HARVARD | BUSINESS | SCHOOL

Are “Better” Ideas More Likely to Succeed? An Empirical Analysis of Startup Evaluation

Erin L. Scott
Pian Shu
Roman M. Lubynsky

Working Paper 16-013

Are “Better” Ideas More Likely to Succeed? An Empirical Analysis of Startup Evaluation

Erin L. Scott
National University of Singapore

Pian Shu
Harvard Business School

Roman M. Lubynsky
Massachusetts Institute of Technology

Working Paper 16-013

Are “Better” Ideas More Likely to Succeed? An Empirical Analysis of Startup Evaluation*

Erin L. Scott — National University of Singapore
Pian Shu — Harvard University
Roman M. Lubynsky — MIT

July 2015

Abstract

Entrepreneurs face high uncertainty, and often make costly investments in new business ideas without knowing the expected payoff. This paper empirically examines whether ex-ante assessment of early-stage startup ideas can predict their subsequent commercialization. We leverage an entrepreneurship program at the Massachusetts Institute of Technology in which early-stage venture ideas, presented in the form of succinct standardized summaries, elicit subjective evaluations from a large set of experienced entrepreneurs and executives. Using data on 652 ventures in multiple industry sectors, evaluated over an 8-year period, we find that ideas that elicit more positive evaluations are significantly more likely to ultimately reach commercialization. We further show that these results are driven by venture ideas with documented intellectual capital in research-and-development-intensive sectors, such as life sciences and medical devices. We find no evidence, by contrast, that experts can effectively assess the commercial potential of venture ideas in non-R&D-intensive sectors such as consumer web and enterprise software. Finally, we find that industry-specific and scientific expertise is not critical to experts’ collective ability to predict ventures’ commercial viability.

JEL Codes: L26, M13, O31, J24, G32

*Scott: Department of Strategy and Policy, National University of Singapore Business School, elscott@nus.edu.sg. Shu: Technology and Operations Management, Harvard Business School, pshu@hbs.edu. Lubynsky: Venture Mentoring Service, MIT, rml@mit.edu. We are grateful to Tom Astebro, Gary Dushnitsky, Joshua Gans, Ben Golub, Shane Greenstein, Bill Kerr, Karim Lakhani, Josh Lerner, Danielle Li, Will Mitchell, Ramana Nanda, Gary Pisano, Ivan Png, Timothy Simcoe, Jasjit Singh, Kulwant Singh, Ariel Dora Stern, Scott Stern, Charles C.Y. Wang, and discussants and participants at the 2014 Academy of Management Annual Meeting, the NBER Productivity Lunch, the NBER Entrepreneurship December Meeting, the Darden & Cambridge Judge Entrepreneurship and Innovation Research Conference, and the NYU Stern Economics of Strategy Workshop for helpful comments. We thank Roberta McCarthy for help with data collection. Rohan Thavarajah provided excellent research assistance. We thank the NBER Entrepreneurship Working Group, the Division of Research at Harvard Business School, and the Singapore Ministry of Education (AcRF Tier 1 Grant R-313-000-106-133) for financial support. All errors are our own.

1 Introduction

Young, high-growth businesses are critical to job creation and economic growth (Haltiwanger *et al.* , 2012; Decker *et al.* , 2014); nevertheless, most entrepreneurial efforts fail (Hall & Woodward, 2010; Kerr *et al.* , 2014b).[1] Transforming a nascent idea into a viable business requires entrepreneurs to devote significant time and resources to its development instead of pursuing conventional career paths. These commitments are typically made with little information on whether the idea will succeed. Can new businesses be meaningfully differentiated as early-stage ideas, before there is a legal entity or any funding? This paper empirically examines whether ex-ante assessment of a start-up idea can predict its future commercial viability.

We study the assessment of startup ideas using data from the Massachusetts Institute of Technology. As natural sources of talented entrepreneurs, universities are instrumental in fostering high-impact entrepreneurship and stimulating local economic activity (Torrance, 2013; U.S. Department of Commerce, 2013). MIT alumni have founded over 25,000 active companies that have collectively employed over 3 million people and generated annual worldwide sales of $2 trillion (Roberts & Eesley, 2009). Our empirical setting, MIT's Venture Mentoring Service (VMS), is one of the university's longest-running programs designed to promote entrepreneurship and innovation. Founded in 2000, it is a free educational service that helps aspiring MIT-affiliated entrepreneurs develop their business ideas, usually at an early stage. As their ideas evolve, entrepreneurs must inevitably decide whether to pursue a venture full-time, forgoing other venture ideas and attractive job options.[2] The feasibility of accurate early assessment of idea quality thus has important implications for the allocation of human capital.

It is difficult to examine assessment of venture ideas in settings in which early-stage ventures are typically evaluated, such as venture-financing firms and government grant agencies. Theoretical work in these contexts has assumed that returns to entrepreneurial ideas are ex-ante unknown and that uncertainty can only be resolved via investment (Bergemann & Hege, 1998, 2005; Manso, 2011; Ewens *et al.* , 2015).[3] This assumption remains largely untested empirically, due to a fundamental identification challenge: evaluation

[1] Hall & Woodward (2010) find that only 2.3 percent of venture-backed entrepreneurs since 1987 received more than $100 million in exit cash; nearly 75 percent received nothing. Kerr *et al.* (2014b) show that 55 percent of U.S. startups that received venture-capital (VC) financing between 1985 and 2009 were terminated at a loss, and the 6 percent of ventures with the highest returns jointly accounted for half of the gross return generated by the entire sample.

[2] According to Hastings *et al.* (2010), average starting salaries for MIT graduates are around $60,000 per year for those with bachelor's degrees and $70,000-$120,000 for those with graduate degrees.

[3] A related stream of theoretical work uses a similar approach (known as the bandit problem) to model innovation and research and development (R&D)(Weitzman, 1979; Roberts & Weitzman, 1981; Jensen, 1983; Bhattacharya *et al.* , 1986; Moscarini & Smith, 2001).

by investors and grant reviewers has a direct impact on development of a venture idea via resource allocation and signaling to key stakeholders. Ventures that elicit positive evaluations also receive additional resources (investment and mentorship), which have been shown to have a positive impact on their outcomes.[4] In response to positive or negative evaluations, entrepreneurs may alter the amount of effort they expend on a venture, resulting in a self-fulfilling prophecy. Furthermore, private investors and public agencies employ complex evaluation mechanisms that take into account numerous factors in addition to the idea's commercial potential,[5] making it more challenging to pinpoint the relationship between evaluators' ex-ante assessments of the underlying ideas and ventures' ultimate outcomes.

The educational nature of our setting allows us to circumvent these empirical challenges. When an entrepreneur enrolls at VMS, all currently active mentors—a pool of over 100 experienced local entrepreneurs and executives on average—receive an objective, standardized summary of the proposed venture, composed by a VMS staff member.[6] Each summary describes the venture idea—the proposed business model and technology, target customers, and current challenges—but provides limited information about the entrepreneur and founding team; the summaries are consistent in form and tone. On the strength of the summary alone, without meeting the entrepreneurs, mentors must decide whether they want to work with a venture, a decision they do not make lightly.[7] The aggregate number of mentors expressing interest in a given venture provides us a measure of the ex-ante perceived quality of the venture in its earliest form.

Aggregate initial interest is unlikely to systematically influence ventures' access to mentoring resources or entrepreneurs' effort levels, due to several institutional factors. First, to provide entrepreneurs with equal access to their mentoring resources, VMS sets the initial mentor team to consist of two to four mentors, which is usually fewer than the number of interested mentors—the median number of interested mentors in our sample is six. VMS selects the initial mentor team from the interested mentors based on a variety of factors including scheduling availability and load balancing. Second, entrepreneurs determine how much mentoring they receive; they are not aware of the magnitude of initial mentor interest, nor do they have a role in choosing the initial mentor team. Third, the composition of the mentor team often changes over

[4]A large body of literature describes various mechanisms whereby venture capitalists and angel investors professionalize ventures and improve their outcomes, such as active mentorship, network access, and control rights (Gorman & Sahlman, 1989; Sahlman, 1990; Lerner, 1995; Hellmann & Puri, 2002; Hsu, 2004; Kerr *et al.* , 2014a). See also Lerner (1999) and Howell (2014) on the impact of government grants, and Cohen & Hochberg (2014), Hallen *et al.* (2014), and Yu (2015) on accelerators.

[5]For instance, see Zacharakis & Meyer (2000), Baum & Silverman (2004), and Bernstein *et al.* (2014) on VC and angel investors' selection criteria.

[6]VMS imposes minimal screening on venture ideas.

[7]Mentors on average express interest in fewer than 5 percent of the ventures they review.

time as the venture develops and its needs evolve, and later-stage team members are not restricted to those who initially expressed interest in the venture. Thus only a semi-random subset of the mentors who initially express interest in a venture ultimately interact with it, and few if any become heavily involved.

We collect detailed data on the characteristics and subsequent outcomes of 652 ventures that joined VMS between 2005 and 2012.[8] The vast majority represent industries characterized by high-impact entrepreneurship, including consumer web and mobile, enterprise software, hardware,[9] and life sciences. Generally speaking, the ventures in our sample are serious endeavors, not recreational pursuits; nearly half of the ideas evolved into launched businesses led by at least one full-time entrepreneur. These ventures also had significant economic impact, raising nearly $800 million from venture financing, government grants, and other sources.

Our study generated three key findings. First, venture ideas that elicit a high degree of initial mentor interest are more likely to ultimately reach commercialization, defined as having recurring revenue and expenses associated with the sale of products and/or services in keeping with the company's business objective. Conditional on a rich set of controls for venture characteristics observed at entry and for venture/mentor interactions, we find that a one-standard deviation increase in the proportion or count of mentors who express interest in a venture idea implies, on average, a 17-percent increase in the likelihood of commercialization (or a 3.8-percentage-point increase over the baseline probability of 22.4 percent). The results are robust to using alternative measures of mentor interest, to restricting the sample of analysis to ventures in which more than four mentors express interest, and to restricting the sample to ventures that have limited interaction with VMS mentors. Using data at the venture/mentor-pairing level to control for mentor fixed effects, we further invalidate the hypothesis that our results are driven by variation in the quality of matching between mentors and ventures. The relationship between mentor interest and ultimate commercialization remains strong for the subsample of venture ideas that entrepreneurs decided to pursue full-time, which suggests that mentors are not simply predicting the behavior of entrepreneurs or excluding obviously non-serious ideas.

Second, we document strong heterogeneity across industry sectors. Following the National Science Foundation (2006), we define research-and-development (R&D)-intensive sectors to include hardware, energy, and life sciences and medical devices. We find that the relationship between initial mentor interest and eventual commercialization is strong and significant for ventures in R&D-intensive sectors, and particularly

[8] Our sample includes all ventures that joined VMS between 2005 and 2012 except for 7 ventures that were already funded when they joined VMS and 10 ventures that were founded by MIT faculty.

[9] That is, products that require large-scale manufacturing processes.

for ventures with documented intellectual capital.[10] In contrast, the relationship is weak and insignificant among ventures in non-R&D-intensive sectors, including consumer web/mobile, enterprise software, and consumer products. This finding is not attributable to a venture's intellectual capital simply functioning as a signal of its maturity; we find that mentor assessment is not effective for the most developed venture ideas in our sample, namely those that have already formed a legal business entity when they join VMS.[11]

Third, we find that mentors' industry-specific and scientific expertise is not a critical determinant of their collective ability to assess commercial viability. For each venture, we calculate mentor interest separately for mentors with and without in-depth experience in the venture's sector. We trace much of the predictability of commercial viability to interest expressed by mentors with limited or no experience in the venture's industry, not by industry experts. Similarly, we show that interest expressed by mentors without doctoral degrees strongly predicts venture commercialization, but that of mentors with doctoral degrees does not. These results do not imply, however, that industry or scientific expertise hinders an individual mentor's ability to assess a venture's commercial potential. Given the diversity of mentors' educational and career backgrounds, only a small proportion of mentors have industry-specific or scientific expertise. We provide suggestive evidence that the predictive power of mentors' assessments arises from aggregating the subjective evaluations of a large and diverse group of mentors.

Our findings make several contributions. Unlike the vast literature on the effectiveness of the peer-review process in evaluating scientific ideas (Cole *et al.* , 1981; Chubin & Hackett, 1990; Lamont, 2009; Li & Agha, 2015), empirical evidence on evaluation of entrepreneurial ideas is scant and inconclusive.[12] Using data on Canadian inventions, Astebro & Elhedhli (2006) find a positive relationship between expert evaluation of an invention and its likelihood of subsequent commercialization and financial returns. Fafchamps & Woodruff (2014) report a positive correlation between small businesses' scores in a Ghanaian business-plan competition and their future growth. In both cases, however, the evaluation is revealed to the entrepreneurs, and thus could influence subsequent outcomes via signaling. In contrast to these studies that find a positive relationship, Kerr *et al.* (2014a) and Kerr *et al.* (2014b) find weak correlations between assessment by venture capitalists and angel investors at the time of financing and a venture's subsequent performance

[10] That is, ventures that are based on academic research or that have filed for intellectual property protection at the time of evaluation.

[11] Around 17 percent of the ventures are incorporated at entry.

[12] In other contexts involving innovative ideas, Kornish & Ulrich (2014) find that evaluation of raw ideas for household consumer products by consumer panelists and expert evaluators positively predicts final product sales, and Goetzmann *et al.* (2012) and Luo (2014) find that the price of a movie script predicts the commercial performance of the final product.

conditional on receiving funding; however, the funded ventures are only a small subset of the full sample of ventures evaluated by the investors, and thus do not shed light on the overall effectiveness of investors' ability to differentiate early-stage venture ideas.[13]

The degree to which new ideas can be effectively differentiated affects entrepreneurs' and innovators' choices to engage in parallel search—to diversify across multiple ideas—or to focus resources on the most promising ideas (Nelson, 1961). Innovative ideas are the fundamental engine of economic growth (Romer, 1990; Aghion & Howitt, 1992; Jones, 1995), but the nature of innovation also implies that the probability distribution of future outcomes is often unknown (Knight, 1921; Rosenberg, 1996). Arrow (2012) draws a parallel to evolutionary biology, pointing out that "it is precisely the way the new species (or the innovation) differs from the present that is of interest, and that is what is difficult to predict." Given limited empirical evidence on the predictability of entrepreneurial outcomes, prior work has emphasized experimentation and diversification as key ingredients of the entrepreneurial process (Stern, 2005; Kerr *et al.* , 2014b; Nanda & Rhodes-Kropf, 2015).[14] We contribute to this literature by demonstrating the predictability of ventures in R&D-intensive sectors, which suggests in turn that the optimal level and form of experimentation vary depending on the nature of the venture.

This paper also builds on the critical-resource literature (Wernerfelt, 1984; Zingales, 2000; Rajan & Zingales, 2001a,b) by contributing evidence on the heterogeneity of the assets—physical, intellectual, or human-capital assets—around which firms form at the earliest stages. Prior studies find that initial business concepts often change and broaden during the idea-formation stage (Bhide, 2003) and that entrepreneurs' human capital is a key differentiator of early-stage firms (Rajan, 2012; Bernstein *et al.* , 2014). This finding appears to be at odds with Kaplan *et al.* (2009), which shows that a venture's intellectual-property assets are formed at the business-plan stage, and remain relatively stable between receiving venture financing and going public, but that the management team changes. Our results on the heterogeneity of ventures suggest that firms form around different critical resources even at very early stages, and that previous findings may apply to the specific types of ventures that comprise the firm samples used in those studies.[15]

[13] Although Kerr *et al.* (2014a) also find that the aggregate interest level of the angel investors in their study positively predicts the probability of raising VC funding for ventures that do not receive funding from these angel investors, the results could be driven by shared preferences among angel and VC investors and thus provide only suggestive evidence on the efficacy of the evaluation mechanisms.

[14] See also Rosenberg (1992) and Qian & Xu (1998) on the importance of experimentation in market-based economies; Fleming (2001) and Fleming & Sorenson (2004) on experimentation in scientific inventions; and Shane (2000) on experimentation in commercial applications of new technologies.

[15] Of the 21 firms studied in Bernstein *et al.* (2014), 18 are in information technology. 72 of the 100 firms interviewed by Bhide (2003) are in computer-related industries, business services, or consumer goods; 25 of the 50 firms studied in Kaplan *et al.* (2009)

The next section describes the institutional setting of VMS in depth. Section 3 discusses our data and summary statistics. Section 4 estimates the relationship between expert evaluation and likelihood of commercialization and rules out alternative explanations. Sections 5 and 6 explore the heterogeneity of venture types and mentor backgrounds. Section 7 concludes.

2 Empirical Setting

To fill a gap in MIT's institutional support of emerging entrepreneurs, Professor David Staelin from the Department of Electrical Engineering and Computer Science and alumnus Alexander Dingee, both highly successful entrepreneurs, founded the MIT Venture Mentoring Service in 2000 with the support of Provost Robert Brown. The program's primary objective is to escalate the economic impact of MIT's ecosystem via entrepreneurship education. Entrepreneurs from the larger MIT community—students, staff, alumni, and faculty—approach VMS with an idea, often in an early form, and receive customized advice from a team of elite volunteer mentors. VMS thus uses very early-stage ideas as the context for providing prospective entrepreneurs a hands-on, practical education. The service is confidential and free of charge.

In addition to volunteer mentors, VMS consists of a small team of full-time staff members, including two mentors-in-residence. In keeping with the focus on entrepreneurial education, VMS staff members share the outlook that their mission is, in the words of one staff member, "to build entrepreneurs, not businesses. The businesses are simply case studies for learning entrepreneurship." Success for VMS is not determined by its ventures' rate of commercialization or successful exit; it is captured in the learning opportunities VMS provides. Positive progress is celebrated, but failure is also embraced. "We think it's a success if the prospective entrepreneur decides there isn't a viable business," remarked a VMS staff member, "or that they really don't want to be an entrepreneur now that they get what you really have to do [to be successful]." Accordingly, a VMS entrepreneur who decided against pursuing a venture expresses gratitude "for [VMS mentors'] insight and experience that helped drive us to this conclusion far faster than we could have reached on our own."

are in biotechnology, telecom, or healthcare. In our sample of 652 venture ideas, 221 are in hardware, life sciences and medical devices, and energy; 384 are in consumer web/mobile, enterprise software, and consumer products.

2.1 VMS Mentors

The volunteer mentors at VMS are experts in business formation and development who have typically acquired entrepreneurial experience in one of three ways: by founding and growing a new company, by leading a new business initiative at an established company, or by providing functional services (e.g. legal or financial) to startups. The majority of VMS mentors have either founded a company or joined a startup very early on. A fair number of these mentors are serial entrepreneurs; others have stayed put and become senior executives as a startup grew into a large company. Most of the remaining mentors have led new business initiatives (e.g., new product lines, new divisions, new markets) at established firms and encountered many of the same issues that entrepreneurs face. A few mentors specialize in particular functional areas, such as law or finance; they may lack direct startup experience, but they have interacted extensively with startups.

Mentors are not compensated for their time, and are often referred by existing mentors, who thus provide an initial filter for the organization. Candidates are carefully screened by VMS staff. An in-depth interview looks for a compelling focus and an interest in helping entrepreneurs; prospective mentors with other personal or business agendas, including active professional investors, are not accepted. Every mentor must sign an agreement that specifies rigorous guidelines and a code of ethics that encourages transparency and limits conflicts of interest. VMS monitors mentor activity and promptly dismisses mentors who violate these principles. On rare occasions, a venture will offer a member of its mentor team a more formal role, such as CEO or board advisor. If the mentor accepts such a role, he or she must resign from the mentor team for that venture; VMS reviews such situations on a case-by-case basis. Considerable care is taken to ensure that the program remains focused on its educational aims and provides objective advice to entrepreneurs.

VMS estimates that active mentors average over 100 hours of volunteer time annually. Mentors report that they do so for a variety of reasons. Among the most commonly articulated motivations are the intellectual appeal of the work, continuing engagement in the Greater Boston entrepreneurship community, and the satisfaction of promoting the development of new entrepreneurs. Mentors share a sense that, in the words of one mentor, "mentoring entrepreneurs is a way to give back for all the help that I received in my career."

2.2 Initial Screening of Venture Ideas

To be eligible for mentoring, an entrepreneur must be affiliated with MIT (e.g., students, alumni, faculty, and staff) and based in the Greater Boston area. Given the educational nature of the program, VMS imposes only minimal requirements on eligible entrepreneurs and their ideas: the only criteria are serious interest in learning about entrepreneurship and an idea that will provide a context and focus for practical entrepreneurship education. Entrepreneurs typically come to VMS very early. They may have conducted preliminary research on the feasibility of the idea, but they usually do not have a business plan, a strategy and revenue model, or a team. Few entrepreneurs are pursuing a venture idea full-time when they join VMS, and few of their ventures are incorporated or funded.

2.3 Matching Venture Ideas with Mentors

VMS follows a standardized routine to match new ventures to their initial mentor teams. Here we describe the matching procedures employed by VMS during our study period (2005–2012), which we also summarize in Figure A.1 in the Appendix.

To receive mentoring from VMS, entrepreneurs must first complete a short enrollment form. Drawing on the form and an initial consultation with the entrepreneur(s), a staff member distills the venture idea into a concise standardized summary for purposes of dissemination to mentors; the same staff member prepared almost all of these summaries throughout our sample period. The summary includes the following information:

- a straightforward description of what the venture intends to do, free of buzzwords and technical jargon
- information on potential customers and products
- the type of help the venture needs, and any relevant challenges, problems, and/or known issues (e.g., intellectual-property and legal problems)
- brief information on the founding entrepreneur(s), including their MIT affiliations

Table A.1 in the Appendix provides sample anonymized written descriptions. Because the program focuses on entrepreneurship education, VMS presents all ventures in positive terms. For ventures of a technological nature, the feasibility of the underlying technology is rarely questioned. (Challenges and problems are not ignored, however; they shed light on the assistance entrepreneurs will need.)

VMS regularly emails venture summaries, in batches, to all active VMS mentors; the summaries are also delivered in printed form and orally at monthly meetings of mentors. Mentors then respond, indicating interest in working with a given venture. Because mentors do so via email or on paper, they evaluate ventures independently and only VMS is aware of the aggregate interest level.

An expression of interest indicates willingness to commit time to a venture, and mentors do not do so lightly. On average, mentors express interest in fewer than 5 percent of the ventures to which they are exposed. Interviews with mentors suggest that the appeal of the underlying technology and/or business idea is the primary driver of interest. One mentor reports basing interest on the "novelty of the idea and whether it offers some positive value to some group of people and/or the planet." Another mentor concurs: "I volunteer if the technology and/or the application is interesting to me." Sometimes, mentors also consider the relevance of their experience and knowledge. But not all mentors look for ventures that hew closely to their own backgrounds. A mentor who reports being "most intrigued by the ventures that are the furthest from my own professional experiences" speaks for many mentors.

Compared to contexts like venture financing, VMS mentors typically make their decisions far earlier in a venture's life cycle, often years before it will approach professional investors. VMS mentors also make a single decision—whether to express interest in a venture—based solely on the summary of the business proposition and without meeting the founding team, in contrast to the multistage investment decision processes of professional investors, which rely on abundant information.[16]

It is important to note that mentor interest is not used as a metric in program evaluation. VMS uses mentor-interest data only in the initial mentor venture pairing process and sets the initial mentor team size to two to four volunteer mentors (excluding the professional VMS staff members). Because more mentors typically express interest than can join the team, only a semi-random subset of mentors expressing interest in a venture interacts with the venture. VMS assembles the mentor team in light of a set of factors that include mutual scheduling constraints and load balancing. Entrepreneurs do not learn the aggregate mentor interest they attract, nor do they select their initial mentor team.

2.4 Mentoring at VMS

VMS ensures that access to mentoring resources does not differ systematically across entrepreneurs and ventures. After being paired with mentor teams, entrepreneurs largely determine the extent of mentoring they receive. Meetings are initiated by the entrepreneurs; VMS attempts to accommodate all requests, and

[16] It is possible that venture capitalists' ample information leads to more bias and inferior evaluations (Zacharakis & Shepherd, 2000; Zacharakis & Meyer, 2000).

checks in regularly with ventures to assure that its records on their status are up to date.

VMS measures the effectiveness of mentoring primarily via the feedback from entrepreneurs; internal evaluation of the program is largely qualitative. Objective metrics include the size of the program (the number of active mentors and entrepreneurs), its rate of growth, mentors' engagement (e.g., hours committed), and entrepreneurs' evaluations. As of July 1, 2014, VMS was working with entrepreneurs on 200 ideas, enrolling over 20 new venture ideas per month, and using the services of around 150 active volunteer mentors.

Assessment of the VMS program is beyond the scope of this paper, but the program is highly regarded by the entrepreneurship community, individual entrepreneurs, and university educators alike.[17] Over 40 institutions worldwide—including Harvard University, Yale University, Columbia University, and New York University—have established mentoring programs based on the VMS model. At MIT, VMS complements a rich array of other services, centers, programs, clubs, and initiatives, both academic and extracurricular, that support innovation and entrepreneurship.[18]

We do not claim that the effect of mentoring on ventures is unvarying. Our identifying assumption is, rather, that the level of mentor interest expressed at the time of venture enrollment does not systematically cause the intensity of mentoring to differ. Generally speaking, a mentor is unlikely to become as heavily involved as a typical investor. This is the case for two reasons. First, entrepreneurs request meetings based on their own needs and not on mentors' schedules. Given the *ad hoc* nature of these meetings, the entire mentor team may not attend. Second, the mentor team may change over time as different kinds of knowledge, skills, and experience become more useful. Later-stage mentors are not limited to those who initially expressed interest in the venture. In many cases, in fact, later mentor venture pairings are based on the specific skills of the mentor and/or facilitated by informal meetings at VMS events.

[17] For instance, the Ewing Marion Kauffman Foundation has identified VMS as a model program. One entrepreneur reports that VMS "provided the critical help when it was the most dangerous to make [the] decisions . . . that could make or break the company" and adds that she "never could have anticipated the depth and quality of support" provided.

[18] For example, the Martin Trust Center for Entrepreneurship is a hub for entrepreneurial courses and activities, and the Deshpande Center for Technological Innovation helps researchers take new discoveries from the lab bench to commercialization.

3 Data and Descriptive Statistics

3.1 Venture Sample

Our sample for analysis consists of all ventures that joined VMS between 2005 and 2012. We exclude the initial cohorts from VMS's first five years of operation because both ventures and mentors were few in number and may have been selected by virtue of connections with VMS's founders. By late 2004, however, VMS had grown substantially, increased awareness of its services in the larger MIT community, and introduced systematic electronic record-keeping. Figure 1 plots the number of new ventures that joined VMS during our sample period by starting year and month. We exclude seven ventures that had already been funded before joining VMS since they had progressed further than the typical venture that affiliates with VMS at the idea stage. Also, third-party validation by investors might have influenced the evaluations of VMS mentors. We also exclude ten ventures founded by MIT faculty, which may have special standing in the university ecosystem. Our resulting sample consists of 652 ventures.

Table 1 presents summary statistics on the observed characteristics of ventures upon joining VMS. The most populous industry sectors are consumer web and mobile (27.9 percent), enterprise (or business-to-business) software (17.8 percent), and hardware/large-scale manufacturing (14.7 percent). Other sectors include life sciences and medical devices (13.3 percent), consumer products (13.2 percent), and energy (5.8 percent). The remaining set (7.2 percent) includes non-profit ventures, lifestyle businesses, and a few ventures in consulting and finance. Given the affiliation with MIT, it is unsurprising that a fair proportion of the ventures have a strong technological component. Around 23 percent already have filed for intellectual-property (IP) protection when they join VMS, but only 16.9 percent have established formal business entities; of the total, 15.5 percent are based on academic research.

Table 2 summarizes venture characteristics by industry. Following the National Science Foundation (2006), we designate life sciences and medical devices, hardware, and energy—which jointly account for 221 venture ideas—as sectors with high research-and-development intensities. Unsurprisingly, a large proportion of these ideas draw on academic research or possess intellectual property when they join VMS; many have also formed legal business entities. Ventures in other sectors, such as consumer web/mobile and enterprise software, are much less likely to draw on research or to have IP at entry.

Students and alumni respectively generate around 38.3 percent and 36.7 percent of venture ideas. The rest come from postdoctoral fellows, research associates, and staff. Around 7.7 percent of the venture ideas in our sample belong to entrepreneurs previously mentored by VMS on a different project.

3.2 Mentor Sample

The sample of mentors consists of 251 volunteer mentors who have ever been active between 2005 and 2012. We exclude full-time VMS staff members from the active mentor pool because they are aware of the aggregate mentor interest and interact with most ventures. The number of active mentors increases during our sample period from 68 in 2005 to 181 in 2012.

We collect detailed data on mentors' backgrounds and expertise by means of surveys and online searches. Table 3 reports mentors' mean characteristics. Around 85 percent of mentors are male; only a few (22.3 percent) have a Ph.D. or M.D. Because many mentors have worked in multiple sectors, we categorize them in two ways. First, we define a mentor's primary sector as the industry in which he or she has worked longest to date (as self-reported or extracted from online career histories). In this classification scheme each mentor has a single primary sector. The three most populous primary sectors are hardware (24.7 percent), life sciences and medical devices (21.5 percent), and enterprise software (21.1 percent). The sector most popular with ventures, consumer web and mobile, is the primary sector of only 6.8 percent of mentors. Second, we capture the breadth of a mentor's experience via seven experience dummies; each dummy is designated as 1 if a mentor has had work experience in the corresponding industry sector. Again, the three most populous sectors are hardware, enterprise software, and life sciences and medical devices. Mentors on average have worked in 2.5 sectors.

3.3 Measuring Initial Mentor Interest

We use two variables to measure aggregate mentor interest: the percentage and the number of active mentors who express interest in a venture shortly after the venture joins VMS.[19] To accommodate delayed responses from mentors and delayed recording of their responses, we include all indications of interest expressed within two months of a venture's eligibility for mentoring.[20] It is not uncommon for a mentor initially uninterested in a venture to become interested as the venture develops; we exclude such cases from our calculations of initial interest because they may be driven by a venture's positive progress, by information provided by other mentors, and/or by other interactions and events sponsored by VMS.

[19]The denominator in the percentage of mentors expressing interest is the number of mentors who were actively involved with VMS at the time, excluding mentors who had not yet joined VMS or who had already left the program.

[20]Our results are also robust to using a threshold of 1.5 months or three months.

On average, a new venture interests around 4.5 percent of active mentors, or 6.3 mentors.[21] The median number of interested mentors is 6. Figure 2 shows the kernel density of aggregate mentor interest measured as a proportion, and a histogram of interest measured as a count.

3.4 Measuring Mentoring Intensity

As noted in Section 2, mentors' initial evaluation of a venture is unlikely to systematically make for differential mentoring resources. The educational structure of the program is designed to maximize entrepreneurs' access to mentoring resources regardless of the potential of their ideas. Nonetheless, we capture the degree of mentoring intensity at the extensive margin using two variables: the number of mentors who have met with the venture at least twice and the number of a venture's meetings at VMS, both measured at the time of data collection. The former measure controls for the relationships that entrepreneurs may have formed with VMS mentors.[22] The latter measure uses number of meetings instead of frequency of meetings to capture VMS's total impact on a venture.[23] Though we do not observe all channels whereby mentors and ventures could interact (such as email), we expect that, on average, ventures that have had more recorded interactions with their mentor teams have received more mentoring. We use additional robustness checks to investigate whether variations in the degree of mentoring at the intensive margin drive our key results.

The average venture in our sample meets with VMS mentors only around three times, and has repeated interactions with fewer than two mentors (see Table 1). Around 36 percent of ventures never meet with VMS mentors or do so only once; 40 percent never interact with any mentor more than once (see Table A.2). The correlations between initial mentor interest and venture mentor interactions are weakly positive (see Figure 3).

3.5 Measuring Venture Outcomes and Milestones

Our primary outcome of interest is whether or not a venture successfully reaches the stage of commercialization, characterized by recurring revenue and expenses associated with sales of the products and/or services that are the business objective of the company, and by a reasonable expectation of repeat business and new

[21] On average, a summary of a new venture is sent to 144 active mentors.

[22] This measure excludes mentors who meet with the venture only once, since a mentor who is not a member of a venture's team may be invited to meet with the entrepreneur to address specialized needs. For instance, a lawyer may meet with the entrepreneurs to discuss how to draft a founder's agreement.

[23] It is also difficult to measure frequency without errors, especially in the case of failed venture ideas since it is hard to pinpoint the precise timing of a failure.

customers. We capture this outcome using public sources, including product listings on popular sites like Amazon.com, news articles, and press releases. Our definition of commercialization excludes revenue from one-off "consulting services" or "pilot-test fees," which are often employed as bootstrap financing vehicles but do not advance the business objective. In the rare cases of business models based on licensing, forging technology-licensing deal(s) is considered commercialization. Commercialized ventures are those whose products and/or services have received validation from customers.

We also collect data on two additional entrepreneurial milestones to measure the progress of each venture. We consider a venture to be launched if at least one of its founding entrepreneurs has ever pursued it full-time. This definition excludes cases in which entrepreneurs pursue a venture part-time while attending school or holding a job. We also measure whether a venture has ever received funding from angel investors and/or venture capitalists. We exclude crowdfunding, government grants, and investments by friends and family from our definition, since the criteria and purposes of such funding channels vary widely. Collectively, these measures portray the growth and impact of a venture idea. VMS tracks ventures' receipt of funding; we hand-collected the other data using VMS's archives and internet searches.

Because we aim to determine how far a venture has progressed to date, our outcomes do not necessarily describe its current status. Instead, our outcomes are intended to capture a venture's potential economic impact. Survival metrics do not measure venture performance effectively, since they are apt to be driven by the venture's underlying technology or industry of the venture; for instance, life-science ventures tend to take longer to fail than web-services ventures (Arora & Nandkumar, 2011). Some newer ventures were still pursuing intermediate milestones in summer 2014 when we collected outcome data. This censoring may cause our data to underestimate the likelihood that ventures in our sample eventually reach commercialization, biasing against finding a positive relationship between initial mentor interest and commercialization.

In our sample, 46.5 percent of ventures launched, 18.6 percent raised funding from professional investors, and 22.4 percent ultimately commercialized (see Table 1). The ventures have raised over $621 million in venture-capital financing and $84.8 million from angel investors. Notably, of the 144 ventures that reached commercialization, 71 did so without funding from professional investors.[24] Overall, these numbers suggest that the venture ideas observed in our data are generally serious endeavors and not recreational pursuits.

[24]Some ventures may not seek venture financing to avoid diluting equity. Instead, they rely on bootstrapping, personal finances, friends and family, small grants, one-off consulting services, and/or business-plan competitions.

4 Initial Mentor Interest and Subsequent Venture Commercialization

4.1 Regression Specification

Figure 2 shows that, without any controls, venture ideas that are eventually commercialized are likely to elicit greater initial interest from mentors. To formally estimate the relationship, we use the following specification:

$$
\begin{aligned}
Pr(COMMERCIALIZATION_i) \quad = \quad & \alpha + \beta MENTOR\_INTEREST_i \\
& + \gamma \left\{ D_i^{MENTOR\_RECUR}, D_i^{MEETINGS} \right\} \\
& + \delta \left\{ D_i^{START\_YEAR}, D_i^{START\_MONTH}, Controls_i \right\} + \varepsilon_i
\end{aligned} \tag{1}
$$

where i denotes a venture and *MENTOR_INTEREST* is either the proportion or the count of active mentors who express initial interest in a venture idea as discussed in Sections 3.3.

To control for the effects of venture age and seasonality, we include dummies for the year and the month that a venture joins VMS. Some venture characteristics, such as industry sector or underlying technological intensity, could drive both mentor interest and commercial viability. We thus include a rich set of controls to determine whether mentors can accurately evaluate a venture's commercial viability beyond picking up on these characteristics. We control for variables that reflect the underlying business proposition by including whether the venture is based on academic research, whether it possesses intellectual property when it joins VMS, and dummies for its industry sector. We control for the venture's stage of development by including a dummy on whether it has a legal business entity (that is, whether it is incorporated) at the time of entry. We further control for the entrepreneur's characteristics by including whether he or she is an MIT student or alumnus and whether he or she has been previously mentored by VMS.[25]

The key coefficient of interest is β, which measures whether a venture idea that attracts more mentor interest in its initial form is more likely to be commercialized in the future. The main identification concern is whether aggregate mentor interest directly affects a venture's growth and outcomes. It could theoretically do so in two ways. First, mentor interest could affect the degree of mentoring that a venture receives from VMS. As discussed in Section 2, this is unlikely given the educational focus and institutional structure of VMS. Second, mentor interest could alter entrepreneurs' and mentors' behavior. This too is unlikely, since

[25] VMS does not systematically record further information about the entrepreneurs at the time of venture enrollment.

neither ventures nor mentors receive information on aggregate mentor interest. Nevertheless, we control for venture mentor interactions as discussed in Section 3.4. To capture the possible nonlinear effect of mentoring, we use tercile dummies for the number of mentors who have met with the venture at least twice and for the number of meetings that a venture has had at VMS.[26]

4.2 Main Results

In Table 4, Columns (1)-(6) present the OLS estimates of Equation (1) with increasing levels of controls and robust standard errors clustered by venture sector and year of affiliation with VMS.[27] Column (1) shows that, controlling only for the starting year and month, a venture that elicits more initial interest from mentors when it first joins VMS is more likely to subsequently commercialize. The magnitude of the coefficient estimate is economically important and statistically significant at the 1 percent level. A one-standard-deviation increase in the proportion of active mentors expressing interest, which is 2.68 percentage points, implies on average a 5.36-percentage-point increase in the probability of recurring revenue and expenses, or a 23.9 percent increase over the baseline probability of 22.4 percent.

Columns (1) through (3) show how the estimated relationship between mentor interest and commercialization changes with the inclusion of additional controls for observed venture and entrepreneur characteristics at the time of enrollment. Column (2) controls for characteristics of the venture observed when it joins VMS, including whether it is based on academic research, whether it possesses intellectual property, whether it is a legal business entity, and its industry sector. The coefficient estimate on mentor interest remains positive and significant, although the magnitude decreases from 0.020 to 0.015. Consistent with our field interviews, this decrease in the coefficient estimate shows that mentors do not express interest randomly. Their evaluations are based, at least in part, on observed venture characteristics that positively predict commercial viability. Adding controls for characteristics of the entrepreneur in column (3) only slightly decreases the magnitude of the coefficient estimate to 0.014, suggesting that mentors base their interest more heavily on the underlying business idea than on the entrepreneur's characteristics. This is inline with mentors observing only limited information about the entrepreneur. Importantly, the magnitude of the coefficient estimate remains economically important and is statistically significant at the 5 percent level.

[26]See Table A.2 on the breakdown of the variable values. The base group for the former includes ventures that have not had repeated interactions with any mentors and the base group for the latter includes ventures that have met with VMS mentors at most once.

[27]See Table A.3 in the Appendix for the estimates from probit and logit specifications, which are nearly identical.

Columns (4)-(6) include additional controls on venture mentor interactions. Columns (4) and (5) add the controls linearly; column (6) uses dummy variables to capture nonlinear effects. Because the number of mentors with whom a venture's entrepreneur(s) have met at least twice and the number of meetings they have had with VMS mentors have a high correlation of 0.76, columns (4) and (5) estimate their linear effects separately. Both variables have weak and insignificant relationships with the venture's likelihood of commercialization. Note that these results do not suggest that mentoring has no effect on a venture's development: entrepreneurs may be more likely to seek assistance both when the venture is struggling and when it is growing rapidly. Consistent with the institutional setting, including the venture mentor interactions has negligible impact on our key coefficient estimate on aggregate mentor interest, other coefficient estimates, and R^2.

Our preferred specification is column (6). After controlling for venture and entrepreneur characteristics at entry and the degree of mentoring at the extensive margin, the proportion of active mentors expressing initial interest in a venture has an economically meaningful, positive, and statistically significant relationship with its likelihood of commercialization. All else equal, a venture that attracts a one-standard-deviation (or 2.68 percentage point) higher degree of interest is on average 3.75 percentage points (or 16.75 percent) more likely to reach commercialization. The relationship is statistically significant at the 5-percent level.

To show that the outliers eliciting extremely high or low mentor interest are not driving our results, column (7) excludes the venture ideas that attracted the top or bottom 5 percent in aggregate mentor interest; and the estimated relationship between mentor interest and likelihood of commercialization becomes even stronger. Column (8) uses the number of mentors expressing interest, instead of the proportion measure used previously, and yields the same finding qualitatively and quantitatively as column (6). A one-standard-deviation increase in the count of mentor interest implies on average a 3.83 percentage point (or 17.10 percent) increase in the likelihood of commercialization. Table A.3 in the Appendix shows that the OLS, probit, and logit estimates of the preferred specification using both measures of aggregate mentor interest are nearly identical.

4.3 Robustness Checks

Although our main specification controls for the frequency of venture mentor interactions, it does not control for variations in mentor engagement or the quality of matching between ventures and mentors. This section addresses this topic with several robustness checks.

4.3.1 Controlling for Variations in Mentor Engagement

Table 5 uses three tests to show that systematic variations in mentor engagement are unlikely to drive the relationship between mentor interest and venture outcome. In columns (1) and (2), we measure aggregate mentor interest as the proportion or count of mentors who express initial interest but never meet with the venture. These mentors have thus not had a chance to directly influence the development of the venture. Using more restrictive measures of aggregate mentor interest yields coefficient estimates and standard errors almost identical to columns (6) and (8) in Table 4. Thus our key findings are not driven by mentors who express interest, meet with the venture, and may thus be particularly engaged with it.

In columns (3) and (4), we investigate the role of mentor-team recruitment. When an insufficient number of mentors expresses interest in working with a venture, VMS formally recruits another mentor and/or member of the staff to complete the mentor team. Though contrary to VMS principles, it is conceivable that recruited mentors are less engaged than those who expressed initial interest, and as a result discourage entrepreneurs from engaging with VMS and/or pursuing the venture. We show that this is not the case: the relationship between aggregate mentor interest and commercialization remains unchanged when we include only the ventures that elicited initial interest from more than four mentors—the maximum initial mentor team size—and therefore did not need recruited mentors.

Mentor engagement may vary for a variety of other reasons. Thus in columns (5) and (6) of Table 5 we restrict our empirical analysis to ventures that have had limited interactions with mentors—that is, those that have had two or fewer meetings with mentors and no repeated interactions with an individual mentor. Examining only these 259 ventures yields results similar to those generated by the full sample. Unreported regressions show that the results in columns (3)-(6) of Table 5 also hold if we use the more restrictive measures of aggregate mentor interest from columns (1) and (2)—that is, the proportion or count of mentors who express initial interest but never meet with the venture.

4.3.2 Controlling for Variations in Mentor Matching

The quality of matching between the initial mentor team and the venture may also vary based on aggregate mentor interest. Namely, ventures that elicit more interest may be matched to higher-quality mentors, given more mentors to select among. This is unlikely to occur systematically because matching at VMS is determined by many factors as discussed previously. Nevertheless, we rule out this explanation directly by controlling for the heterogeneous effects that mentors may have on ventures' development using data at the venture mentor pairing level:

$$\begin{aligned} Pr(COMMERCIALIZATION_i) &= \alpha + \beta INTEREST_{i,m} + \xi M_{i,m} \\ &\quad + \delta \left\{ D_i^{START\_YEAR}, D_i^{START\_MONTH}, Controls_i \right\} + \varepsilon_{i,m} \end{aligned} \tag{2}$$

where i denotes a venture, m denotes a mentor, and each observation is a pairing between the two. For each venture, we only include the pairings with mentors who were active at the time of venture entry. $INTEREST_{i,m}$ is 1 if mentor m expresses interest in venture i, and $M_{i,m}$ is a set of 251 (the number of mentors ever active during our sample period) dummies that equal 1 if mentor m has met with venture i. The mentor meeting dummies $M_{i,m}$ control for the heterogeneous effects that meeting with a mentor could have on a venture's probability of commercialization. We include controls for venture and entrepreneur characteristics and timing of entry to VMS as included in Equation (1) and defined previously. As in the case of the main specification, the key coefficient of interest is β, which measures whether a venture idea that attracts more initial mentor interest is more likely to be commercialized in the future.

Table 6 presents the OLS estimates of Equation (2) with different measures of mentor interest and various degrees of controls. The standard errors are robust and clustered at the venture level. In columns (1)-(3), the key independent variable is a dummy that equals 1 if an active mentor expresses initial interest in a venture, regardless of whether they meet later. Column (1) does not control for any venture mentor interactions; the specification is thus similar to column (3) in Table 4. Column (2) includes a dummy that equals 1 if the mentor has met with the venture. The meeting dummy thus captures the average effect of meeting with a mentor; the effect does not vary by mentor. Column (3) allows the mentors to have heterogeneous effects on ventures by including the 251 mentor-meeting dummies. In all three specifications, the coefficient estimate on mentor interest is positive and statistically significant. The estimates on mentor interest in column (2) and (3) are identical, indicating that controlling for variations in mentor-meeting effects does not affect our main results. In columns (4)-(6) of Table 6, we repeat the exercise using the more restrictive measure of mentor interest, which is 1 if the mentor expresses interest in the venture and the pair never meet. The coefficient estimate on mentor interest remains positive and statistically significant.

This approach does not fully capture the differential effects across mentors and ventures that may occur due to venture-mentor match quality. A remaining concern is that a venture eliciting more mentor interest may be matched to a mentor team whose skills are particularly well aligned with the venture's needs, regardless of mentor quality. However, it is counter-intuitive to conclude that any remaining variations in venture mentor fit drive our key results, given that the current controls for venture mentor interactions have a negligible effect on the relationship between mentor interest and subsequent commercialization. Furthermore, our results are robust to restricting the sample of analysis to ventures that had only a few interactions with mentors and where variations in the degree and/or quality of mentoring are more likely to be limited (see columns (5) and (6) of Table 5).

4.4 Nonlinear Relationship between Mentor Interest and Commercialization

We find that aggregate mentor interest in early-stage venture ideas predicts the likelihood of subsequent commercialization, and that the relationship is not driven by variations in the degree or quality of mentoring. However, if mentors appear to evaluate the commercial potential of venture ideas simply because a large quantity of these ideas were clearly not serious ventures, our findings would have little generalizability. Because the entrepreneurs in our sample are highly educated and have high opportunity costs, they do not lightly decide to pursue a venture full-time. We thus use this decision as a minimum threshold to show that mentors can differentiate among serious entrepreneurial pursuits. Table 7 shows that the relationship between mentor interest and venture commercialization is strongly positive and statistically significant for the 303 ventures whose primary entrepreneur pursued the venture full-time.[28] Furthermore, as noted previously, mentors are highly selective in their expressions of interest. If most of the ideas in our sample were superficial, we would expect the distribution of mentor interest to exhibit a long left tail, signifying very low interest in many of the ventures. We do not observe this configuration (see Figure 2).[29]

We next investigate whether mentors distinguish between ideas at the lower and higher ends of the quality distribution. To do so, we increase the flexibility of our main specification by using dummy variables for the quintile of mentor interest relative to other ventures in the same sector and plot the coefficient estimates in Figure 4. Compared to ventures in the lowest quintile, being in the next two quintiles (between the 20-percent and 60-percent percentiles) results in similar likelihoods of commercialization, even though mentor interest varies considerably. (The 60-percent percentile in a given sector interests between 4 to 7 percent of mentors, or 7 to 12 mentors by count). In contrast, the likelihood of commercialization increases

[28]The entrepreneur's full-time commitment to the venture usually occurs after joining VMS.

[29]In comparison, Kerr *et al.* (2014a) find that 64 percent of ventures that sought funding from a group of over 300 angel investors (Tech Coast Angels) elicited no interest.

markedly in the fourth quintile (the 60-80-percent percentiles) and even more in the top quintile. These patterns suggest that the relationship between mentor interest and venture outcome is driven by ideas that elicit above-median mentor interest. (Ventures in the top quintile interest on average 8 percent of mentors, or 11.9 mentors by count). Taken together, these findings strongly suggest that mentors recognize high-quality ideas; they do not merely avoid non-serious ideas.

5 Heterogeneity across Venture Sectors

To this point we have assumed that the relationship between mentor interest and venture outcome is constant across ventures even though the nature of the ventures' underlying ideas may vary considerably, particularly across sectors. Table 2 shows that, compared to other ventures, those in R&D-intensive sectors are more likely to have documented intellectual capital—to be based on academic research and/or to possess IP at entry—and to be incorporated when they join VMS. We explore heterogeneity across sectors and estimate:

$$\begin{aligned} Pr(Outcome_i) \quad = \quad & \alpha + \beta_1 MENTOR\_INTEREST_i * (RD\_SECTOR_i = 1) \\ & + \beta_2 MENTOR\_INTEREST_i * (RD\_SECTOR_i = 0) \\ & + \gamma(Controls)_i + \varepsilon_i \end{aligned} \tag{3}$$

where we use the same controls as in our preferred specification reported in column (6) of Table 4. Thus β_1 measures the relationship between mentors' initial interest and the venture's outcome for ventures in sectors characterized by intensive R&D, and β_2 measures the same relationship for ventures in other sectors. The R&D-intensive sectors in our sample are hardware, energy, and life sciences and medical devices. We report the results using only the proportion of active mentors who express interest as the key variable; the results using the count are nearly identical.

Column (1) in Table 8 reports that the relationship between initial mentor interest and subsequent commercialization is particularly strong for ventures in R&D-intensive sectors. For ventures in other sectors, the coefficient estimate for aggregate mentor interest is weak and insignificant. To investigate the significance of documented intellectual capital and having a legal business entity, columns (2) to (4) restrict the analysis to ventures in R&D-intensive sectors. Among such ventures, aggregate mentor interest has a stronger and highly significant relationship for ventures that are based on academic research or possess IP at entry than those without. In contrast, having a legal business entity at entry weakens the predictive power of mentor interest. The results suggest that the predictive power of mentor interest is the strongest among unincorporated venture ideas with documented intellectual capital in R&D-intensive sectors

One explanation for the divergence of our findings across sectors is that for ventures with clear intellectual capital in R&D-intensive sectors, the initial idea is more likely to match the business proposition that is eventually commercialized and thus mentors' evaluation more consistently accords with the outcome. Ventures that draw on specific intellectual capital are by their nature more limited in the range of experimentation they can undertake. This observation is consistent with the finding of Kaplan *et al.* (2009) that a venture's intellectual assets (measured by patents and other types of intellectual property) stay relatively stable between the business-plan stage and the eventual initial public offering. In contrast, entrepreneurs in non-R&D-intensive sectors, such as consumer web and mobile, enjoy much lower costs of experimentation. They are more likely to conduct rapid repeated iterations of experiments to gather information and to adapt accordingly, sometimes completely changing their focus (Kerr *et al.* , 2014b; Nanda & Rhodes-Kropf, 2015). Our findings highlight the differences between firms centered around different types of critical resources (Rajan & Zingales, 2001a,b) and signify that intellectual capital is a critical resource for early-stage ventures in R&D-intensive sectors.

That mentors can accurately evaluate the commercial potential of ventures with a strong technological component is not at odds with the argument of Rosenberg (1996) that new technologies face a high degree of uncertainty regarding the feasibility and applications of their technologies, as well as development of and access to complementary technologies. Rosenberg's discussion is particularly relevant to the rare revolutionary technologies that have created new industries and changed the entire economy (e.g., telephone and computer). The new technologies in our sample are typically less radical and thus characterized by a more limited degree of uncertainty. This does not mean that the technological ventures in our sample are unrepresentative of technological ventures in other entrepreneurial settings, or that they promise only incremental economic value. In Table 9, we consider raising a large sum in angel and/or VC financing as an alternative outcome. Columns (A1) and (A2) show that, among the ventures in R&D-intensive sectors, aggregate mentor interest is positively and significantly correlated with the probabilities of raising over $1 million and over $5 million in angel/VC funding. Thus, mentor interest also predicts a high valuation with professional investors. Mentors and investors may apply similar criteria when identifying ideas with high commercial potential, but it is not the case that mentors are simply predicting the preferences of investors. Columns

(A3) and (A4) in Table 9 show that aggregate mentor interest is positively and significantly correlated with raising venture financing and becoming commercialized, but exhibits a weak and nonsignificant relationship with raising venture financing without becoming commercialized.[30] Panel B in Table 9 shows that the same findings hold if we include only ventures in R&D-intensive sectors pursued by an entrepreneur full-time.

Beyond demonstrating the economic value of these ideas, Table 9 also provides suggestive evidence that investors are allocating resources to venture ideas with greater likelihood of commercialization.[31] However, similar to Kerr *et al.* (2014a) and Kerr *et al.* (2014b), in unreported regressions we find no evidence that the ex-ante assessment of venture ideas predicts commercial viability conditional on receiving angel or VC funding.[32] The funded ventures in our sample may have less variation in their potential for commercialization than those pursued by an entrepreneur full-time. This could be due to decision makers' effective evaluation across their set of ventures and/or entrepreneurs' selection into seeking venture financing,[33] but distinguishing between the two is beyond the scope of this paper.

6 Heterogeneity across Mentors

We show that it is possible to use succinct summaries of business ideas to predict the future commercial viability of ventures with clear intellectual capital in R&D-intensive sectors (hardware, energy, and life sciences). This section investigates why mentors are able to evaluate such venture ideas effectively. Given the wide variety of mentors' industry and educational backgrounds (Table 3), the majority of the mentors who evaluate a given venture do not possess relevant industry expertise. Thus two types of mentors evaluate a venture (a given mentor could belong to either type, depending on the nature of the venture): a small group with considerable experience in the venture's industry, and a large group without such experience who possess general entrepreneurial skills and knowledge. To examine the degree to which each group drives our main results, we estimate:

$$\begin{aligned} Pr(Outcome_{i,j}) &= \alpha + \beta_1 MENTOR\_INTEREST_{i,j} + \beta_2 MENTOR\_INTEREST_{i,-j} \\ &\quad + \gamma(Controls)_i + \varepsilon_i \end{aligned} \tag{4}$$

[30]Of the funded ventures in R&D-intensive sectors, 40 percent have not commercialized.

[31]However, since we do not observe entrepreneurs' choice to raise funding, the results are not conclusive evidence.

[32]We estimate Equation (1) within the sample of ventures funded by professional investors; the coefficient estimate on mentor interest is weak and insignificant.

[33]For instance, the decision to raise external financing may be influenced by asymmetric information or perceptions of market competition (Chan, 1983; Amit *et al.* , 1990; Eckhardt *et al.* , 2006).

where j is the venture's sector, $MENTOR\_INTEREST_{i,j}$ is the proportion of mentors from sector j expressing initial interest in venture i, and $MENTOR\_INTEREST_{i,-j}$ is the proportion of mentors not from sector j expressing initial interest. We use the same set of controls as in our preferred specification (column (6) of Table 4). Based on Section 5, we restrict the sample of analysis to ventures in R&D-intensive sectors.

We first define $MENTOR\_INTEREST_{i,j}$ to include mentors whose primary sector is j. Column (1) in Table 10 reports the coefficient estimates. Interest on the part of mentors whose primary sector matches the venture's has a small, negative, and insignificant relationship with the likelihood of commercialization. In contrast, interest from mentors in other sectors has a strong, positive, and highly significant relationship with the likelihood of commercialization. An F-test rejects the null hypothesis that the two coefficients are the same at the 1-percent level with an F-statistic of 12.43. On average, the ventures in the regression sample are evaluated by 29.8 mentors in the same sector and 110.1 mentors in other sectors. The differences in the coefficient estimates are thus consistent with two possible explanations: that mentors are more adept at evaluating ventures in sectors outside their own primary areas of expertise, and that having a large number of independent evaluators increases the efficacy of evaluation overall.

We next relax the definition of $MENTOR\_INTEREST_{i,j}$ to include mentors with any experience at all in sector j. Doing so results in more numerically balanced groups: the average number of mentors with at least some relevant experience in a venture's sector is 73.5; the average number without any relevant experience is 66.4. Column (2) in Table 10 shows that interest from mentors without any relevant experience still positively and significantly predicts venture commercialization, although the magnitude of the estimate is smaller than in column (1). Unlike in column (1), interest from mentors with at least some relevant experience has a small and positive relationship with venture outcome, and the F-test does not reject the null hypothesis that the two coefficient estimates representing these balanced groups are the same.

Finally, we categorize mentors by whether or not they possess a doctoral degree (Ph.D. or M.D.). On average, ventures in R&D-intensive sectors were evaluated by 30.5 mentors with doctoral degrees and 109.4 mentors without such a degree, although roughly half had obtained a masters degree. As in column (1), in column (3) we find that the estimate on mentor interest is large, positive, and significant among mentors without a doctoral degree and weak and insignificant among mentors with a doctoral degree.

Table 10 thus shows that expertise or experience in the industry of the venture being evaluated is not a critical factor in mentors' collective ability to differentiate venture ideas; neither is extensive specialized training and knowledge in science and technology. These results do not imply that specialized expertise or knowledge makes a mentor worse at evaluating entrepreneurial ideas. Instead the results provide suggestive evidence that aggregating the evaluations of a large group reduces the noise and bias of individual evaluation. This finding is consistent with prior studies on voting, committee decision making, and crowd funding (Klevorick *et al.* , 1984; Sah & Stiglitz, 1988; Li *et al.* , 2001; Li & Suen, 2004; Mollick & Nanda, 2014).

7 Conclusion

Although early-stage business ideas are rudimentary in nature and incorporate many assumptions, we find that they contain pertinent information on the ventures' eventual commercial viability. In collaboration with MIT's Venture Mentoring Service, we collected and examined detailed data on 652 early-stage venture ideas across a wide range of industry sectors. The venture ideas that elicited more positive evaluations from a large number of skilled practitioners in the Greater Boston entrepreneurship and technology communities were significantly more likely to ultimately reach commercialization. This relationship is strong for ventures in industries requiring intensive research and development but weak for ventures in non-R&D-intensive industries. We further show that this result is not driven by mentors' industry-specific or scientific expertise, but instead by aggregating the subjective evaluations of a large and diverse set of experienced entrepreneurs and executives.

Our results suggest that firms in different sectors form around distinct critical resources at early stages. Ventures in R&D-intensive sectors are more likely to form around intellectual capital than ventures in non-R&D-intensive sectors. This may enable evaluators to assess the commercial potential of the underlying business ideas at early stages because the venture idea is tied to relatively stable intellectual capital and unlikely to change drastically. In contrast, ventures in non-R&D-intensive sectors may be more likely to form around entrepreneurs' human capital, giving entrepreneurs more freedom to adapt and change the business ideas. In these sectors, it may be particularly prudent to carefully assess the capability of the entrepreneurs in addition to the viability of the business propositions.

That business propositions in R&D-intensive sectors can be used to assess commercial viability does not imply that entrepreneurs are inconsequential. On the contrary, because the knowledge required to innovate has become more costly to obtain (Jones, 2009), eliciting useful information on the commercial viability of early-stage venture ideas allows entrepreneurs in R&D-intensive sectors to better allocate their valuable human capital. Such information may also be helpful because entrepreneurs tend not to make optimal business entry decisions (Kahneman & Lovallo, 1993; Camerer & Lovallo, 1999).

Another key implication of our findings is that policies designed to foster entrepreneurship should be tailored to the heterogeneous nature of uncertainty in different sectors. Just as treating entrepreneurship as experimentation allows for consideration of "business models and technologies in domains with greater uncertainty than otherwise possible" (Kerr *et al.* , 2014b), knowing whether and how evaluation of early-stage ventures is feasible will allow entrepreneurs, investors, and policy makers to consider a broader range of ventures. Effective evaluation will be especially valuable in domains where experimentation is otherwise constrained or prohibitively costly, such as R&D-intensive industries. Even at early stages, experimentation involves direct costs (such as the upfront investment in research and production equipment), indirect costs (such as the stigma of failure), and the opportunity costs of forgone projects. Our results suggest that seeking feedback from experienced entrepreneurs and executives with different backgrounds, including those outside the venture's industry, may be an alternative means for entrepreneurs and other decision makers to resolve some uncertainty. However, evaluation should be viewed not merely as a substitute for experimentation but also as a complementary tool in the allocation of resources to high-growth entrepreneurship. Given the prevalence of evaluation mechanisms in VC firms, incubator and accelerator programs, and government innovation and small-business funds, it would be beneficial for future research to examine the efficacy of these mechanisms.

References

Aghion, Philippe, & Howitt, Peter. 1992. A Model of Growth Through Creative Destruction. *Econometrica*, **60**(2), 323–351.

Amit, Raphael, Glosten, Lawrence, & Muller, Eitan. 1990. Entrepreneurial Ability, Venture Investments, and Risk Sharing. *Management Science*, **36**(10), 1232–1245.

Arora, Ashish, & Nandkumar, Anand. 2011. Cash-Out or Flameout! Opportunity Cost and Entrepreneurial Strategy: Theory, and Evidence from the Information Security Industry. *Management Science*, **57**(10), 1844–1860.

Arrow, Kenneth. 2012. The Economics of Inventive Activity over Fifty Years. *Pages 43–48 of: The Rate and Direction of Inventive Activity Revisited*. University of Chicago Press.

Astebro, Thomas, & Elhedhli, Samir. 2006. The Effectiveness of Simple Decision Heuristics: Forecasting Commercial Success for Early-Stage Ventures. *Management Science*, **52**(3), 395–409.

Baum, Joel A. C., & Silverman, Brian S. 2004. Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. *Journal of Business Venturing*, **19**(3), 411–436.

Bergemann, Dirk, & Hege, Ulrich. 1998. Venture capital financing, moral hazard, and learning. *Journal of Banking & Finance*, **22**(6-8), 703–735.

Bergemann, Dirk, & Hege, Ulrich. 2005. The Financing of Innovation: Learning and Stopping. *The RAND Journal of Economics*, **36**(4), 719–752.

Bernstein, Shai, Korteweg, Arthur, & Laws, Kevin. 2014. Attracting Early Stage Investors: Evidence from a Randomized Field Experiment. *Working Paper*.

Bhattacharya, Sudipto, Chatterjee, Kalyan, & Samuelson, Larry. 1986. Sequential Research and the Adoption of Innovations. *Oxford Economic Papers*, **38**(Nov.), 219–243.

Bhide, Amar V. 2003. *The Origin and Evolution of New Businesses*. OUP USA.

Camerer, Colin, & Lovallo, Dan. 1999. Overconfidence and Excess Entry: An Experimental Approach. *American Economic Review*, **89**(1), 306–318.

Chan, Yuk-Shee. 1983. On the Positive Role of Financial Intermediation in Allocation of Venture Capital in a Market with Imperfect Information. *The Journal of Finance*, **38**(5), 1543–1568.

Chubin, Daryl E., & Hackett, Edward J. 1990. *Peerless Science: Peer Review and U. S. Science Policy*. SUNY Press.

Cohen, Susan, & Hochberg, Yael V. 2014. *Accelerating Startups: The Seed Accelerator Phenomenon*.

Cole, S., Cole, J. R., & Simon, G. A. 1981. Chance and consensus in peer review. *Science (New York, N.Y.)*, **214**(4523), 881–886.

Decker, Ryan, Haltiwanger, John, Jarmin, Ron, & Miranda, Javier. 2014. The Role of Entrepreneurship in US Job Creation and Economic Dynamism. *The Journal of Economic Perspectives*, **28**(3), 3–24.

Eckhardt, Jonathan T., Shane, Scott, & Delmar, Frederic. 2006. Multistage Selection and the Financing of New Ventures. *Management Science*, **52**(2), 220–232.

Ewens, Michael, Nanda, Ramana, & Rhodes-Kropf, Matthew. 2015. Entrepreneurship and the Cost of Experimentation. *Harvard Business School Working Paper, No. 15-070*, July.

Fafchamps, Marcel, & Woodruff, Christopher. 2014 (Apr.). *Identifying Gazelles: Expert panels vs. surveys as a Means to Identify Firms with Rapid Growth Potential*.

Fleming, Lee. 2001. Recombinant Uncertainty in Technological Search. *Management Science*, **47**(1), 117–132.

Fleming, Lee, & Sorenson, Olav. 2004. Science as a map in technological search. *Strategic Management Journal*, **25**(8-9), 909–928.

Goetzmann, William N., Ravid, S. Abraham, & Sverdlove, Ronald. 2012. The pricing of soft and hard information: economic lessons from screenplay sales. *Journal of Cultural Economics*, **37**(2), 271–307.

Gorman, Michael, & Sahlman, William. 1989. What Do Venture Capitalists Do? *Journal of Business Venturing*, **4**(4), 231–248.

Hall, Robert E., & Woodward, Susan E. 2010. The Burden of the Nondiversifiable Risk of Entrepreneurship. *The American Economic Review*, **100**(3), 1163–1194.

Hallen, Benjamin, Bingham, Chris, & Cohen, Susan. 2014. *Do Accelerators Accelerate? A Study of Venture Accelerators as a Path to Success*.

Haltiwanger, John, Jarmin, Ron S., & Miranda, Javier. 2012. Who Creates Jobs? Small versus Large versus Young. *Review of Economics and Statistics*, **95**(2), 347–361.

Hastings, Daniel, Lerman, Steven, & Parker, Melanie. 2010. The Demand for MIT Graduates. *MIT Faculty Newsletter*, **XXII**(3).

Hellmann, Thomas, & Puri, Manju. 2002. Venture Capital and the Professionalization of Start-Up Firms: Empirical Evidence. *The Journal of Finance*, **57**(1), 169–197.

Howell, Sabrina. 2014. *Financing Constraints as Barriers to Innovation: Evidence from R&D Grants to Energy Startups*.

Hsu, David H. 2004. What Do Entrepreneurs Pay for Venture Capital Affiliation? *The Journal of Finance*, **59**(4), 1805–1844.

Jensen, Richard. 1983. Innovation adoption and diffusion when there are competing innovations. *Journal of Economic Theory*, **29**(1), 161–171.

Jones, Benjamin F. 2009. The Burden of Knowledge and the "Death of the Renaissance Man": Is Innovation Getting Harder? *The Review of Economic Studies*, **76**(1), 283–317.

Jones, Charles I. 1995. R & D-Based Models of Economic Growth. *Journal of Political Economy*, **103**(4), 759–784.

Kahneman, Daniel, & Lovallo, Dan. 1993. Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking. *Management Science*, **39**(1), 17–31.

Kaplan, Steven N, Sensoy, Berk A., & Stromberg, Per. 2009. Should investors bet on the jockey or the horse? Evidence from the evolution of firms from early business plans to public companies. *The Journal of Finance*, **64**(1), 75–115.

Kerr, William R., Lerner, Josh, & Schoar, Antoinette. 2014a. The Consequences of Entrepreneurial Finance: Evidence from Angel Financings. *Review of Financial Studies*, **27**(1), 20–55.

Kerr, William R., Nanda, Ramana, & Rhodes-Kropf, Matthew. 2014b. Entrepreneurship as Experimentation. *Journal of Economic Perspectives*, **28**(3), 25–48.

Klevorick, Alvin K., Rothschild, Michael, & Winship, Christopher. 1984. Information processing and jury decisionmaking. *Journal of Public Economics*, **23**(3), 245–278.

Knight, Frank H. 1921. *Risk, uncertainty and profit*. Boston, MA: Houghton Mifflin Company.

Kornish, Laura J., & Ulrich, Karl T. 2014. The Importance of the Raw Idea in Innovation: Testing the Sow's Ear Hypothesis. *Journal of Marketing Research*, **51**(1), 14–26.

Lamont, MichÃšle. 2009. *How Professors Think*. Harvard University Press.

Lerner, Josh. 1995. Venture Capitalists and the Oversight of Private Firms. *Journal of Finance*, **50**(1), 301–318.

Lerner, Josh. 1999. The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program. *The Journal of Business*, **72**(3), 285–318.

Li, Danielle, & Agha, Leila. 2015. Big names or big ideas: Do peer-review panels select the best science proposals? *Science*, **348**(6233), 434–438.

Li, Hao, & Suen, Wing. 2004. Delegating Decisions to Experts. *Journal of Political Economy*, **112**(S1), S311–S335.

Li, Hao, Rosen, Sherwin, & Suen, Wing. 2001. Conflicts and Common Interests in Committees. *The American Economic Review*, **91**(5), 1478–1497.

Luo, Hong. 2014. When to Sell Your Idea: Theory and Evidence from the Movie Industry. *Management Science*, **60**(12), 3067–3086.

Manso, Gustavo. 2011. Motivating Innovation. *The Journal of Finance*, **66**(5), 1823–1860.

Mollick, Ethan, & Nanda, Ramana. 2014. Wisdom or Madness? Comparing Crowds with Expert Evaluation in Funding the Arts. *Harvard Business School Working Paper, No. 14-116*, June.

Moscarini, Giuseppe, & Smith, Lones. 2001. The Optimal Level of Experimentation. *Econometrica*, **69**(6), 1629–1644.

Nanda, Ramana, & Rhodes-Kropf, Matthew. 2015. Financing Entrepreneurial Experimentation. *In: Innovation Policy and the Economy, Volume 16*. University of Chicago Press.

National Science Foundation. 2006. *Science and Engineering Indicators*.

Nelson, Richard R. 1961. Uncertainty, Learning, and the Economics of Parallel Research and Development Efforts. *The Review of Economics and Statistics*, **43**(4), 351–364.

Qian, Yingyi, & Xu, Chenggang. 1998. Innovation and Bureaucracy under Soft and Hard Budget Constraints. *The Review of Economic Studies*, **65**(1), 151–164.

Rajan, Raghuram G. 2012. Presidential Address: The Corporation in Finance. *The Journal of Finance*, **67**(4), 1173–1217.

Rajan, Raghuram G., & Zingales, Luigi. 2001a. The Firm As A Dedicated Hierarchy: A Theory Of The Origins And Growth Of Firms. *The Quarterly Journal of Economics*, **116**(3), 805–851.

Rajan, Raghuram G., & Zingales, Luigi. 2001b. The Influence of the Financial Revolution on the Nature of Firms. *The American Economic Review*, **91**(2), 206–211.

Roberts, Edward B., & Eesley, Charles E. 2009. Entrepreneurial Impact: The Role of MIT. *Report to the Kauffman Foundation*, Feb.

Roberts, Kevin, & Weitzman, Martin L. 1981. Funding Criteria for Research, Development, and Exploration Projects. *Econometrica*, **49**(5), 1261–1288.

Romer, Paul M. 1990. Endogenous Technological Change. *Journal of Political Economy*, **98**(5), S71–S102.

Rosenberg, Nathan. 1992. Economic Experiments. *Industrial and Corporate Change*, **1**(1), 181–203.

Rosenberg, Nathan. 1996. Uncertainty and technological change. *In: The Mosaic of Economic Growth*. Stanford University Press, Stanford, CA.

Sah, Raaj Kumar, & Stiglitz, Joseph E. 1988. Committees, Hierarchies and Polyarchies. *The Economic Journal*, **98**(391), 451–470.

Sahlman, William A. 1990. The structure and governance of venture-capital organizations. *Journal of Financial Economics*, **27**(2), 473–521.

Shane, Scott. 2000. Prior Knowledge and the Discovery of Entrepreneurial Opportunities. *Organization Science*, **11**(4), 448–469.

Stern, Scott. 2005. Economic Experiments: The Role of Entrepreneurship in Economic Prosperity. *In: Kauffman Foundation ThoughtBook*.

Torrance, Wendy E. F. 2013. Entrepreneurial Campuses: Action, Impact, and Lessons Learned from the Kauffman Campuses Initiative. *Ewing Marion Kauffman Foundation Research Paper*, Aug.

U.S. Department of Commerce. 2013 (Oct.). *The Innovative and Entrepreneurial University: Higher Education, Innovation and Entrepreneurship in Focus*.

Weitzman, Martin L. 1979. Optimal Search for the Best Alternative. *Econometrica*, **47**(3), 641–654.

Wernerfelt, Birger. 1984. A resource-based view of the firm. *Strategic Management Journal*, **5**(2), 171–180.

Yu, Sandy. 2015. *The Impact of Accelerators on High-Technology Ventures*.

Zacharakis, Andrew, & Meyer, G. Dale. 2000. The potential of actuarial decision models: Can they improve the venture capital investment decision? *Journal of Business Venturing*, **15**(4), 323–346.

Zacharakis, Andrew, & Shepherd, Dean. 2000. The nature of information and overconfidence on venture capitalists' decision making. *Journal of Business Venturing*, **16**(4), 311–332.

Zingales, Luigi. 2000. In Search of New Foundations. *The Journal of Finance*, **55**(4), 1623–1653.

Tables and Figures

Table 1: Descriptive Statistics of Ventures (N = 652)

Definition	Mean	Std. Dev.	Min	Max
Year the venture joined VMS	2009.9	1.959	2005	2012
Month the venture joined VMS	6.469	3.400	1	12
Venture Characteristics				
Sector: Consumer web/mobile	0.279	0.449	0	1
Sector: Enterprise software	0.178	0.383	0	1
Sector: Hardware	0.147	0.355	0	1
Sector: Life sciences/medical devices	0.133	0.340	0	1
Sector: Consumer products	0.132	0.339	0	1
Sector: Energy	0.058	0.234	0	1
Sector: Other	0.072	0.259	0	1
Based on academic research	0.155	0.362	0	1
Has intellectual property at entry	0.232	0.422	0	1
Has a legal business entity at entry	0.169	0.375	0	1
Entrepreneur Characteristics				
Primary entrepreneur: MIT student	0.383	0.487	0	1
Primary entrepreneur: MIT alumnus	0.367	0.482	0	1
Primary entrepreneur: MIT postdoc/staff	0.250	0.433	0	1
Primary entrepreneur previously mentored by VMS	0.077	0.266	0	1
VMS-Related Variables				
Proportion of active mentors expressing initial interest (%)	4.447	2.683	0	16.44
Number of active mentors expressing initial interest	6.265	3.828	0	20
Number of meetings	3.212	3.100	0	21
Number of mentors met at least twice	1.724	1.896	0	9
Venture Milestones and Outcome				
Full-time entrepreneurial pursuit	0.465	0.499	0	1
Receipt of angel/venture-capital funding	0.186	0.389	0	1
Commercialization with recurring revenue and expenses	0.224	0.417	0	1

Table 2: Venture Characteristics at VMS Entry, by Sector

Sector	N	Based on research (%)	Has IP (%)	Has business entity (%)
Consumer web/mobile	182	4.4	4.9	9.9
B2B software	116	7.8	19.8	24.1
Hardware	96	31.3	52.1	30.2
Life sciences/medical devices	87	43.7	55.2	27.6
Consumer products	86	2.3	5.8	7.0
Energy	38	31.6	36.8	10.5
Other	47	4.3	4.3	2.1

Table 3: Mentor Background (N = 251)

Characteristic	Mean
Male	85.3%
Highest degree: Ph.D. or M.D.	22.3%
Primary sector: Consumer web/mobile	6.8%
Primary sector: Enterprise software	21.1%
Primary sector: Hardware	24.7%
Primary sector: Life sciences/medical devices	21.5%
Primary sector: Consumer products	2.4%
Primary sector: Energy	5.2%
Primary sector: Other	18.3%
Any experience in consumer web/mobile	13.1%
Any experience in enterprise software	58.2%
Any experience in hardware	66.5%
Any experience in life sciences/medical devices	40.2%
Any experience in consumer products	10.8%
Any experience in energy	28.3%
Any experience in other	29.5%
Number of sectors with any experience	2.47

Table 4: Estimated Relationships between Aggregate Mentor Interest and Likelihood of Commercialization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Full	Full	Full	Full	Full	Full	Exclude top/bottom 5%	Full
Proportion of active mentors expressing initial interest	0.020***	0.015**	0.014**	0.014**	0.014**	0.014**	0.020**	
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	
Number of active mentors expressing initial interest								0.010**
								(0.004)
Number of mentors met at least twice				-0.002				
				(0.010)				
Number of meetings					0.003			
					(0.006)			
Based on academic research		0.114*	0.115*	0.118*	0.108*	0.110*	0.111	0.110*
		(0.060)	(0.061)	(0.064)	(0.064)	(0.062)	(0.069)	(0.062)
Intellectual property at entry		0.050	0.053	0.053	0.055	0.055	0.075	0.055
		(0.047)	(0.046)	(0.047)	(0.047)	(0.049)	(0.052)	(0.049)
Legal business entity at entry		0.324***	0.320***	0.322***	0.316***	0.318***	0.347***	0.318***
		(0.054)	(0.055)	(0.055)	(0.054)	(0.053)	(0.055)	(0.053)
Dummies for number of mentors met at least twice	No	No	No	No	No	Yes	Yes	Yes
Dummies for number of meetings	No	No	No	No	No	Yes	Yes	Yes
Entrepreneur controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for sector	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for year joined VMS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for month joined VMS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	652	652	652	652	652	652	590	652
R^2	0.12	0.24	0.25	0.25	0.25	0.25	0.25	0.25

Notes: Coefficients estimated from Linear Probability Model. Standard errors are robust and clustered by venture sector and year of affiliation with VMS. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$. *Entrepreneur controls* include dummies for the entrepreneur's MIT affiliation (student or alumnus) and prior mentoring by VMS.

Table 5: Robustness Checks on Estimated Relationships between Aggregate Mentor Interest and Likelihood of Commercialization

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Full		> 4 mentors expressing interest		Limited interactions	
Proportion of active mentors expressing initial interest			0.018*		0.017*	
			(0.010)		(0.010)	
Number of active mentors expressing initial interest				0.012*		0.010*
				(0.006)		(0.006)
Proportion of mentors expressing interest & not interacting with the venture	0.015**					
	(0.007)					
Number of mentors expressing interest & not interacting with the venture		0.010**				
		(0.005)				
N	652	652	421	421	259	259
R^2	0.25	0.25	0.24	0.24	0.35	0.35

Notes: Coefficients estimated from Linear Probability Model. Standard errors are robust and clustered by venture sector and year of affiliation with VMS. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. For columns (5) and (6), the sample consists of ventures that met with VMS mentors twice at most and had no repeat interactions with any mentors. All regressions include whether the venture is based on academic research, whether the venture has intellectual property at entry, whether the venture has a legal business entity at entry, dummies for number of mentors met at least twice, dummies for number of meetings, dummies for sector, dummies for year and month of affiliation with VMS, and dummies for the entrepreneur's MIT affiliation and prior mentoring by VMS.

Table 6: Estimated Relationships between Mentor Interest and Likelihood of Commercialization at the Venture*Mentor Level

	(1)	(2)	(3)	(4)	(5)	(6)
Expression of initial interest	0.018**	0.020*	0.020*			
	(0.008)	(0.012)	(0.012)			
Expression of initial interest & no meeting				0.025**	0.025**	0.025**
				(0.012)	(0.012)	(0.012)
At least one meeting		-0.003			0.013	
		(0.012)			(0.008)	
Mentor meeting FE	No	No	Yes	No	No	Yes
N	93672	93672	93672	93672	93672	93672
R^2	0.22	0.22	0.22	0.22	0.22	0.22

Notes: Observation at the venture-mentor level. Coefficients estimated from Linear Probability Model. Standard errors are robust and clustered by venture. $*p < 0.10$; $**p < 0.05$; $***p < 0.01$. All regressions include whether the venture is based on academic research, whether the venture has intellectual property at entry, whether the venture has a legal business entity at entry, dummies for sector, dummies for year and month of affiliation with VMS, and dummies for the entrepreneur's MIT affiliation and prior mentoring by VMS.

Table 7: Estimated Relationships between Aggregate Mentor Interest and Likelihood of Commercialization Conditional on Full-time Entrepreneurs

	(1)	(2)	(3)	(4)
Sample	Entrepreneurs committing full-time			
Proportion of active mentors expressing initial interest	0.030**			
	(0.011)			
Number of active mentors expressing initial interest		0.023**		
		(0.009)		
Proportion of mentors expressing interest & not interacting with the venture			0.045***	
			(0.016)	
Number of mentors expressing interest & not interacting with the venture				0.032***
				(0.011)
N	303	303	303	303
R^2	0.19	0.20	0.20	0.20

Notes: Coefficients estimated from Linear Probability Model. Standard errors are robust and clustered by venture sector and year of affiliation with VMS. $*p < 0.10$; $**p < 0.05$; $***p < 0.01$. The sample consists of ventures to which the entrepreneurs will commit full-time. All regressions include whether the venture is based on academic research, whether the venture has intellectual property at entry, whether the venture has a legal business entity at entry, dummies for number of mentors met at least twice, dummies for number of meetings, dummies for sector, dummies for year and month of affiliation with VMS, and dummies for the entrepreneur's MIT affiliation and prior mentoring by VMS.

Table 8: Estimated Relationships between Aggregate Mentor Interest and Likelihood of Commercialization by Venture Characteristics

	(1)	(2)	(3)	(4)
Sample	Full	In hardware/life sciences/energy sectors		
Mentor interest * in hardware/life sciences/energy sectors	0.021**			
	(0.010)			
Mentor interest * in other sectors	0.009			
	(0.009)			
Mentor interest * (based on academic research = 1)		0.045***		
		(0.010)		
Mentor interest * (based on academic research = 0)		0.015		
		(0.016)		
Mentor interest * (IP at entry = 1)			0.036***	
			(0.009)	
Mentor interest * (IP at entry = 0)			0.014	
			(0.018)	
Mentor interest * (business entity at entry = 1)				0.010
				(0.017)
Mentor interest * (business entity at entry = 0)				0.034***
				(0.011)
N	652	221	221	221
R^2	0.26	0.26	0.26	0.26

Notes: Coefficients estimated from Linear Probability Model. Standard errors are robust and clustered by venture sector and year of affiliation with VMS. $*p < 0.10$; $**p < 0.05$; $***p < 0.01$. Mentor interest is measured as the proportion of active mentors expressing initial interest in the venture. All regressions include whether the venture is based on academic research, whether the venture has intellectual property at entry, whether the venture has a legal business entity at entry, dummies for number of mentors met at least twice, dummies for number of meetings, dummies for sector, dummies for year and month of affiliation with VMS, and dummies for the entrepreneur's MIT affiliation and prior mentoring by VMS.

Table 9: Estimated Relationships between Aggregate Mentor Interest and Venture Financing

Dependent Variable	Angel/VC funding > \$1 million	Angel/VC funding > \$5 million	Angel/VC funding and commercialized	Angel/VC funding and not commercialized
	Panel A: Ventures in hardware/life sciences/energy sectors (N=221)			
	(A1)	(A2)	(A3)	(A4)
Prop. of mentors expressing interest	0.0171*	0.0178*	0.0185*	-0.0013
	(0.0090)	(0.0088)	(0.0100)	(0.0061)
	Panel B: Ventures in hardware/life sciences/energy sectors with full-time entrepreneurs (N=131)			
	(B1)	(B2)	(B3)	(B4)
Prop. of mentors expressing interest	0.0301**	0.0328**	0.0309**	-0.0059
	(0.0120)	(0.0134)	(0.0142)	(0.0111)

Notes: Coefficients estimated from Linear Probability Model. Standard errors are robust and clustered by venture sector and year of affiliation with VMS. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. All regressions include whether the venture is based on academic research, whether the venture has intellectual property at entry, whether the venture has a legal business entity at entry, dummies for number of mentors met at least twice, dummies for number of meetings, dummies for sector, dummies for year and month of affiliation with VMS, and dummies for the entrepreneur's MIT affiliation and prior mentoring by VMS.

Table 10: Estimated Relationships between Aggregate Mentor Interest and Likelihood of Commercialization by Mentor Expertise

	(1)	(2)	(3)
Sample	In hardware/life sciences/energy sectors		
Prop. of interested mentors in the venture's sector	-0.004		
	(0.004)		
Prop. of interested mentors in other sectors	0.037***		
	(0.011)		
Prop. of interested mentors with some experience in the venture's sector		0.007	
		(0.007)	
Prop. of interested mentors without experience in the venture's sector		0.017*	
		(0.010)	
Prop. of interested mentors with a doctoral degree			-0.003
			(0.006)
Prop. of interested mentors without a doctoral degree			0.031**
			(0.012)
F-statistic	12.43***	0.60	4.36*
N	221	221	221
R^2	0.28	0.25	0.26

Notes: Coefficients estimated from Linear Probability Model. Standard errors are robust and clustered by venture sector and year of affiliation with VMS. $*p < 0.10$; $**p < 0.05$; $***p < 0.01$. Sample includes ventures in hardware/life sciences/energy sectors. All regressions include whether the venture is based on academic research, whether the venture has intellectual property at entry, whether the venture has a legal business entity at entry, dummies for number of mentors met at least twice, dummies for number of meetings, dummies for sector, dummies for year and month of affiliation with VMS, and dummies for the entrepreneur's MIT affiliation and prior mentoring by VMS.

Figure 1: Number of Ventures by Year and Month of Joining VMS

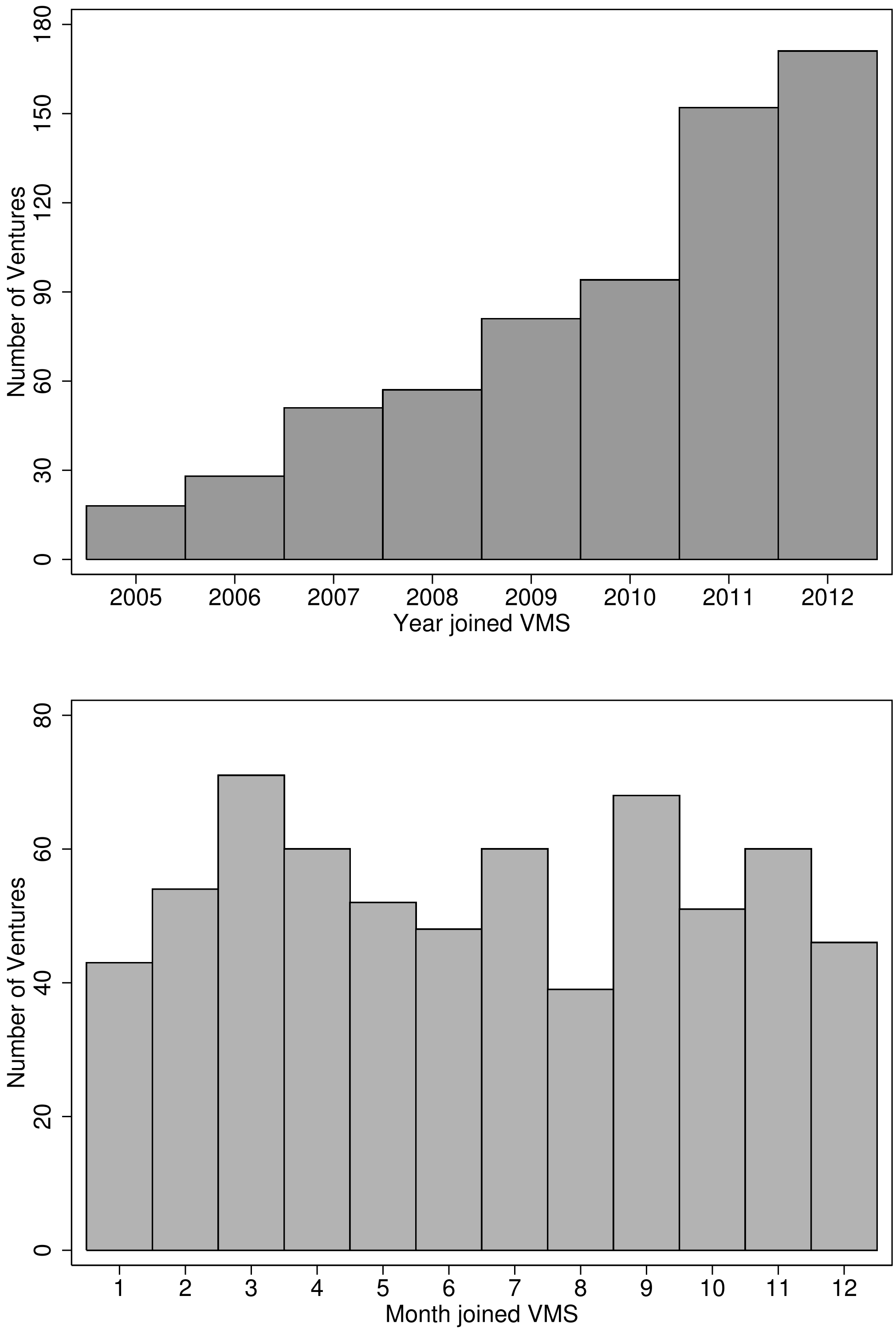
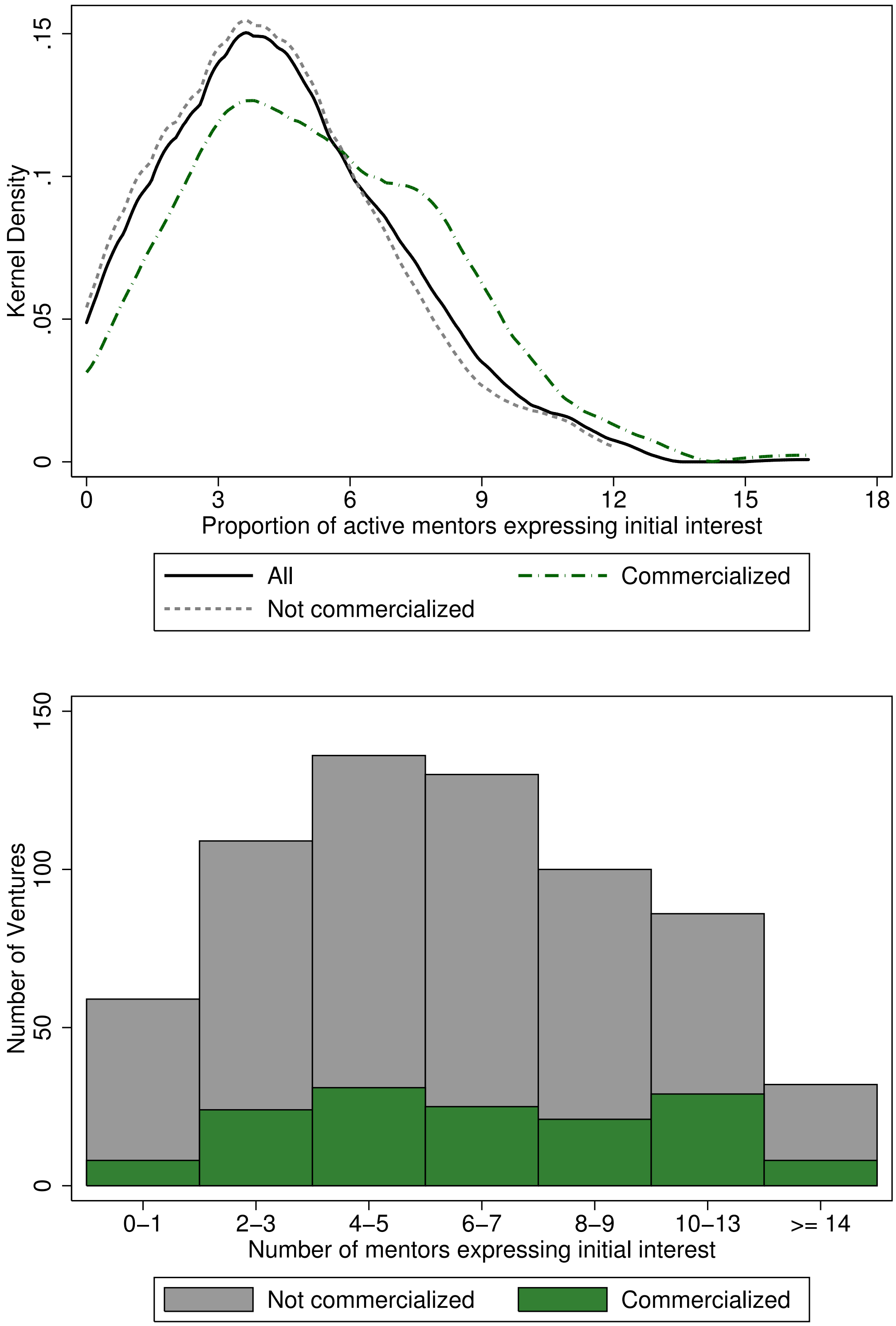
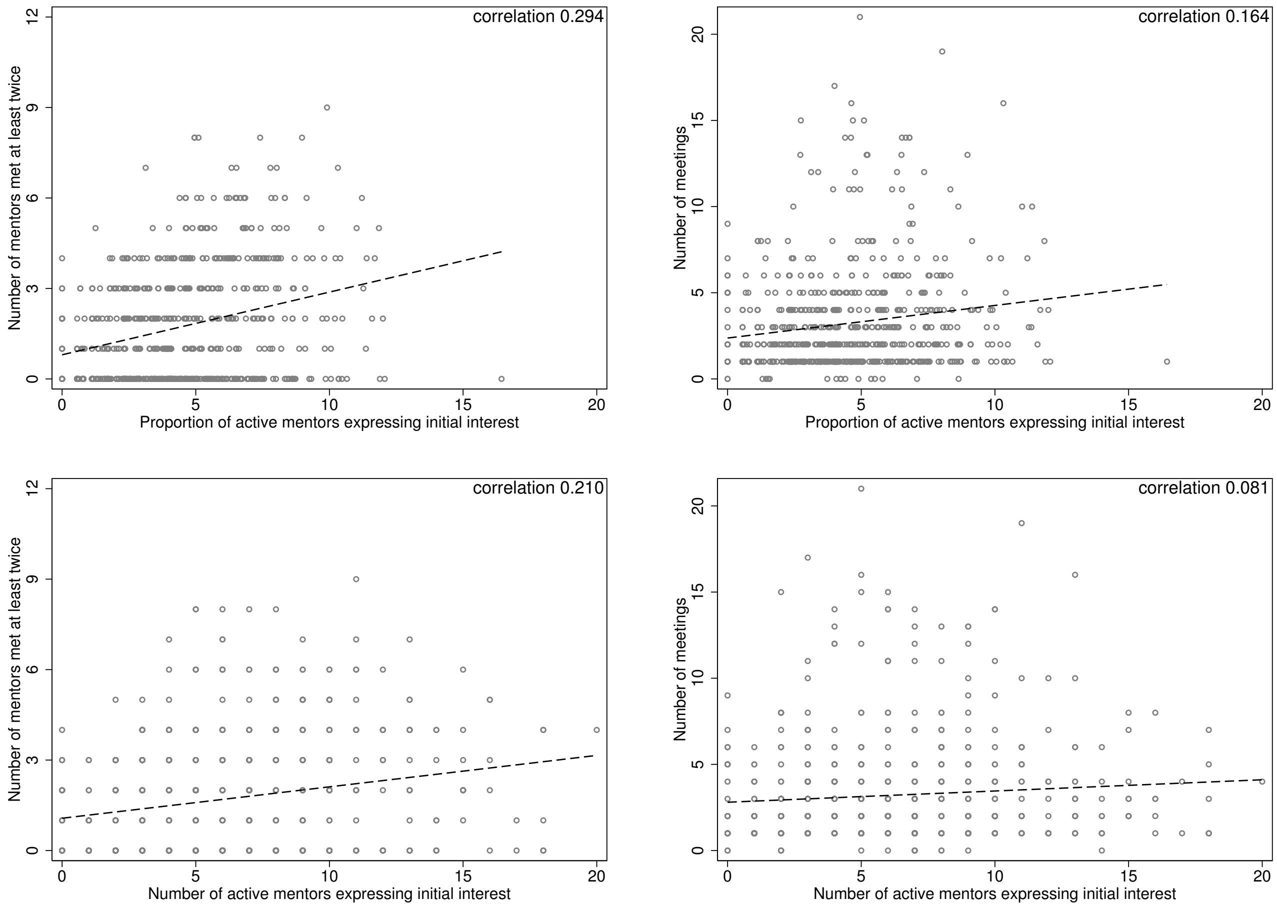


Figure 2: Distribution of Aggregate Mentor Interest



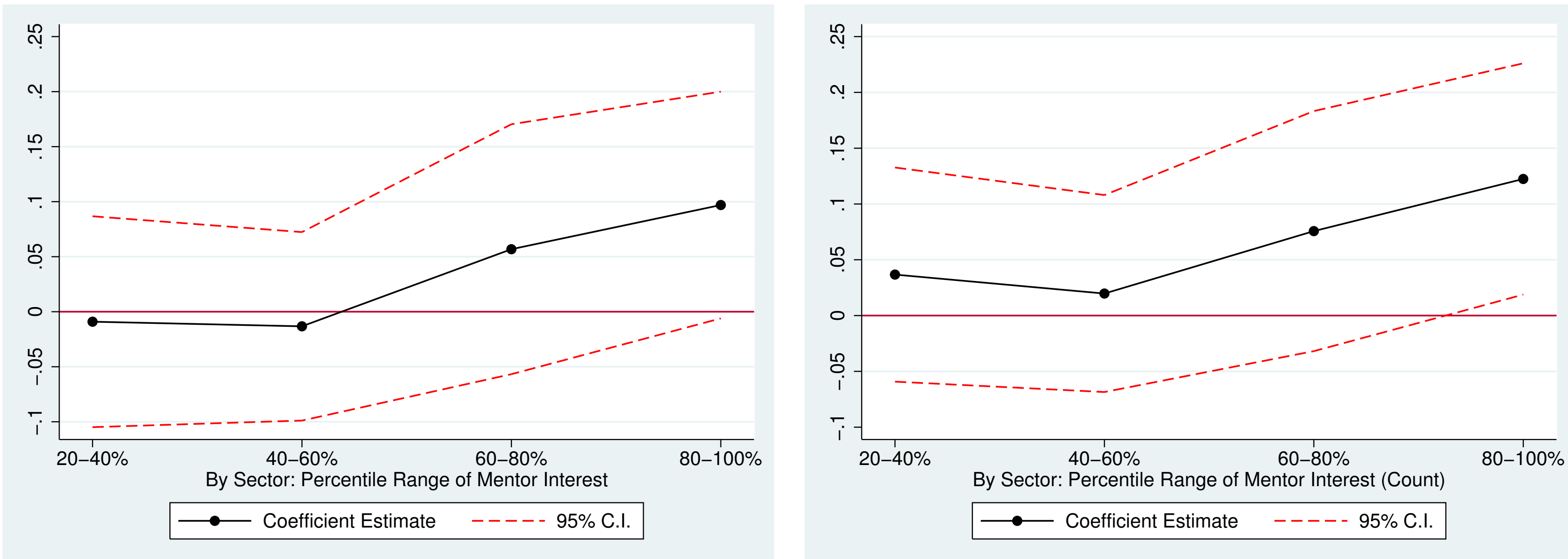
Notes: This figure plots the kernel density of the proportion of active mentors who express initial interest in a venture and a histogram of the number of mentors expressing interest.

Figure 3: Raw Relationships between Venture Mentor Interactions and Aggregate Mentor Interest



Notes: This figure presents scatter plots of the raw relationships between initial mentor interest and venture mentor interactions for all ventures. Both plots include a linear line of best fit.

Figure 4: Estimated Relationships between Commercialization and Mentor Interest, by Percentiles



Notes: This figure presents the parameter estimates and confidence intervals on percentile dummies of initial mentor interest (determined within each sector).

Appendix Tables and Figures

Table A.1: Anonymized Sample Venture Descriptions

Venture X — Student. The company is developing software that assesses [a certain medical condition] by capturing and analyzing [relevant characteristics]. This software provides the first objective measure of [the condition] based on analysis of physical characteristics rather than on a subjective evaluation. This will permit healthcare organizations and practitioners to diagnose and monitor [the condition] more effectively and at lower cost. The team is experienced in systems development and in medical research. So far they have developed and filed provisional patents on the core algorithms, and they have completed several studies in local hospitals demonstrating the feasibility of their approach. They are now in conversations with a potential client to develop the software for a pilot. They seek guidance from VMS on negotiations and also on organizational issues, IP portfolio strategy, marketing, and funding.

Venture Y — Students. The idea is to deliver [a certain content service] to subscribers, customizing the content delivered according to each subscriber's interests and tastes. The service will feature a proprietary behavioral system which monitors user behavior and solicits user tagging and feedback to teach the system. The venture also will offer tools for sharing interests among close friends to create an "addicting social network." Revenue will come from targeted advertising based on users' interests and demographics, and from partnerships with magazines and newspapers. Two student founders are doing the technical development. They have finalized the design and are currently building the prototype. They have come to VMS for practical advice on their business plan, getting to market, building a team, and obtaining funding.

Table A.2: Frequency of Venture Mentor Interactions

Number of mentors met at least twice	Frequency	Percentage	Cumulative Percentage
0	263	40.34	40.34
1 ~ 2	191	29.29	69.63
3 or more	198	30.37	100
Number of meetings	**Frequency**	**Percentage**	**Cumulative Percentage**
0	17	2.61	2.61
1	219	33.59	36.20
2 ~ 3	210	32.21	68.40
4 or more	206	31.60	100

Table A.3: Estimated Relationships between Aggregate Mentor Interest and Likelihood of Commercialization ; LPM/Probit/Logit

	(1)	(2)	(3)	(4)	(5)	(6)
	LPM	Probit	Logit	LPM	Probit	Logit
Proportion of active mentors expressing initial interest (%)	0.014**	0.014**	0.015**			
	(0.007)	(0.006)	(0.006)			
Num. of mentors expressing initial interest				0.010**	0.011***	0.011***
				(0.004)	(0.004)	(0.004)
Based on academic research	0.110*	0.094*	0.091*	0.110*	0.094*	0.092*
	(0.062)	(0.051)	(0.051)	(0.062)	(0.050)	(0.050)
Intellectual property at entry	0.055	0.040	0.041	0.055	0.040	0.040
	(0.049)	(0.040)	(0.039)	(0.049)	(0.040)	(0.039)
Legal business entity at entry	0.318***	0.223***	0.210***	0.318***	0.223***	0.210***
	(0.053)	(0.032)	(0.030)	(0.053)	(0.032)	(0.030)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	652	652	652	652	652	652
Pseudo R^2	0.25	0.23	0.23	0.25	0.23	0.23

Notes: Marginal effects reported. Standard errors are robust and clustered by venture sector and year of affiliation with VMS. $*p < 0.10$; $**p < 0.05$; $***p < 0.01$. All regressions include dummies for number of mentors met at least twice, dummies for number of meetings, dummies for sector, dummies for year and month of affiliation with VMS, and dummies for the entrepreneur's MIT affiliation and prior mentoring by VMS.

Figure A.1: Overview of the Initial Venture Mentor Pairing Process