expenditure associated with this type of research may have an impact on the number of spin-offs
produced by a university. Powers and McDougall (2005) previously examined how the level of industry research funding received by an institution relates to the number of start-up companies formed. Industry funding is important because they are usually ear-marked for specific projects such as the development of prototypes or preliminary scientific experimentation to verify hypotheses. Industry-backed research activities, aimed at addressing specific tasks, tend to be “applied” in contrast to traditional “academic” research. The ramification is that successful industry-backed research projects can spin into technology that is readily transferred to market. Unfortunately, the amount of industry research funding that is invested in university research is minuscule compared to funding from government (Powers & McDougall, 2005). Furthermore, most research active universities require their faculty, especially those in the sciences and engineering, to compete for government grants to fund their research (Etzkowitz, 1998). As R&D became more relevant over the years, the United States government, through the National Science Foundation (NSF), has consistently increased university research dollars. For example, for the 1953 fiscal year, NSF reported a funding of $121 million ear-marked as “university-administered, federally funded research and development centers.” This amount was increased to approximately $7.8 billion for the 2006 fiscal year - a 64-fold increase within a span of two generations (or 53 years). Based upon the evidence cited above, in addition to literature currently under review but not yet cited, we would hypothesize that:

**Hypothesis 1:** The level of total sponsored research expenditure by universities will be positively related to the number of university start-up companies formed.

### 2.2. University Entrepreneurship Culture

Business culture, also known as corporate culture, refers to those values, beliefs, and behaviors upon which firms form their image. Corporate culture tends to reflect the mission and orientation of the company. Culture evolves, perhaps due to people with different backgrounds working together, or due to the availability of an enabler such as technology. The culture within an organization can vastly affect the organization outcomes. Benitez-Amado et al. showed that intrapreneurship culture can predict firm’s market performance (Benitez-Amado et al., 2010). They further stated that investment in information technology resources had a positive effect on the development of intrapreneurship culture, which in turn positively influenced firm performance.

In this work, we have considered entrepreneurship culture an institutional factor because culture is a feature that must be systemically entrenched within an organization. Srinivas made the case that it is not enough for performance management to be a company objective, but that it must become part of organization’s culture in order to manifest real value (Srinivas, 2009). Furthermore, it has been shown that a firm’s culture affects its competitive advantage (Barney, 1986; Hult, 2002), further underscoring the importance of organizational culture and how it can affect the expected outcome.

Until recent times, very few universities embraced the idea of faculty participating in commercial activities; therefore, entrepreneurship was relegated to non-academic or industrial sectors: The notion was that university should solely focus on pure academic functions (Lee, 1996). True, the fundamental mission of a university is the creation and dissemination of knowledge; however, both new venture creation and new knowledge creation and dissemination are vital drivers of renewed economic activity. Therefore, it is
necessary in this day and age for universities and their faculty to do both. Apparently, universities that have a culture that promotes entrepreneurship would have greater number start-up companies formed compared to their counter-parts that do not share similar values. The question that remains is: “How can entrepreneurship culture at a university be measured?” To answer this, we first referred to Slater and Narver who stated that “a culture that values entrepreneurship and innovation provides the environment in which learning from exploration and experimentation is most likely to take place” (Slater & Narver, 1995). This suggests that a university that values entrepreneurship would provide an entrepreneurship exploratory haven. An environment for this type of learning and experimentation is the University Research and Technology Park (URTP) because URTP are typically endowed with incubators. Incubators are usually managed by a technology transfer agent and facilitate the interaction of start-ups with potential Angel investors and outside firms (Wonglimpiyarat, 2010). These features increase the chances of successfully launching a start-up company. Another way to gauge the entrepreneurship capture of a university is to investigate university and departmental press releases to determine if entrepreneurship is indeed valued and celebrated. Based upon the evidence cited above, in addition to literature currently under review but not yet cited, we would hypothesize that:

Hypothesis 2: The extent of entrepreneurship culture in universities will be positively related to the number of start-up companies formed.

2.3. Full-time Entrepreneur or Business Manager

Academic faculty in science and engineering fields who are interested in starting technologically-based companies are often fraught with difficulties because they often lack the necessary business know-how to jump-start a new venture. According to Oakey and Mukhter, many High-Technology Small Firms (HTSFs) performed little marketing because they spent too much of their investment capital on R&D (Oakey and Mukhter, 1999). They authors further suggested that HTSF entrepreneurs could use some relevant general management training. In contrast, Oakey and Dahlstrand noted that technology entrepreneurs who start companies having worked in the industry often draw from their past business know-how, management experience, contacts, and market knowledge to start a new venture (Dahlstrand, 1997; Oakey, 1995). Expectedly, seasoned technology entrepreneurs tend to approach the markets in a more methodological fashion – tailoring their R&D to match their client needs (Bower, 1998).

The ability to anticipate customer needs is crucial. Studies have shown that understanding customer needs and close communication with customers led to better performance in the marketplace (Hippel, 1977; Rothwell et al., 1974; von Hippel, 1976). Science and engineering faculty often lack the necessary business experience required to compete and thrive in the marketplace. To mitigate this, grants, incentives, and other business development programs have been made available to potential entrepreneurs who wish to start a business (Bower, 2003). But, there is no study showing whether faculty members took advantage these business development programs prior to starting a university spin-off. There is also no study showing whether or not participation of faculty in business training programs positively correlated with the number of ventures started. Moreover, science and engineering faculties may not be able to afford the time to participate in business trainings; therefore, in lieu of participating in such trainings, perhaps,
start-up teams are organized such that at least a team member is a well-trained, experienced business person - a full-time entrepreneur/business manager - someone other than the founding faculty member. Based upon the evidence cited above, in addition to literature currently under review but not yet cited, we would hypothesize that:

**Hypothesis 3:** The number of university start-ups that included the sufficient level of full-time entrepreneurs/business managers in their team will positively relate to the number of successful start-up companies.

### 2.4. Graduate Students

According to BankBoston, MIT alone spun off 150 new firms per annum since 1990 (BankBoston, 1997). Based on the report, an economy composed of the 4,000 MIT spin-off companies would be the 24th largest national economy in the World. Interestingly, the credit for that performance was attributed to both faculty and graduate students. The students had not only worked on the research projects that formed the bases for the start-up, but they joined forces with their faculty mentors to start the companies. This is not surprising since innovation and research emanating from scientific research groups usually result from a joint effort between graduate students and their major professors. For this reason, faculty members often acknowledge the contribution by their graduate students to a project and vice versa at various conference proceedings. Furthermore, the number of research publications, also a measure of faculty productivity (Vesper & Gartner, 1997), appears to be proportional to the number of graduate students (Chung, 2009) under the faculty. In science and engineering departments, these publications often bear the names of graduate students as first authors and their major professors as co-authors.

Studies have shown that experienced entrepreneurs were able to identify more innovative opportunities because they were able to process information quicker than less experienced or novice entrepreneurs, thereby devoting more time to pursue more innovative ideas (Roure & Keeley, 1990). Because starting a business based on innovative ideas is paramount to the success of a start-up, compared to their counterparts without graduate students, one would expect entrepreneurial faculty members working with graduate students to have a greater chance of starting a company. The reason for this is that the faculty members would likely devote more time to identifying innovative ideas if their graduate students are focused on the core research in laboratories. Also, one might expect that the probability of starting a company would increase if the same students who may have been working on the core science behind a start-up were part of the start-up process. Furthermore, it is not uncommon to find student names as co-authors along with their faculty mentors on patent applications, especially if they had contributed to developing the novel product or technique that is being protected. Despite these basic intimate relationships that exist between graduate students and faculties, the role of graduate students in the start-up process has not been explored. For example, the participation of graduate students in meetings with venture capitalists may have a positive effect in securing seed money. Based upon the evidence cited above, in addition to literature currently under review but not yet cited, we would hypothesize that:

**Hypothesis 4:** The number of university start-ups that included sufficient level graduate student their team will positively relate to the number of start-ups.
2.5. University Research Center Personnel

How start-up companies are formed would differ from one university to another (Adams, 1993), and university research centers across the nation may account for some of these differences since their respective missions would differ. The BankBoston study reported in 1997 highlighted the role of university research centers in forming MIT spin-offs, which created unparalleled employment and wealth. University research centers have been described as boundary-spanners between universities and their environments; thus, they are in a unique position to promote the transfer university technologies (Steffensen et al., 2000).

Steffensen et al. investigated the role of university-based research centers in the formation of new high-technology companies from UNM. They considered 55 research centers, which at the time of their investigation were resident at UNM, as well as 19 spin-off companies from these research centers. The authors collected data from key individuals in each of six new start-up companies that met certain criteria and sought to understand the relationship between each university research center and its spin-off companies. Based on their interviews, they found that the success of a new spin-off company depended, in part, upon the degree to which it was supported during the start-up process by the university research center to which they were affiliated. However, the authors’ findings cannot be generalized since the authors only examined one U.S. research university, and as they rightly pointed out, the culture at another university may be different. For example, the MIT culture permits and strongly encourages faculties, including those in science and engineering fields, to consult and start new businesses. This also supports the notion that U.S. universities may differ in their culture, views, and approaches to spinning off companies. Based upon the evidence cited above in addition to literature currently under review but not yet cited, we would hypothesize that:

**Hypothesis 5:** The number of university start-ups that included sufficient level university research center personnel in their team will positively relate to the number of start-ups.

3. Data Collection and Methodology

3.1. Sample

We obtained respective university start-ups (dependent variable) and sponsored research expenditure data (independent variable) from annual licensing surveys of the Association of University Technology Managers (AUTM). We will administer surveys to collect data for remaining independent variables (i.e., the presence of full-time entrepreneurs/business managers, graduate students and research center-type personnel, as well as entrepreneurship culture). We have limited our scope to investigating start-ups from 100 universities between 2001 and 2009.

3.2. Control Variables

Because of the vast differences in endowment and faculty size across universities, the extraneous effects of these variables on the dependent variable should be eliminated; therefore, they should be treated as control variables. One way to control for these variables
is to only consider 100 universities of similar size and endowments such as those published by the Carnegie Classification of Institutions of Higher Education.

3.3. Prediction of University Performance

We are also interested in performing quantitative analysis. For instance, we want to be able to run a regression and examine any correlation between dependent and independent variables. It would be interesting to predict the number of start-ups a university can produce *ceteris paribus* and given a set of independent variables. To this end, we have modified the Jensen’s model, commonly used to estimate return on investment (Ling & Naranjo, 2002), into an equation for regression analysis. In our case, we would use Equation 1 to estimate the number start-ups:

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#SU = \alpha + \beta_1 (RE) + \beta_2 (EC) + \beta_2 (FE) + \beta_2 (GS) + \beta_3 (CP) + e
\]  

(1)

where #SU is the number of start-ups from a university used to measure university start-up performance, \(\alpha\) is a constant, RE is the total sponsored research expenditure; EC is entrepreneurship culture; FE is the number of full-time entrepreneurs, GS is the number of graduate students, CP is the number of university research center personnel, \(\beta_1, \beta_2, \beta_3, \beta_4,\) and \(\beta_5\) tells us to what degree #SU is affected by a variation in RE, EC, FE, GS, and CP, respectively, and e is the error term.

4. Validation

To validate results, we would use the regression analysis to predict 2010 results and then compare our results with actual 2010 data.

5. References


