The Organization of Venture Capital Firms*

Amitay Alter†

December 7, 2009

Abstract

This paper studies the economic factors determining the size and composition of venture capital (VC) firms. I construct a novel panel data set documenting California VC firms' composition and investments and derive statistical relationships between firm size, its partners' experience, and industry trends. To interpret these empirical findings, I develop a model which highlights firms' role in facilitating training of junior professionals and supporting a more efficient use of their time by senior professionals. I examine alternative views about the role and organization of firms and demonstrate that my model offers a more complete and compelling explanation for the findings.

1 Introduction

Venture capital (VC) firms vary widely in both size and composition. The number of partners in a VC firm can range from as low as one partner to more than a dozen, even across firms specializing in the same field. Even within the same VC firm, the number of partners can fluctuate dramatically over time. This heterogeneity within and across firms is puzzling, given that all VC firms provide relatively similar services and typically operate in a similar manner. What, then, determines the size and composition of VC firms?

While there is a wide theoretical literature studying the organization and role of professional services firms, empirical investigations are scarce, possibly due to the lack of detailed data documenting the organization of these typically private firms. This paper addresses this challenge by assembling a novel panel data set documenting the composition and investments of VC firms in California. Focusing on the VC industry in California is interesting for several reasons. First, this industry had a major

*I would like to thank Itai Ater, Tim Bresnahan, Gary Dushnitsky, Liran Einav, Chaim Fershtman, Bart Hamilton, Han Hong, Ohad Kadan, Josh Lerner, Phillip Leslie, Jon Levin, Romans Pancs, Yossi Spiegel, Konrad Stahl, Timothy Van Zandt, and Rebecca Zarutskie for helpful suggestions.

†John M. Olin School of Business at Washington University in St. Louis. Email: alter@wustl.edu.

impact on innovation and economic growth; Silicon Valley VC firms funded many of the world's most successful and innovative companies and have been the envy of economies all over the world. Second, California is by far the largest VC market in the world, and accounts for about 50% of VC investments in the US, and more than a third of VC investment worldwide.[1] Third, I believe that my study has broader implications beyond the VC industry, as it can shed light on the motivation for professionals to group together and form firms.

The data set covers the period 1982 to 2002 and includes all California early stage VC firms engaged in investments during the period studied. For each sample period, the data set contains detailed information about the names of the VC partners in each firm and the specific investments that each firm made. This fine level of detail enables me to explore the relationship between firm size, the experience of the VC partners, the investment activity in the firm's field of specialization, and the likelihood of spin-outs (i.e., the probability that a partner leaves his VC firm and starts a new VC firm). The novel empirical findings create a unique opportunity to test the predictions of different views about the benefits driving professionals to group together in firms.

Venture capitalists emphasized in interviews the role of firms in facilitating joint execution of projects by senior and junior venture capitalists, where the seniors bring deals to the firm and train the juniors who execute the project. Existing theories however do not study firm size and do not relate the organization of firms to the characteristics of their members and to general industry trends.[2] Hence, they cannot be applied "as is" to explain the observed heterogeneity in firm size and composition. Moreover, the goal of these contributions is to demonstrate how firms enable professionals to perform certain transactions more efficiently within a firm compared to across firms. Therefore, in general, their predictions cannot be tested directly, as it is hard to observe and measure the outcomes of specific transactions. Due to these limitations, I develop a model which builds on these former contributions and highlights the superior transaction opportunities generated by firms. In addition, based on institutional details, the model relates the frequency, benefit and cost of these transactions to the characteristics of the firm members and to general industry trends. These elements of the

[1] Sources: PricewaterhouseCoopers/National Venture Capital Association MoneyTree Report and Dow Jones VentureSource report.

[2] For example, Morrison and Wilhelm (2004), and Bar-Isaac (2007).

model generate implications about the optimal size and composition of firms which can be tested with the data.[3]

The model postulates that a primary driver for the formation of VC firms is to facilitate joint execution of projects by senior and junior VC partners and to allow a more efficient use of the junior partners' time. Specifically, senior agents in my model provide the knowledge necessary to execute the tasks, while junior agents provide the labor but only provided that senior agents spend unobservable effort in training them. Training in this context should be interpreted broadly as including the different efforts made by the senior agents in identifying projects and using their skills and contacts for assisting the juniors. The size of the firm is driven by two considerations. First, senior agents face uncertainty regarding the availability of future tasks and hence whether the input of junior agents will or will not be needed. By joining together, senior agents can reduce this uncertainty and better utilize junior agents in their firm. Thus, the firms enjoy economies of scale in training and mentoring; the larger the number of senior agents, the less volatile is the average number of tasks per senior agent, and the more efficient is the use of the juniors time. Second, the profits of the firm are divided among the senior agents according to an ex ante profit sharing arrangement.[4] Consequently, training juniors is essentially a public good - a senior agent incurs the full cost of training, but shares the benefits with other senior agents - and hence, there is an upper bound for the firms' size: once the number of senior agents exceeds a certain threshold, senior agents do not provide training anymore.

I show that the theoretical framework explains the observed heterogeneity in firm size and composition in my data. Specifically, the theoretical model is consistent with the following empirical findings: 1) more experienced venture capitalists form larger firms; 2) firms with a larger number of experienced partners also have a larger number of inexperienced partners; 3) the number of venture capitalists in a firm is positively correlated with the trend of aggregate investments made by all VC

[3]This modeling approach builds on the framework developed by Bresnahan and Reiss (1991) who study the effect of competitors' entry on profits, without observing firms' profits. Their inference is based on the relationship between variation in market characteristics and firms' entry decisions. This paper examines the relationship between variation in variables that proxy for the frequency and value of transactions and the size and composition of firms.

[4]Profit sharing is an integral element in the organization of VC firms. Until the 1990s, most VC firms were incorporated as Limited Partnerships; therefore, their partners had to share the firm profits according to predefined proportions. Limited Liability Companies became the most popular form of incorporation in the 1990s. While this form allows for more flexible sharing rules, anecdotal evidence suggests that the senior partners are allocated ex-ante a large portion of the firm profits.

firms specializing in the same field — that is, firms specializing in "hot" industries are larger; and 4) partners are more likely to spin-out from their firm when they have more colleagues who remain in the industry in the following period.

In addition to testing the model's predictions I consider alternative theories about the factors determining firm size and composition: namely, risk sharing and the promotion of efficient transactions between symmetric agents. I show that while these alternative views can explain some of the observed empirical regularities, my model offers a unified framework consistent with all the facts and strongly motivated by institutional details.

This paper contributes to the literature on organization of professional services firms in several ways. First, to my best knowledge, this is the first study in this literature which tests a theory predicting the size of a firm. Second, it is the first to develop an analytical model which allows to test, without observing the outcome of transactions, predictions of theories on the role of firms in facilitating more efficient transactions among professionals.[5] Moreover, the analysis also extends a body of work studying the operation and organization of VC firms.[6]

The paper is organized as follows. Section 2 presents the model and motivates its assumptions, and Section 3 derives predictions about firm size and composition from the model. The data collection and the data set construction are described in Section 4. Section 5 reports the empirical regularities, and shows they are consistent with the model's predictions. Section 6 examines whether the empirical regularities and institutional details are consistent with alternative explanations about the factors determining the size and composition of firms. Finally, Section 7 concludes. All technical proofs are in the Appendix.

[5]Garicano and Hubbard (2008) also test theories about the benefits driving professionals to group together in firms, though they do not rely on a formal model. They study the field boundaries of law firms and find support for the hypothesis that law firms allow lawyers who specialize in different fields to share knowledge and monitor each other more effectively.

[6]Gompers et al (2009) study the relationship between firm specialization, the degree of specialization of its members and the firm's performance, while taking the organizational structure of VC firms as given. Other studies point to organizational issues which may play a major role in the operation of VC firms; In their review paper Gompers and Lerner (2001) ask how the dramatic growth of the VC industry affects VC organizations. A related question, posed in Kaplan and Schoar (2005), asks what are the sources of diseconomies of scale in VC firms. The empirical and theoretical analyses employed in this paper contribute to the understanding of these questions.

2 Model

In order to explore the heterogeneity in VC firms' size and composition I present a model, motivated by institutional details about the VC industry, which generates predictions about the optimal organization of VC firms.

2.1 The VC Industry - Institutional Details

Venture capitalists are financial intermediaries who raise capital from private and institutional investors and invest in early-stage entrepreneurial companies developing novel technologies. Typically, the role of venture capitalists goes beyond screening and assessing potential investments, as they also take an active role in managing and monitoring these start-up companies (Gompers and Lerner 1999; Sahlman 1990; Sorensen 2007).[7] Since every aspect of this investment process requires relevant knowledge and expertise, a key factor for the success of venture capitalists is their industry experience and network of contacts.

Although the VC industry is extremely knowledge intensive, much of this knowledge is tacit and cannot be acquired through formal education. As Gompers and Lerner (2002) indicate, "Many of the crucial skills of being an effective venture capitalist cannot be taught formally; rather, they need to be developed through a process of apprenticeship." Similarly, Helsong (1988) highlights the value of learning through mentorship in the education of a venture capitalist: "What university or college can be attended to study to be a venture capitalist? The answer is – None. ...B-schools have courses in VC, but there are no majors or degrees in the subject. Basically, VC as an 'industry' is founded on the old idea of apprenticeship. The young VC learns by doing—by slogging through business plans, trying to make sense out of the due diligence, researching the market place, and talking to older VCs."[8]

This view of the VC industry as largely dependent on tacit knowledge is also reflected in the way VC firms market their services. A website of a VC firm in the US argues that: "...at its core, VC

---

[7]Timmons and Bygrave (1986) surveyed venture funded entrepreneurs and found that entrepreneurs were interested in raising capital from venture capitalists who could help recruit management, provide valuable contacts and credibility to their company, and assist in developing the company's strategy.

[8]The importance of VC industry specific knowledge and experience is demonstrated in Zarutskie (2008). Zarutskie analyzes the performance of first-time venture capital funds, and finds that funds perform better when their management team has a larger fraction of managers with past venture investing experience.

is truly an apprenticeship business. It takes years of mentoring to learn how to assess investment opportunities, set pricing and strategy, build and motivate management teams, deal with inevitable and unpredictable threats to the businesses, source additional capital and strategic partners, and, finally, divest (for better or worse) these illiquid investments."[9] Accordingly, venture capitalists often describe the skill of picking good investments as an "art."

Another institutional detail characterizing this industry is the allocation of functions within the firm. In VC firms all partners typically engage in similar activities; each partner is responsible for some of the firm's investments and represents the firm in these companies' board of directors. While responsibility for companies is shared among all partners, senior partners are usually more dominant in making investment decisions and raising capital.

Next, I present a parsimonious model that captures key elements in the operation of VC firms and the institutional details discusses above. Specifically, my model accounts for both the distinction between junior and senior agents, and among agents within each of these groups. Further, it highlights tacit knowledge as critical input in the production of VC services, and the role of the firm in facilitating the provision of training.

2.2 Agents

There are two types of risk-neutral agents in the model: a fixed number of senior agents and an unlimited number of junior agents.[10] Junior agents can either work as venture capitalists or be employed in a different industry in which they earn an alternative wage $\omega > 0$. Each senior agent either has access to a single task with probability p, or does not have access to any task with probability $1-p$. I consider p as reflecting the aggregate activity in the industry, since during growth periods senior agents are likely to have access to more business opportunities.

In order to execute a task, the senior agent must exert effort and obtain the labor input of a junior agent. Each junior agent can execute a single task per period. Without the senior's effort, the junior agent cannot implement the task. I assume that a senior's effort is unobservable and denote

[9] *www.b4ventures.com/venture_capital.htm*

[10] Assuming risk neutrality is not a limitation, but rather a strength of my model. It allows me to demonstrate that a framework which is not based on professionals' risk aversion as a motivation for forming multiple-partner firms, can explain the empirical findings.

the associated private cost to the senior by k. This cost represents the cost of identifying the project, collecting useful information required for implementing it, and training the junior agent executing it. An executed task generates a revenue of $H > k + \omega$ and is therefore profitable. The parameter H represents the task's profitability and depends on the ability of the senior agent to access and identify projects with high returns.

Although provision of training generates net surplus, training transactions cannot be supported by spot market contracts due to the fact that the effort of senior agents is unobservable. In the next subsection, I demonstrate how the formation of a firm addresses these problems, and gives senior agents an incentive to exert unobservable effort in training juniors.

2.3 VC firms

When a firm forms, a group of S senior agents and J junior agents get together and agree to equally share the future profits of the firm among the senior agents and to compensate junior agents with a fixed wage.[11] Although their effort is still unobservable, the senior agents now have a financial incentive to train the junior agents, since the execution of tasks by the juniors increases the firm's profit, and thereby the senior's payoff. I assume that senior agents decide whether or not to join firms before each of them learns if he has access to a task or not. The parameters S and J will be determined endogenously.

Given that there is an unlimited number of junior agents, I assume that juniors who join firms receive a fixed wage equal to their alternative wage, ω. A junior agent who is hired by a VC firm contributes H to the firm profits if he executes a task. A junior agent who does not receive a task is idle and generates no profits.

Now consider a senior agent who has access to a task. If he allocates the task to a junior agent and trains him, then, given that the firm's profit is equally shared among all senior agents, the senior agent's payoff (net of the cost of training the junior agent) increases by $\frac{H}{S} - k$. Hence the senior agent will allocate a task to a junior agent and then train him if and only if:

$$\frac{H}{S} \geq k, \qquad \Longrightarrow \qquad S \leq \widehat{S} \equiv \frac{H}{k}. \tag{1}$$

[11] Since agents in the model are risk neutral, assuming that junior agents receive carry (a share of their firm's profits) instead of a fixed wage does not change the results.

When there are more than $\widehat{S}$ senior agents, each will no longer pass tasks to the juniors, so the firm's profit will drop to $-J\omega$.

Next suppose that $S \leq \widehat{S}$ and let Q_S be a random variable that represents the aggregate number of tasks that the firm's seniors have access to. Recalling that each junior agent can execute a single task, the firm can implement at most J tasks. If $J \leq Q_S$, the firm must discard $Q_S - J$ tasks and its profit from the tasks it executes is JH. If $J > Q_S$, the firm can implement all Q_s tasks and its profit is $Q_S H$. Altogether then, the profit of a firm with $S \leq \widehat{S}$ seniors and J juniors is:

$$\pi(J,S) = H \min(J, Q_S) - J\omega. \tag{2}$$

Ex ante, before each senior agent learns if he has access to a task or not, the agent expects his share in his firm's profit to be $\frac{1}{S}\mathbb{E}[\pi(J,S)]$. I assume that ex ante all senior agents are equally likely to discard their tasks if eventually $J \leq Q_S$. Hence, a senior agent expects to incur the cost of training, k, with probability $\frac{1}{S}\mathbb{E}[\min(J,Q_S)]$, which is the probability that he will have access to a task and his task will be executed in the firm. Consequently, the expected payoff of a senior agent from joining a firm (provided that $S \leq \widehat{S}$) is

$$\begin{aligned} U(J,S) &= \frac{1}{S}\mathbb{E}[\pi(J,S) - k\min(J,Q_S)] \\ &= \frac{(H-k)}{S}\mathbb{E}[\min(J,Q_S)] - \frac{J\omega}{S}. \end{aligned} \tag{3}$$

3 The internal organization of VC firms

The number of senior and junior agents per firm is chosen to maximize the expected payoff of each senior agent:

$$\max_{S,J} U(J,S) = \frac{(H-k)}{S}\mathbb{E}[\min(J,Q_S)] - \frac{J\omega}{S},$$

subject to $S \leq \widehat{S}$. In what follows, I will use the solution of the optimal organization problem to derive predictions regarding the factors determining firm size, firm composition and the probability of spin-out events.

3.1 Firm size

The optimal size and composition of firms depend on the nature of interaction between its members. To examine how the magnitude of the value of tasks, the cost of training and the probability that a senior agent has access to a task determine the optimal structure of a firm, I characterize the solution of the optimal organization problem.

An important property of the expected payoff per-senior, $U(J,S)$, which is formalized in the next lemma, is that its value is increasing when the firm's size is scaled up, i.e., the number of senior and junior agents increases proportionally, as long as $S \leq \widehat{S}$. Since the number of tasks in a firm, Q_S, is a random variable, there is uncertainty about the extent to which the junior agents in a firm will be utilized. If $Q_S > J$, the firm does not have the capacity to execute all its tasks. By contrast, if $Q_S < J$, then junior agents are under-utilized. Consequently, scaling up the firm's size leads to a more efficient use of junior agents' labor capacity. For example, suppose that two identical firms, a and b, merge. When firm a has more tasks than it can execute, it can pass some of them to firm b. Similarly, when firm a under-utilizes its junior agents, it may receive tasks from the senior agents in firm b. Therefore, scaling up the firm's size reduces the uncertainty about the extent to which the junior agents can be utilized. Note, however, that when the number of seniors increases from S to S', scaling up the number of juniors proportionally to $\frac{S'}{S}J$ may result in a noninteger number of juniors. The following lemma shows that the result holds also when the number of junior agents after the scale-up must be an integer number. In particular, $\frac{S'}{S}J$ should be either truncated down to its floor value or truncated up to its ceiling value.[12] The proof of the lemma as well as all other technical proofs are in the Appendix.

Lemma 1. *The expected profit per-senior is increasing when scaling up the firm size to* $\left(\left\lfloor \frac{S'}{S}J \right\rfloor, S'\right)$ *or to* $\left(\left\lceil \frac{S'}{S}J \right\rceil, S'\right)$ *so long as the number of seniors does not exceed* $\widehat{S}$: $U(J,S) \leq U\left(\left\lfloor \frac{S'}{S}J \right\rfloor, S'\right)$ *or* $U(J,S) \leq U\left(\left\lceil \frac{S'}{S}J \right\rceil, S'\right)$ *for all* $S < S' \leq \widehat{S}$.

Lemma 1 allows me to derive the following predictions about the optimal size of firms.

[12] The floor function maps a real number to the largest integer not greater than the number and the ceiling functions maps a real number to the smallest integer not smaller than the number. The notations $\lfloor \cdot \rfloor$ and $\lceil \cdot \rceil$ are used to denote the floor function and the ceiling function, respectively.

Proposition 1. *The optimal number of agents in a firm is as follows:*

(i) The number of senior agents in a firm, S, is increasing in the value of tasks, H, decreasing in the cost of training, k, and is unaffected by the probability that a senior agent has access to a task, p.

(ii) The number of junior agents in a firm, J, is increasing in H and p, and decreasing in k.

(iii) The total number of agents in a firm, $S + J$, is increasing in H and in p, and decreasing in k.

Proposition 1 gives rise to the following testable hypothesis. First, to the extent that more experienced senior VC partners have on average higher values of H and lower values of k, Proposition 1 implies that firms with more experienced VC partners will be bigger. The reason that experienced VC partners are likely to have higher values of H is that over time, VC partners acquire knowledge and contacts that give them better access to investment opportunities and allow them to better screen these opportunities. Moreover, the career path of VC partners is often described by practitioners as a selection process in which only the best survive. Hence, longer time in the industry is associated with an established reputation, which is a key for attracting good portfolio companies. Moreover, learning by doing allows experienced partners to mentor junior partners at a lower cost and to write more detailed contracts which decrease the magnitude of the component k for which they are not compensated.

Second, according to venture capitalists, in boom periods in the VC industry there is an increase in the number of tasks that VC partners can execute, i.e., p is higher. Insofar as periods of an increase in aggregate investments are associated with access to more tasks, Proposition 1 suggests that when aggregate investment activity increases, the number of junior partners in the firm should grow though, interestingly the number of senior partners should remain unaffected.[13] The intuition follows from the features of the profit sharing arrangement; Allocating profits generated by the junior partners to the senior partners supports joint execution of tasks by senior and junior partners within the firm.

[13]Note that in contrast to Lucas (1978) "span-of-control theory of the firm" my framework generates predictions regarding the optimal size and composition of firms without assuming complementarities between individuals. Instead, in this paper these complementarities are derived as a result.

Thus, when senior partners have access to more tasks, they can utilize a larger capacity of junior partners, and therefore it is optimal to have a larger J. Another implication of equally sharing the firm profits among the senior partners is that training juniors is essentially a public good and hence there is an upper bound on the number of senior partners in a firm. As this threshold depends on the benefits and costs of task execution, but not on the number of tasks, an increase in p does not affect the optimal S.

3.2 Spin-outs

Many VC firms are founded by partners who were earlier members of other VC firms. For example, 22 of the 53 new California VC firms in the sample founded between 1998 and 2002 had at least one partner who was earlier a member of another VC firm. This type of situation, where an agent leaves his own firm and starts a new one is called a "spin-out."[14] In this subsection, I extend the analysis by adding a first initial period to the model and then use the two-period model to make predictions about spin-outs from VC firms. In period 2 of the extended model (the last period), the organization of firms is as in the previous subsection. In period 1, things are a bit more involved, since junior agents who execute tasks acquire the skills and knowledge needed to become seniors in period 2. Hence, working as a junior in period 1 generates an extra benefit which affects the willingness of junior agents to work for the firm. To account for agents' potential attrition, I assume that each agent continues in the industry to period 2 with probability μ and exits the industry at the end of period 1 with probability $1-\mu$.

I study spin-outs in period 2 by solving the model backwards. Proposition 1 implies that in period 2, the number of senior agents is $S_2 = \lfloor \widehat{S} \rfloor$ and the number of junior agents, J_2, is the largest J for which

$$\Pr(Q_{S_2} \geq J) \geq \frac{\omega}{H-k}.$$

Substituting S_2 and J_2 in Equation (3), the expected payoff of a senior agent in period 2 is

$$U_2 = \frac{(H-k)}{S_2}\mathbb{E}\left[\min\left(J_2, Q_{S_2}\right)\right] - \frac{J_2 \omega}{S_2}.$$

[14] While the terms "spin-out" and "spin-off" are often used interchangeably, I adopt the distinction used by Franco and Filson (2006), whereby a spin-out is an independent firm formed by an individual who left an existing firm, while a "spin-off" is a new firm which is established by an existing firm which turns one of its divisions into an independent firm.

Next, I turn to period 1. According to Proposition 1, the number of senior agents in period 1 is $S_1 = \lfloor \widehat{S} \rfloor$. The remuneration of junior agents in this period has two components: their financial earnings, and the expected value of on-the-job training.[15] The probability that a junior who works in a firm with S_1 seniors and J_1 juniors executes a task in period 1 is given by

$$\gamma\left(J_1, S_1\right) = \sum_{N=1}^{J_1} Pr(Q_{S_1} = N) \binom{J_1}{Q_{S_1}} + Pr(Q_{S_1} > J_1),$$

which is a weighted average of the probability of a junior agent to execute a task across all the realizations of Q_{S_1}. If the number of tasks in the firm does not exceed the number of junior agents, $Q_{S_1} \leq J_1$, each agent executes a task with probability $\binom{J_1}{Q_{S_1}}$, while when $Q_{S_1} > J_1$ the probability is equal to 1. The expected value of on-the-job training is $\mu\gamma\left(J_1, S_1\right) U_2$ which is the probability that the agent stays in the industry, μ, times the probability that he executes a task in period 1, $\gamma\left(J_1, S_1\right)$, times the value of being a senior in period 2, U_2. Recall that the juniors' total payoff (i.e., financial earnings and training) is equal to the alternative wage ω. Therefore, the cost of hiring a junior in period 1 is $\max\left[0, \omega - \mu U_2 \gamma\left(J_1, S_1\right)\right]$.[16]

Due to the lower wage of juniors in period 1, the profit function of the firm in period 1 is now given by:

$$\pi\left(J_1, S_1\right) = H \min\left(J_1, Q_{S_1}\right) - J_1 \max\left[0, \omega - \mu U_2 \gamma\left(J_1, S_1\right)\right].$$

This expression differs from Equation (2) in that each junior earns $\max\left[0, \omega - \mu U_2 \gamma\left(J_1, S_1\right)\right]$ compared to ω in the static model. Using $\pi\left(J_1, S_1\right)$ and following the same steps as in the proof of Proposition 1, the number of junior agents in period 1, J_1, is the largest J for which

$$\Pr(Q_{S_1} \geq J) \geq \frac{\max\left[0, \omega - \mu U_2 \gamma\left(J_1, S_1\right)\right]}{H - k},$$

where the left hand side of the inequality is decreasing in J and the right hand side is increasing in J. Note that holding the parameters H, k, ω, and p fixed, a firm hires more junior agents in period 1 compared to period 2. The intuition is that the value generated by task execution is larger in period 1

[15] Lazear (1976) studies empirically the relationship between the wage growth pattern of individuals and their employment history. He finds that young workers receive about one-third of their remuneration in the form of human capital accumulation.

[16] The cost is assumed to be positive as in reality juniors do not pay for jobs or commit to long-term wage contracts. Inefficiencies associated with these imperfections are studied in Tervio (2009).

than in period 2 and therefore the returns from each additional junior are higher in period 1 compared to period 2.

I assume that the information whether a specific junior agent did or did not execute a task in period 1 is public. Therefore, a junior agent who did not execute a task in period 1 cannot become a senior in period 2, in his period 1 firm or in a different firm. I assume that task execution, which reflects human capital accumulation, is public information, since according to venture capitalists, productivity of a partner is closely related to his "track record" — the success or failure of the investments he previously managed in his career, and this information is typically public. Moreover, the VC community is characterized, particularly in the Silicon Valley, by relationships and flow of information also across firms.[17]

The next proposition studies the factors driving junior agents to spin-out and start new firms.

Proposition 2. *Conditional on staying in the industry, the probability that a junior agent spins-out from a firm between period 1 and period 2 is increasing in the number of agents from his firm who continue in the industry from period 1 to period 2.*

Proposition 2 implies that a junior agent who has more colleagues who continue in the industry to period 2 is more likely to spin-out to a new firm.

4 Data

The panel data set includes information about firm composition and firm investments in portfolio companies. It was constructed by combining information from two main sources and validated using a number of additional independent sources. *Pratt's Guide to Venture Capital Sources* is an annual directory providing information on VC firms in the United States. Each volume reports firm information, including firm name, firm contact information, names and titles of individual venture capitalists (for example, *Managing Partner*, *Partner*, and *Associate*) and firm preferences in terms of stage of investment, geography, and industry. The directory is the main source of information about the com-

[17]Empirical evidence supporting this view is provided by Hochberg et al (2007). Their analysis defines the network position of a VC firm based on the syndicated investments it made in portfolio companies. The authors find that investment made by VC firms with more influential network positions have significantly better performance.

position of each firm in each period. The second source is the financial database *VentureXpert*, which includes information about firm investments in portfolio companies.

4.1 Firm Composition

The sample includes independent VC firms with main offices in California that specialize in early-stage investments and invested in more than 20 companies during the sample period.[18] There are other types of organizations and businesses that finance young companies such as angel investors and bank subsidiaries. Angel investors are wealthy individuals who invest their own funds in young startups, typically at an earlier stage of the company and with a smaller investment (less than $1 million) than VC firm financing. They are excluded from the sample since their service and form of organization differ from those of VC firms. Bank subsidiaries and corporate investment arms are a common source of financing; they provide a service similar to that provided by VC firms. While VC firms serve as intermediaries between institutional investors and portfolio companies, bank subsidiaries and corporate investment arms often invest their firm's capital. They are excluded from the sample because *Pratt's Guide* does not accurately report their composition, and their affiliation with big corporations may affect their organization and operation. These criteria for firm inclusion in the sample create a relatively homogenous group of firms in terms of organizational form and the service they provide.[19]

Potential changes in the name format of the same partner across directory volumes (due to typographical errors or the use of different versions of the same name) were a major challenge in constructing the data set. I performed several checks on the raw data to find names that might belong to the same individual.[20] Ambiguous entries were further investigated and fixed using information about partner biographies.

Three additional sources provided information about the biographies of the VC partners. The

[18]Firms were categorized as California based if they only had a California office, or if they had several offices but the California office was the largest one (as determined by the number of partners in each office). For all firms in the sample, the analysis includes all the partners in the firm, including partners in offices other than California.

[19]Although the firms in the sample operate in the same industry, the sample should not be considered a market; competitors such as corporate investment arms are excluded, and firms in the sample do not necessarily compete with each other in product space or geographic space.

[20]I pooled partners by firms and looked for partners with similar names in the same firm. In addition, I sorted all partner names in the data set using different criteria and looked for similar names that appeared next to each other in the sorted lists.

search engine ZoomInfo uses the web to automatically create biographies of professionals. Prospectus filings of portfolio companies with the Securities and Exchange Commission (SEC) provide a short biography of each board member, including VC partners who sit on the company board. The websites of active VC firms provide the biographies of their partners and, occasionally, biographies of partners emeritus.

In addition to resolving ambiguities regarding partners' names, the biographies allow me to investigate cases in which (according to *Pratt's Guide*) a partner is affiliated with more than one firm during the same sample period. After resolving these cases using biographical information about the partner's career path, each partner in the panel data is a member of exactly one firm for each sample period. Moreover, I verified the reliability of the firm composition information from *Pratt's Guide* by comparing the directory's information with information from partners' biographies. Additionally, I exploited the fact that, until the 1990s, VC firms were most commonly incorporated as Limited Partnerships (LPs). LPs are required to file the names of the general partners with the Secretary of State (SOS), so I compared the composition of firms with a sample of California SOS filings.[21]

The firm composition information includes the names of all partners in each VC firm. Individuals who hold other positions in the firm are not included in the sample due to limitations of the data.[22] While information about other firm members would have made the data even richer, the available information is still insightful, as VC partners are the dominant individuals in VC firms with respect to its major activities: evaluating investment opportunities, managing investments, and raising capital. Additionally, unlike law firms and other professional services firms, most of the individuals who work in VC firms are partners.

To capture the importance of experience and training in the VC industry, the partners are classified as either senior or junior partners. In the first period for which a partner is observed in the sample he is classified as a junior; starting from the second period, he is classified as a senior. This classification method captures all the years of experience each partner obtained, not only within his current firm,

[21] In general, I did not find any major discrepancies between *Pratt's Guide* and the other sources. The most common inconsistency is that firms sometimes first appear in the directory a few years after their founding date.

[22] Other non-partner positions may include venture partners who specialize in bringing investment opportunities to the firm, entrepreneurs in residence who are experts in specific fields and are usually affiliated with the firm for a short period of time (less than two years) and aid in evaluating investment opportunities and initiating new startup ideas, and associates who are apprentices within a VC firm (senior associates are sometimes called principals).

but also in previous California VC firms he was part of. However, the data set cannot account for related work experience that was acquired outside the California VC industry (e.g., in VC firms in other states or in the finance industry).

4.2 Investment Activity

The empirical analysis exploits shifts in aggregate activity in the VC industry to test the model's prediction of a positive relationship between the amount of tasks and the composition of VC firms.[23] Boom and bust periods in the VC industry last between a few years to about a decade (see Gompers and Lerner, 1998). Therefore, an important consideration in the construction of the panel date set was to cover a long enough period of time in which the industry experienced shifts in aggregate activity. The firm composition data from *Pratt's Guide* was collected for a 20 years period, from 1982 to 2002. As transferring this information into a digital format is a time-consuming and delicate process, the *Pratt's Guide* directories were sampled every 4 years. The panel data therefore covers 6 time periods; the first year in the sample is 1982, and the last year is 2002, with 4 year intervals between any two sample periods. I believe that 4 year intervals do not involve a serious loss of information as the career paths of venture capitalists are determined by the success of the investments they manage which take at least $2-3$ years to mature. Moreover, it is uncommon for a venture capitalist to hold a partner position in a firm for less than 4 years.

To allow for a richer and more accurate examination of industry trends, rather than examining general investment trends I focus on trends in the firm's specific field of specialization. During the period covered by the sample, the vast majority of VC firms' investments can be broadly divided to two main areas: Information Technology (IT) and Life Science (LS). These can be further divided into sub-fields; Information Technology includes "communication and media," "computer related," and "semiconductors/other elect;" Life Science includes "biotechnology" and "medical/health/life sciences." The database *VentureXpert* divides portfolio companies into a detailed categorization, using the 5 sub-fields mentioned above and an additional category for "non-high-technology." However, since

[23]Gompers and Lerner (1998) investigate what generate the dramatic movements in VC fundraising. Their analysis distinguishes between supply effects related to the willingness of investors to provide capital to VC funds or factors related to entrepreneurs' demand for VC. They find that mainly demand factors and not supply factors determine the aggregate level of VC fundraising.

VC firms typically define themselves using the broader level of specialization (Information Technology or Life Science), and often invest in several sub-fields within their specialization, my analysis is based on these two broad categories (IT or LS). Moreover, while investment trends within these sub-categories are highly correlated, investment trend across these two broad categories (IT and LS) are less correlated with each other. Investments in companies labeled by *VentureXpert* as "non high-technology" include diverse and unrelated industries, which are not affected by common industry trends. As this relatively small group of portfolio companies (less than 8% of the observations) cannot be identified with a specific industry, it was dropped from the sample.

To identify each firm's field of specialization, I use the information in *VentureXpert* about the firm's investments in portfolio companies.[24] I matched each firm-period observation from *Pratt's Guide* (i.e., firm composition information) with information from *VentureXpert* about the firm's investments for that period. For example, a firm appearing in the 1994 directory is matched with information about its investments for 1991 through 1994. This information is used for classifying firms as specializing in Information Technology (IT), in Life Science (LS) or in both fields.

This classification of VC firms and their portfolio companies into fields is also used for constructing the aggregate trend variables. I define the aggregate investment activity in a field during a certain four-year period as the total number of portfolio companies in that field that raised their first round of investment during that period from VC firms that are in my sample. Then, I define the trend as the change in the aggregate investment activity from the previous four-year period to the current four-year period. Basic statistics about firm size and composition for each sample period and the proportional changes in aggregate investment activity are reported in Table 1.

5 Empirical Findings

This section reports various empirical facts about the organization of VC firms. The analysis exploits information about the names of the partners who belong to each firm for each sample period. The fine level of detail about firm composition enables me to document statistical relationships between firm size, its partners' level of experience, the investment activity in the firm's field of specialization,

[24] I label categories "communication and media," "computer related," and "semiconductors/other elect" as Information Technology (IT) and categories "biotechnology" and "medical/health/life sciences" as Life Science (LS).

and the likelihood of spin-outs. The analysis demonstrates that my theoretical framework which emphasizes the role of VC firms in facilitating training is consistent with the following empirical facts: a positive relationship between firms' size and partners' experience, a positive relationship between firms size and the trend of aggregate investment activity in the industry, and a positive relationship between the probability of a partner to spin-out and the number of his colleagues who remain in the industry in the following period.

I begin with cross-tabulations and then perform regression analysis. Equations in which the dependent variable is a count variable representing the number of partners in a firm were estimated with a Poisson regression, which places probability mass only at nonnegative integer values.[25]

5.1 Cross-Tabulation

I first explore patterns related to the relationship between firm size and the experience of the senior partners in the firm. To account for variation over time and across firms in VC experience of senior partners, I construct the variable MeanExp_{it} which is equal to the mean of experience (in years) of the senior partners in firm i at period t. Using the mean implies an assumption that the experience of different parters in a firm are perfect substitutes; the analysis in this section yielded similar results when statistics other than the mean (the lower quartile, the median, and the upper quartile) were used to capture variation across firms in the experience of the senior partners. Another potential limitation of this measure is that since the sample begins in 1982, experience is observed only from 1982 onward, and therefore I cannot account for experience of VC partners before 1982. I believe that this concern does not have a major effect on the results, since the volume of activity in the California VC industry before the early 1980s was much smaller than the activity in the 1980s and later on.

Panel A in Table 2 provides initial evidence that the average experience of the senior partners in a firm is positively associated with the number of senior partners as well as with the total number of partners in that firm. The tabulations also suggest that there a is positive relationship between the experience of the senior partners and the number of junior partners, but the relationship is not monotonic over quartiles.

[25]Very similar estimates were obtained when these equations were estimated with a negative binomial regression which allows the Poisson process to have greater variation than that of a true Poisson. Additionally, the equations were estimated with a linear regression which yielded similar results qualitatively.

A second source of variation which I exploit to investigate heterogeneity in firm size is shifts over time in the aggregate investment activity in the California VC industry. As VC firms specialize in different fields, fluctuations in investment activity in each field create variation not only over time but also across the firms specializing in different fields. To control for the investment activity in the firm's field of specialization, I construct the variable InvestTrend_{it} which is equal to the weighted average of the aggregate trends in Life Science (LS) and Information Technology (IT) according to the number of investments the firm made in LS and in IT in the relevant period.

Panel B in Table 2 illustrates that firms experiencing higher growth in their field tend to have more junior partners and more partners. There does not seem to be a systematic relationship between the trend and the number of senior partners in the firm. The univariate comparison, however, does not control for the fact that in boom periods there is massive entry of new firms which are relatively small. Therefore, I turn to regression analysis which controls simultaneously for market conditions and the characteristics of the senior partners in the firm.

5.2 Regression Analysis

I study empirically the internal organization of VC firms by estimating the equation:

$$\text{Y}_{it} = \alpha + \beta \text{MeanExp}_{it} + \gamma \text{InvestTrend}_{it} + \delta \text{Dummies}_{it} + \epsilon_{it}, \quad (4)$$

where MeanExp_{it} and InvestTrend_{it} were defined above, Dummies_{it} are period dummies, and in Y_{it} I substitute the number of senior partners, the number of junior partners, or the total number of partners in the firm.

The underlying theoretical framework, which was formulated in the model, and summarized in Equation (4), proposes that the internal organization of VC firms is determined endogenously conditional on two major economic factors: the human capital of the senior partners, represented by MeanExp_{it}, and market conditions, captured by InvestTrend_{it}.[26]

[26]The investment trend is exogenous to the structure of a particular VC firm, and thus the causal relationship is clear. Changes in VC firms' composition are likely to reflect considerations associated with the human capital of the senior partners in the firm. Additionally, senior VC partners very rarely leave their firm to join an existing VC firm. It is therefore reasonable to assume that senior partners' experience would be a factor explaining variation in firm size and composition.

I examine whether the VC experience of the senior partners in a firm and the aggregate trend in the firm's field of specialization are associated with the number of senior partners in a firm by estimating Equation (4) while substituting $\mathrm{Y}_{it} = \mathrm{Seniors}_{it}$. Column (1) in Table 3 reports the Poisson regression results. The coefficient of the mean experience variable is statistically significant and its magnitude implies that the number of senior partners in a firm with highly experienced seniors (that is, at the 75^{th} percentile of mean experience, or 8) is 1.64 times larger, than the number of senior partners in a firm with less experienced seniors (that is, at the 25^{th} percentile of mean experience, or 4). The effect of the aggregate investment trend on the number of senior partners is not statistically significant. These results are consistent with prediction (i) of Proposition 1 suggesting that the number of senior partners in a firm is positively associated with the level of experience of those senior partners, but does not depend on the probability of access to a task.

As discussed in Section 3, the experience of the senior partners in a firm can be used to indirectly control for variation across firms in the value of tasks and the cost of training (the parameters H and k, respectively). Experienced VC partners are likely to have more valuable deals, since over time they acquire industry specific human capital which gives them better access to investment opportunities and allows them to better screen these opportunities. Moreover, VC partners who survive in the industry are likely to have an established reputation, which is a key for attracting good portfolio companies. The private cost experienced VC partners incur when training junior partners should be smaller due to learning by doing and to their ability to write more detailed contracts.

Next, I investigate the empirical relationship between the senior partners' experience, the aggregate trend and the number of junior partners in the firm. I estimate Equation (4) while substituting $\mathrm{Y}_{it} = \mathrm{Juniors}_{it}$. Poisson regression estimates are reported in Column (2) of Table 3. The aggregate changes in the investment activity in the firm's field of specialization are positively associated with the number of junior partners in the firm. The coefficient is statistically significant and its magnitude implies that an increase from the lower quartile (-0.41) to the upper quartile (0.95) of the aggregate trend is associated with 3.4 times more junior partners in the firm.

The relationship between the senior partners' experience and the number of junior partners is positive but not statistically significant. In the model the link between the number of junior partners and mean experience is indirect, and results from the positive relationship predicted by the model between mean experience and number of seniors which then determines the number senior partners. Thus, I estimate a similar specification in which the variable MeanExp_{it} is replaced by Seniors_{it}. The estimates, reported in Column (3) of Table 3, show that the field trend coefficient is similar to the coefficient obtained in the previous specification and that the coefficient for the number of senior partners is positive and statistically significant as predicted by result (ii) in Proposition 1. The estimates suggest that the expected number of junior partners is 1.26 times larger when there is a one-standard-deviation increase in the number of senior partners. Proposition 1 suggests that more experienced senior partners form firms with a larger number for senior partners and therefore they can utilize a larger capacity of junior partners.[27]

Finally, I study the variation across firms in the total number of partners (senior and junior). I estimate Equation (4) where $Y_{it} = \text{Partners}_{it}$. The estimates of a Poisson regression, reported in Column (4) in Table 3, suggest that more experienced senior partners are affiliated with larger firms and that in growth periods firms are bigger. The coefficient of the mean experience variable is statistically significant and its magnitude implies that the number of senior partners in a firm with highly experienced seniors (that is, at the 75^{th} percentile of mean experience, or 8) is 1.39 times larger, than the number of senior partners in a firm with less experienced seniors (that is, at the 25^{th} percentile of mean experience, or 4). An increase from lower quartile (-0.41) to the upper quartile of the aggregate trend (0.95) is associated with 1.95 times more partners in the firm.[28]

The positive association between changes in aggregate activity in the industry and the number of partners in a firm implies that in periods of aggregate expansion there is an increase not only in the total number of firms in the industry, but also in the number of partners in each firm.[29] This result is consistent with result (iii) in Proposition 1 illustrating that the optimal size of firms is larger when

[27] Proposition 1 also explains the empirical findings regarding the organization of VC firms described in Wasserman (2005). His empirical definitions of senior and junior workers are different: senior workers are the general partners in the firm, and junior workers are the principles and associates. He reports that the firms in his sample increased the ratio between junior workers and senior workers by an average of 0.031 between 1997 and 2000, a period in which the aggregate activity in the industry grew significantly.

[28] The positive relationship between aggregate activity and firm size is consistent with Cumming (2006) who finds a positive connection between funds' portfolio sizes and market returns.

[29] Across the sample periods, the number of new VC firms is positively correlated with the trend of aggregate investment activity.

there is an increase in the number of tasks that can be executed jointly by senior and junior partners. The positive correlation between the total number of partners and the senior partners' experience is consistent with result (iii) in Proposition 1. Firms whose senior partners are more experienced have more senior partners (as established by Proposition 1). Then, since the firm has more seniors, it has access to more tasks. Consequently, it is optimal for the firm to have a larger capacity to execute tasks which implies having more junior partners and also more partners overall.[30]

Discussion and Robustness Checks

To examine the extent to which variation in firm size is explained by firm-level unobserved heterogeneity, the different specifications of Equation (4) were estimated with Poisson regressions including firm level fixed effects. The estimates of the experience and trend coefficients are statistically insignificant suggesting that the fixed effects absorb the variation in size across firms, possibly due to the relatively small size of the sample. A random effect Poisson regression which is much more restrictive with respect to the form of unobserved heterogeneity it allows across firms yielded results similar to the population-averaged regression. Even if firm-level unobserved heterogeneity explains the variation in firms' size, this result is consistent with the predictions of the model. In the context of VC firms, variation which is presumably driven by unobserved firm level factors could be explained by the model. Since ownership of intellectual property or physical assets does not play a key role in the operation of VC firms, the unobserved component is probably due to heterogeneity in the human capital of the partners across firms. According to the model, we may find persistence over time in firms' size even when there is turnover, if consecutive generations of senior partners can maintain superior skill over time (e.g., better senior partners recruit better junior partners and train them more effectively).

Another unobserved factor which may systematically affect the optimal organization of firms is "management technology". During the two decades I study, there was an increase in the availability and improvement in the capabilities of Information Technology (IT) products. To the extent that this trend makes it optimal to have larger firms, we expect firms observed in later periods of the sample to

[30] Proposition 1 is also useful for interpreting results presented in Kaplan and Schoar (2005) who study empirically VC firm returns and capital flows. They report that better performing firms raise more capital. This fact can be explained by Proposition 1 if higher returns are associated with venture capitalists with larger H or smaller k and if raising more capital is associated with larger firms in terms of number of partners.

be larger than firms observed in early sample periods.[31] Additionally, due to the youth of the industry and its dramatic growth in the time period I study, partners who are observed in later sample periods are on average more experienced than partners who are observed in earlier sample periods. Taken together, these arguments raise the concern that the unobserved "management technology" biases upward the coefficient of the experience variable. To account for this possibility, I considered an alternative measure of senior partners experience, and defined the experience with relation to the average experience of all senior partners in the industry in the same period. This analysis yielded results which are consistent with the results reported in Table 3.

Unobserved heterogeneity in the skill of the junior partners who join the firm has the potential to be a source of bias. Institutional details suggest, however, that many of the abilities required from VC partners are unique and cannot be acquired in other industries. Thus, heterogeneity in previous work experience across junior partners is not necessarily associated with their competence as VC partners. Moreover, since the venture capitalists' job requires unique skills, previous track record in other professions may not be informative about the future success as a venture capitalist. To the degree that there is heterogeneity across junior VC partners, which is observed by the senior partners and systematically affects their recruiting decisions, it may bias the estimates of Equation (4).

There are several unobserved factors which could facilitate the recruiting of more partners to the firm and therefore affect firm size and composition. These factors include the ability to raise more capital, attract more and better deals, provide better training to junior partners, and offer larger compensation to new partners. The firm's ability to offer these benefits and skills is mainly driven by the human capital of the senior partners and thus is likely to be positively correlated with the senior partners' experience. Therefore, the experience coefficient should be interpreted broadly as associated with the human capital of the senior partners (i.e., their skills, reputation, and contacts).

5.3 Firm Composition and Spin-outs

I test the prediction of Proposition 2 regarding spin-outs by constructing a sub sample in which the unit of observation is a junior partner. The sub sample includes only partners who are observed in

[31] Advanced IT technology may facilitate more efficient information sharing and control within the firm. In the context of the model, this can be illustrated for example by a decrease over time in the component of the effort spent in training for which senior agents are not compensated (the parameter k in the model).

the full sample at least two periods. Junior partners' spin-outs are analyzed by estimating a Probit regression in which the dependent variable is a dummy which is equal to 1 if the junior partner spins-out to a new firm between his first and second periods in the industry and to 0 if he continues in the same firm.[32] The independent variables include the number of partners in the firm who continue in the industry to the next period and control variables.

Table 4 shows that the marginal effect of an additional continuing partner is significant and its magnitude is 0.012. According to specification (1), the probability of spinning-out at the mean of the independent variable is 0.051. The magnitude of the effect is such that a one standard deviation (2.27) increase in the number of continuing partners in a firm increases the probability of spin-out by 0.025 when the independent variables are equal to their mean value.[33] This result is consistent with Proposition 2 which predicts that the probability that a junior partner spins-out from a firm is increasing in the number of partners from his firm who continue in the industry to the next period. Next, I turn to investigating whether different theoretical arguments can explain these reported facts.

6 Alternative Explanations

In this section, I examine whether alternative views about the benefits motivating professionals to group together and form firms are consistent with the documented facts.[34] I demonstrate that my model offers a more complete interpretation of the empirical findings and a more compelling explanation given institutional details.

Risk sharing seems as a promising argument for explaining what drives venture capitalists to form firms. Venture capitalists make very risky investments and only few of these investments yield significant positive returns (see Hall and Woodward, 2009). To examine whether a framework based on risk sharing can explain the empirical regularities, I draw on the analysis in Lang and Gordon

[32]There are no instances in the sample in which a partner leaves his firm and joins an existing firm.

[33]Additional evidence for limitations on the extent to which VC firms can grow is provided in Gompers and Lerner (2002). They anecdotally describe how growth of the following firms resulted in partners splitting apart or firms experiencing organizational distress during the 1990s: Schroder Ventures, Institutional Venture Partners, Brentwood Venture, Summit Partners, and Foster Capital Management.

[34]Professionals who form firms also incur costs and face different limitations. Farrell and Scotchmer (1988) show that a profit sharing rule which allocates the firm's profits to individuals independently of their ability has implications on the equilibrium size and composition of firms. Another factor that could affect the organization of firms is the magnitude of the costs incurred in the search process for new qualified individuals.

(1995), who model partnerships as mutual insurance associations and study the tradeoff between efficiency and risk sharing. Their analysis shows, as we would intuitively expect, that optimal firm size is increasing when the disutility of agents from bearing risk is larger and when the stochastic shock to individual agent profitability is more volatile (see Equation (7), in p. 617 in Lang and Gordon, 1995).

It follows from this result that the risk sharing view can explain the positive relationships between firm size and its partners' experience and between firm size and the aggregate investment trend if these two factors are associated with more risk aversion or with larger exposure to risk. There are several reasons to believe that experience is actually correlated with more wealth accumulation and larger expected income, and therefore with less risk aversion. Experienced partners, however, may be exposed to more risk since they are likely to manage more investments and to hold more equity in each portfolio company. Risk sharing can explain a positive relationship between partners' experience and firm size if the effect of a potentially larger exposure to risk outweighs the wealth effect.[35] The income of VC partners is expected to increase in boom periods, since such periods often follow periods with large numbers of initial public offerings and acquisitions (see Gompers and Lerner, 2002) and also partners manage more investments and more capital. Exposure to risk may increase in boom periods as more capital is invested and investments may be more risky. The risk sharing view can explain the positive correlation between firm size and aggregate investment activity if the potential effect of exposure to more risk dominates the wealth effect.

A theoretical framework based on risk sharing can explain spin-outs by postulating that partners who survive in the industry accumulate more wealth and hence become less risk averse. Consequently, spin-outs may take place as it becomes optimal for them to have smaller firms (following again the result from Lang and Gordon (1995)). This argument is inconsistent with the empirical fact that firms which had spin-outs on average get bigger in the period following the spin-out, as new partners replace the partners who left. Also, it does not explain the fact, reported in Subsection 5.3, that partners are more likely to spin-out from their firm when they have more colleagues who remain in

[35] Assessing which one of the effects dominates requires estimating partners' risk preferences, quantifying the riskiness of the investments, and observing the profit sharing contracts. Such analysis is challenging with respect to its data requirements.

the industry in the following period.

Institutional details and anecdotal evidence provide limited support to the view that observed heterogeneity in VC firms size reflects variation in partners' risk preferences. Venture capitalists are often very wealthy individuals.[36] Consequently, we would expect them to have high tolerance for risk. In fact, some practitioners even argue that venture capitalists are people who love risk. Additionally, venture capitalists can diversify the risk they bear due to holding their portfolio companies' equity by syndicating their investments with venture capitalists from other firms.[37] Spreading risk through syndication creates a larger degree of flexibility than profit sharing, since with profit sharing all the partners are forced to have holdings in all the portfolio companies of their firm. Finally, in interviews, venture capitalists did not emphasize risk sharing as a major motivation behind recruiting new partners or changing firms' size. These institutional details together with the empirical facts provide partial support for the view that risk sharing is a dominant economic force shaping the size and composition of VC firms.[38]

Another view is risk sharing from the investor side as a motive for forming multiple-partner firms. If there is a fixed cost associated with investing into a VC fund (or more generally the cost is concave), it is less costly to invest in multiple-partner firms as opposed to diversifying the investment by investing in many one partner firms. However, as investors are typically big institutions (e.g., pension funds), rather than individuals, risk-sharing considerations from the investor side are less important. Moreover, this view does not provide an intuitive interpretation for the observed empirical regularities.

A third view that could potentially explain the results suggests that firms facilitate transactions between symmetric agents, where all agents are equally likely to transact with each other. In contrast, the model in this paper highlights the role of firms in supporting transactions between senior and junior agents. This symmetric agents view can be formalized with a version of the model in Section 3

[36]Many venture capitalists have made their fortune as entrepreneurs (who raised capital from VC firms) and have become venture capitalist after successfully selling their company; others have accumulated wealth by making successful investments as venture capitalists.

[37]Lerner (1994) reports that in their first and second round of investments portfolio companies have on average 2.2 and 3.3 venture investors, respectively.

[38]Garicano and Hubbard (2008) study the field boundaries of law firms and find little support for the hypothesis that risk-sharing among lawyers is a main factor in explaining law firms field boundaries.

which includes only senior agents and assumes that a senior agent who has a task needs the labor of another senior in order to execute the task (as opposed to the labor of a junior in the model in Section 3). The same arguments used in Subsection 5.2 are also valid for showing that such a framework is consistent with the observed relationship between partners' experience and firm size. This view can also explain the increase in firm size in boom periods if the costs of recruiting qualified colleagues are smaller in such periods. This framework could explain spin-outs if agents experience positive or negative shocks to their human capital that make it optimal for them to leave their firm and join a firm with individuals with similar level of human capital. However, the probability of a spin-out in this case does not depend on the number of colleagues who continue in the industry, and thus does not explain the spin-out regularities.

In sum, while the alternative views I considered can explain some of the empirical facts, my model offers a unified framework consistent with all the facts and strongly supported by institutional details.

7 Conclusions

This paper employed novel data, a theoretical model, an empirical analysis, and institutional details to study the economic factors determining VC firms' size and composition, and more broadly understand the forces driving professionals to group together and form firms. The analysis demonstrates that the model proposed in this paper, emphasizing the role of firms in facilitating efficient transactions between senior and junior professionals, provides a more complete explanation for the empirical facts compared to alternative views about the role and organization of firms. Thus, the theoretical and empirical analyses taken together support the view that a primary driver for the formation of professional services firms is facilitating joint execution of projects by junior and senior professionals and allowing a more efficient use of junior professionals' time. According to this view, the size and composition of professional services firms are determined by the human capital of their members.

The paper makes at least two important contributions to the literature studying the organization of professional services firms. First, this is the first study, to my best knowledge, testing a theory predicting the size of such firms. Second, the paper proposes a modeling approach which allows testing predictions of the Coasian view, which states that certain transactions are performed more efficiently within a firm compared to across firms. In particular, the model relates the frequency, benefit and cost of these transactions to the characteristics of the firm members and to general industry trends. This framework allows exploiting observed variation in individuals' characteristics and market conditions to test indirect implications of the Coasian view. This method can be applied to test implications of the transaction cost theory of the firm in other industries. Additionally, the modeling approach can be used to quantify the productivity gains from joint work of individuals within a firm (Alter, 2008).

8 Appendix

Following are the proofs of Lemma 1 and Propositions 1 and 2.

Proof of Lemma 1: To prove the result, I must show that one of the following inequalities holds:

$$\underbrace{\frac{(H-k)}{S}\mathbb{E}\left[\min\left(J,Q_S\right)\right]-\frac{J\omega}{S}}_{U(J,S)}\leq\underbrace{\frac{(H-k)}{S'}\mathbb{E}\left[\min\left(\left\lfloor\frac{S'}{S}J\right\rfloor,Q_{S'}\right)\right]-\frac{\left\lfloor\frac{S'}{S}J\right\rfloor\omega}{S'}}_{U\left(\left\lfloor\frac{S'}{S}J\right\rfloor,S'\right)}\tag{5}$$

or,

$$\underbrace{\frac{(H-k)}{S}\mathbb{E}\left[\min\left(J,Q_S\right)\right]-\frac{J\omega}{S}}_{U(J,S)}\leq\underbrace{\frac{(H-k)}{S'}\mathbb{E}\left[\min\left(\left\lceil\frac{S'}{S}J\right\rceil,Q_{S'}\right)\right]-\frac{\left\lceil\frac{S'}{S}J\right\rceil\omega}{S'}}_{U\left(\left\lceil\frac{S'}{S}J\right\rceil,S'\right)}.\tag{6}$$

First, I show that

$$\underbrace{\frac{(H-k)}{S'}\mathbb{E}\left[\min\left(\frac{S'}{S}J,Q_{S'}\right)\right]-\frac{J\omega}{S}}_{U\left(\frac{S'}{S}J,S'\right)}\leq\underbrace{\frac{(H-k)}{S'}\mathbb{E}\left[\min\left(\left\lfloor\frac{S'}{S}J\right\rfloor,Q_{S'}\right)\right]-\frac{\left\lfloor\frac{S'}{S}J\right\rfloor\omega}{S'}}_{U\left(\left\lfloor\frac{S'}{S}J\right\rfloor,S'\right)}\tag{7}$$

or,

$$\underbrace{\frac{(H-k)}{S'}\mathbb{E}\left[\min\left(\frac{S'}{S}J,Q_{S'}\right)\right]-\frac{J\omega}{S}}_{U\left(\frac{S'}{S}J,S'\right)}\leq\underbrace{\frac{(H-k)}{S'}\mathbb{E}\left[\min\left(\left\lceil\frac{S'}{S}J\right\rceil,Q_{S'}\right)\right]-\frac{\left\lceil\frac{S'}{S}J\right\rceil\omega}{S'}}_{U\left(\left\lceil\frac{S'}{S}J\right\rceil,S'\right)}.\tag{8}$$

Define $\Delta=\frac{S'}{S}J-\left\lfloor\frac{S'}{S}J\right\rfloor$. Using the definition of Δ, Inequality (7) can be rewritten as:

$$(H-k)\mathbb{E}\left[\min\left(\left\lfloor\frac{S'}{S}J\right\rfloor+\Delta,Q_{S'}\right)-\min\left(\left\lfloor\frac{S'}{S}J\right\rfloor,Q_{S'}\right)\right]\leq\Delta\omega.\tag{9}$$

Similarly, Inequality (8) can be rewritten as:

$$\left(1-\Delta\right)\omega\leq(H-k)\mathbb{E}\left[\min\left(\frac{S'}{S}J+(1-\Delta),Q_{S'}\right)-\min\left(\frac{S'}{S}J,Q_{S'}\right)\right].\tag{10}$$

Since the realizations of $Q_{S'}$ are integer numbers, Inequality (9) is equivalent to:

$$\Delta(H-k)Pr\left(Q_{S'} \geq \left\lceil \frac{S'}{S}J \right\rceil\right) \leq \Delta\omega, \tag{11}$$

and Inequality (10) is equivalent to:

$$(1-\Delta)\omega \leq (1-\Delta)(H-k)Pr\left(Q_{S'} \geq \left\lceil \frac{S'}{S}J \right\rceil\right). \tag{12}$$

It follows that Inequality (11) or Inequality (12) must hold. Therefore, Inequality (7) or Inequality (8) must hold. Hence, a sufficient condition for Inequality (5) or Inequality (6) to hold is:

$$\underbrace{\frac{(H-k)}{S}\mathbb{E}\left[\min\left(J, Q_S\right)\right] - \frac{J\omega}{S}}_{U(J,S)} \leq \underbrace{\frac{(H-k)}{S'}\mathbb{E}\left[\min\left(\frac{S'}{S}J, Q_{S'}\right)\right] - \frac{J\omega}{S}}_{U\left(\frac{S'}{S}J, S'\right)}, \tag{13}$$

or,

$$\mathbb{E}\left[\min\left(\frac{J}{S}, A_S\right)\right] \leq \mathbb{E}\left[\min\left(\frac{J}{S}, A_{S'}\right)\right], \tag{14}$$

where $A_M \equiv \frac{Q_M}{M}$ denotes a lottery whose outcome is equal to the average number of tasks per senior in a firm with M seniors. Note that $\mathbb{E}\left[A_M\right] = p$ for all M. I show below that $A_{S'}$ second-order stochastically dominates A_S.[39] Then, since the function $\min\left(\frac{J}{S}, \cdot\right)$ is concave, it follows immediately that inequality (14) must hold. This completes the proof.

A sufficient condition for $A_{S'}$ to second-order stochastically dominate A_S is that A_{M+1} second-order stochastically dominates A_M for all $M \geq 1$. Intuitively, A_M is a more risky lottery than A_{M+1} because the average number of tasks per senior is more volatile in a firm with M seniors compared to a firm with $M+1$ seniors. Formally, I show that A_M is a mean-preserving spread of A_{M+1}: lottery X_2 is a mean-preserving spread of lottery X_1 if the distribution of X_2 is identical to the distribution of a compound lottery whose first stage is the lottery X_1 and in its second stage each outcome x of X_1 is further randomized, such that the mean of the new second stage lottery following outcome x is x (see p. 197 in Mas-Colell, Whinston and Green, 1995).

To show that A_M is a mean preserving spread of A_{M+1}, I start with describing the distribution of the lottery A_{M+1} which has $M+2$ possible outcomes: $0, \frac{1}{M+1}, \frac{2}{M+1}, \ldots, \frac{M}{M+1}, 1$. Consider the outcome

[39] For two distribution X_1 and X_2 with the same mean, X_1 second-order stochastically dominates distribution X_2 if $E[h(X_2)] \leq E[h(X_1)]$ for every nondecreasing concave functions h (see definition 6.D.2. in page 197 in Mas-Colell, Whinston and Green 1995).

$A_{M+1} = \frac{N}{M+1}$, where $N = 0, 1, 2, \ldots, M+1$. This outcome is such that N seniors have access to 1 task and $M+1-N$ seniors have access to 0 tasks. Recalling that each senior agent has access to 1 task with probability p, and to 0 tasks with probability $1-p$, the random variable A_{M+1} follows the binomial distribution:

$$\Pr\left(A_{M+1} = \frac{N}{M+1}\right) = \binom{M+1}{N} p^N (1-p)^{M+1-N}. \tag{15}$$

Similarly, the lottery A_M has $M+1$ possible outcomes: $0, \frac{1}{M}, \frac{2}{M}, \ldots, \frac{M-1}{M}, 1$ and it also follows the binomial distribution:

$$\Pr\left(A_M = \frac{N}{M}\right) = \binom{M}{N} p^N (1-p)^{M-N}. \tag{16}$$

Next, I construct a compound lottery in which the first stage is A_{M+1}. I define the lottery which follows the outcome $A_{M+1} = \frac{N}{M+1}$ as:[40]

$$O_2 = \begin{cases} \frac{N}{M}, & \textit{with probability } \frac{\binom{M}{N}}{\binom{M+1}{N}}, \\ \frac{N-1}{M}, & \textit{with probability } \frac{\binom{M}{N-1}}{\binom{M+1}{N}}, \end{cases} \tag{17}$$

where O_2 is the stage-2 outcome. Equation (17) defines a lottery since:

$$\begin{aligned} \frac{\binom{M}{N}}{\binom{M+1}{N}} + \frac{\binom{M}{N-1}}{\binom{M+1}{N}} &= \frac{1}{\binom{M+1}{N}} \left[\frac{M!}{N!(M-N)!} + \frac{M!}{(N-1)!(M-N+1)!} \right] \\ &= \frac{1}{\binom{M+1}{N}} \left[\frac{M!(M-N+1) + M!N}{N!(M-N+1)!} \right] \\ &= 1. \end{aligned}$$

The mean of the lottery defined by Equation (17) which follows the outcome $A_{M+1} = \frac{N}{M+1}$ is equal to $\frac{N}{M+1}$:

$$\begin{aligned} \frac{\binom{M}{N}}{\binom{M+1}{N}} \frac{N}{M} + \frac{\binom{M}{N-1}}{\binom{M+1}{N}} \frac{N-1}{M} &= \frac{1}{\binom{M+1}{N}} \left[\frac{M!}{N!(M-N)!} \frac{N}{M} + \frac{M!}{(N-1)!(M-N+1)!} \frac{N-1}{M} \right] \\ &= \frac{1}{\binom{M+1}{N}} \left[\frac{M!(M-N+1)\frac{N}{M} + M!N\frac{N-1}{M}}{N!(M-N+1)!} \right] \\ &= \frac{N!(M+1-N)!}{(M+1)!} \frac{M!N}{N!(M-N+1)!} \\ &= \frac{N}{M+1}. \end{aligned}$$

[40] It follows from Bayes' rule that the lottery described by Equation 17 is identical to the conditional probability function $\Pr(A_M | A_{M+1})$ where A_{M+1} is the average number of tasks in a group of $M+1$ seniors which includes the M seniors from A_M plus one additional senior.

Finally, I need to prove that the distribution of the compound lottery is identical to the distribution of A_M. To this end, note that the definition of the second stage lottery in Equation (17) implies that there are only two possible first stage outcomes which can yield the second stage outcome $\frac{N}{M}$: $A_{M+1} = \frac{N}{M+1}$ and $A_{M+1} = \frac{N+1}{M+1}$. Thus:

$$\begin{aligned}
\Pr(Q_2 = \frac{N}{M}) &= \Pr\left(A_{M+1} = \frac{N}{M+1}\right)\frac{\binom{M}{N}}{\binom{M+1}{N}} + \Pr\left(A_{M+1} = \frac{N+1}{M+1}\right)\frac{\binom{M}{N}}{\binom{M+1}{N+1}} \\
&= \binom{M+1}{N}p^N(1-p)^{M+1-N}\frac{\binom{M}{N}}{\binom{M+1}{N}} + \binom{M+1}{N+1}p^{N+1}(1-p)^{M+1-N-1}\frac{\binom{M}{N}}{\binom{M+1}{N+1}} \\
&= p^N(1-p)^{M+1-N}\binom{M}{N} + p^{N+1}(1-p)^{M-N}\binom{M}{N} \\
&= \binom{M}{N}p^N(1-p)^{M-N} \\
&= \Pr\left(A_M = \frac{N}{M}\right),
\end{aligned}$$

where the second equality follows from Equation (15) and the last equality follows from Equation (16). This result establishes that A_M is a mean preserving spread of A_{M+1}.

The two lotteries A_M and A_{M+1} have the same mean and A_M is a mean preserving spread of A_{M+1}. It follows from Proposition 6.D.2. in Mas-Colell, Whinston and Green (1995) that A_{M+1} second-order stochastically dominates A_M. ■

Proof of Proposition 1: (i) According to Lemma 1 for every firm composition (S, J), where $S < \lfloor \widehat{S} \rfloor$, the profit per senior agent can be increased by raising the number of senior agents to $\lfloor \widehat{S} \rfloor$ (where $\widehat{S} \equiv \frac{H}{k}$) and the number of junior agents to $\left\lfloor \frac{\lfloor \widehat{S} \rfloor}{S} J \right\rfloor$ or $\left\lceil \frac{\lfloor \widehat{S} \rfloor}{S} J \right\rceil$. Therefore, the number of senior agents that maximizes the profit per senior is $\lfloor \widehat{S} \rfloor$.

(ii) Using Equation (3) the expected marginal net benefit per senior agent from hiring the J-th junior agent is:

$$
\begin{aligned}
&U(J,S) - U(J-1,S) \\
&= \frac{(H-k)}{S}\mathbb{E}\left[\min(J,Q_S)\right] - \frac{J\omega}{S} - \left(\frac{(H-k)}{S}\mathbb{E}\left[\min(J-1,Q_S)\right] - \frac{(J-1)\omega}{S}\right) \\
&= \frac{(H-k)}{S}\left[\left(\sum_{j=1}^{J}\Pr(Q_S=j)j + \Pr(Q_S \geq J+1)J\right)\right. \\
&\left.-\left(\sum_{j=1}^{J-1}\Pr(Q_S=j)j + Pr(Q_S \geq J)(J-1)\right)\right] - \frac{\omega}{S} \\
&= \frac{(H-k)}{S}\Pr(Q_S \geq J) - \frac{\omega}{S} \\
&= \frac{(H-k)}{S}\left[\Pr(Q_S \geq J) - \frac{\omega}{H-k}\right].
\end{aligned}
$$

where $\frac{(H-k)}{S}\Pr(Q_S \geq J)$ is the benefit per senior and $\frac{\omega}{S}$ is the cost per senior. The benefit per senior is decreasing in J and is equal to 0 for $J > S$ (since $Q_S \leq S$). The optimal value of J is the largest J for which $U(J,S) \geq U(J-1,S)$, or

$$\Pr(Q_S \geq J) \geq \frac{\omega}{H-k}. \tag{18}$$

Clearly, the optimal J is higher when H is higher and k is lower. Since an increase in the probability that a senior agent has access to a task, p, induces a first order stochastic shift in Q_S, $\Pr(Q_S \geq J)$ increases for all J, so the largest J satisfying inequality (18) is higher.

(iii) This part follows immediately from parts (i) and (ii). ■

Proof of Porposition 2: Consider an agent who is a junior in period 1 and continues in the industry to period 2. Let V be the number of agents in his firm who also continue in the industry to period 2. Since only $\widehat{S}$ senior agents can stay in the firm, it is optimal for $V - \widehat{S}$ senior agents to spin-out. The probability that a partner spins-out conditional on continuing in the industry to period 2 is equal to $\binom{V}{V-\widehat{S}}$ and thus is increasing in V. ■

9 References

Alter, Amitay (2008) "Estimating the Return to Organizational Form in the California Venture Capital Industry." Stanford University Working Paper

Bar-Isaac, Heski (2007) "Something to Prove: Reputation in Teams." *RAND Journal of Economics* Vol. 38, No. 2, pp. 495-511.

Bresnahan, Timothy F., and Peter C. Reiss (1991) "Entry and Competition in Concentrated Markets," *Journal of Political Economy,* pp. 977-1009.

Coase, Ronald (1937) "The Nature of the Firm." *Economica*, New Series, Vol.4, No.16, pp. 386-405

Cumming, Douglas J. (2006) "The Determinants of Venture Capital Portfolio Size: Empirical Evidence." *Journal of Business*, Vol. 79, No. 3, pp. 1083-1126.

Farrell, Joseph, and Suzanne Scotchmer (1988) "Partnerships." *The Quarterly Journal of Economics*, Vol. 103, No. 2, pp. 279-297.

Franco, April M., and Darren Filson (2006) "Spin-outs: Knowledge Diffusion through Employee Mobility." *Rand Journal of Economics*, 37(4), pages 841-60.

Garicano, Luis, and Thomas N. Hubbard (2008) "Specialization, Firms, and Markets: The Division of Labor Within and Between Law Firms." *Journal of Law, Economics, and Organization* Advance Access published on May 7, 2008, DOI 10.1093/jleo/ewn003.

Gibbons, Robert, and Lawrence F. Katz (1991) "Layoffs and Lemons." *Journal of Labor Economics*, Vol. 9, No. 4, pp. 351-380.

Gompers, Paul, Anna Kovner, and Josh Lerner (2009) "Specialization and Success: Evidence from Venture Capital." *Journal of Economics and Management Strategy*, Volume 18, Number 3 , pp. 817-844.

Gompers, Paul, and Josh Lerner (1998) "What Drives Venture Capital Fundraising?" *Brookings Papers on Economic Activity. Microeconomics*, Vol. 1998, pp. 149-204.

Gompers, Paul, and Josh Lerner (1999) "The Venture Capital Cycle." MIT Press

Gompers, Paul, and Josh Lerner (2001) "The Venture Capital Revolution." *The Journal of Economic Perspectives*, Vol. 15, No. 2, pp. 145-168.

Gompers, Paul, and Josh Lerner (2002) "Short-Term America Revisited? Boom and Bust in the Venture Capital Industry and the Impact on Innovation." *Innovation Policy and the Economy*, Volume 3.

Hall, Robert E., and Susan E. Woodward (2009) "The Burden of the Nondiversifiable Risk of Entrepreneurship," forthcoming, *American Economic Review*.

Helsong, Roy (1988) "Ventures Capital inside out." Transwest: San Francisco.

Hochberg, Yael, Alexander Ljungqvist, and Yang Lu (2007) "Whom You Know Matters: Venture Capital Networks and Investment Performance," *Journal of Finance*, Vol. 62, No. 1, pp 251-301.

Kaplan, Steven N., and Antoinette Schoar (2005) "Private Equity Returns: Persistence and Capital Flows." *Journal of Finance* 60, pp. 1791-1823.

Laing, Derek (1994) "Involuntary Layoffs in a Model with Asymmetric Information Concerning agent Ability." *The Review of Economic Studies*,Vol. 61, No. 2, 375-392.

Lang, Kevin, and Peter-John Gordon (1995) "Partnerships as Insurance Devices: Theory and Evidence," *RAND Journal of Economics*, 26 (1995), pp 614-629.

Lazear, Edward P. (1976) "Age, Experience, and Wage Growth," *The American Economic Review*, Vol. 66, No. 4, pp. 548-558.

Lerner, Josh (1994) "The Syndication of Venture Capital Investments," *Financial Management*, Vol. 23, No. 3, pp. 16-27.

Lucas, Robert E., Jr. (1978) "On the Size Distribution of Business Firms." *Bell Journal of Economics*, 9(2), pp. 508-523.

Mas-Colell, A., M. Whinston, and J. Green (1995) "Microeconomic Theory." Oxford University Press.

Morrison, Alan D., and William J. Wilhelm (2004) "Partnership Firms, Reputation, and Human Capital." *The American Economic Review*, Vol. 94, No. 5, pp. 1682-1692.

Pratt, Stanley E. "Pratt's Guide to Venture Capital Sources," Wellesley Hills, Mass. 1982, 1986, 1990, 1994, 1998, and 2002 Volumes.

Rothschild, M. and J. E. Stiglitz (1970) "Increasing Risk: I. A Definition." *Journal of Economic Theory*, Vol. 2, 225-243.

Sahlman, William A. (1990) "The Structure and Governance of Venture Capital Organizations." *Journal of Financial Economics*, 27, 473-521.

Sorensen, Morten (2007) "How Smart is Smart Money: A Two-Sided Matching Model of Venture Capital," *Journal of Finance*, 62, 2725-2762.

Tervio, Marko (2009) "Superstars and Mediocrities: Market Failure in the Discovery of Talent," *Review of Economic Studies*, 76(2), pp. 829-850.

Timmons, Jeffry A., and William D. Bygrave (1986) "Venture Capital's Role in Financing Innovation for Economic Growth." *Journal of Business Venturing*, 1 (2), 161-176.

Wasserman, Noam (2005) "Upside-down Venture Capitalists and the Transition Toward Pyramidal Firms: Inevitable Progression, or Failed Experiment." *Entrepreneurship, Research in the Sociology of Work*, Volume 15, 151-208.

Zarutskie, Rebecca (2008) "The Role of Top Management Team Human Capital in Venture Capital Markets: Evidence from First-time Funds." *Journal of Business Venturing*, forthcoming.

10 Tables and Figures

Table 1: Firm size and composition summary statistics and aggregate investment trends, by sample period

The sample includes independent VC firms with main offices in California that specialize in early-stage investments. *Mean Size* is the mean number of partners in a firm, *Median Size* is the median number of partners, *Mean Seniors* is the mean number of senior partners, and *Mean Juniors* is the mean number of junior partners in a firm. *Trend IT* and *Trend LS* report the proportional change between the previous sample period and the current sample period in the total number of investments made by California VC firms ($(Inv_t - Inv_{t-1})/Inv_{t-1}$) in Information Technology (IT) and Life Science (LS) companies. The sample includes 158 firm-period observations; firm composition information was obtained from *Pratt's Guide to Venture Capital Sources*, an annual directory providing information on VC firms in the US. Information about VC firms' investments in portfolio companies is based on the financial database *VentureXpert*.

Sample Period	Mean Size	Median Size	Mean Seniors	Mean Juniors	Trend IT	Trend LS
1986	5.22	5	2.74	1.71	99%	84%
1990	4.79	4	3.32	1.46	-27%	68%
1994	5.17	4	4.21	0.96	-19%	-3%
1998	6.53	6	4.57	1.94	180%	31%
2002	7.21	7	3.21	4	95%	-31%

Table 2: Firm size and composition by senior partners' experience quartiles and by investment trend quartiles

The unit of observation is firm-period. Senior partners' experience is the average number of years of experience of the senior partners in the firm at that period. The lower quartile of the average experience is 4, the median is 6, the upper quartile is 8 and the mean is 6.46. Investment trend captures the industry trends in the firm's field of specialization. For each firm-period observation, I calculate the weighted average of *Trend IT* and *Trend LS*, based on the number of investments the firm made in IT versus LS in that period (*Trend IT* and *Trend LS* are the proportional change between the previous sample period and the current sample period in the total number of investments made by California VC firms in Information Technology (IT) and Life Science (LS) companies). The lower quartile of investment trend is −0.41, the median is 0.38, the upper quartile is 0.95 and the mean is 0.41.

Panel A: Firm size and composition by senior partners' experience quartiles				
Quartile		Mean	SD	N
1	Senior Partners	2.17	.14	62
	Junior Partners	2.05	.29	62
	Total Partners	4.22	.31	62
2	Senior Partners	3.62	.31	29
	Junior Partners	1.83	.49	29
	Total Partners	5.44	.64	29
3	Senior Partners	4.56	.35	30
	Junior Partners	1.97	.36	30
	Total Partners	6.53	.51	30
4	Senior Partners	4.78	.37	37
	Junior Partners	3.21	.43	37
	Total Partners	8	.61	37
Panel B: Firm size and composition by investment trend quartiles				
Quartile		Mean	SD	N
1	Senior Partners	3.61	.32	39
	Junior Partners	1.43	.29	39
	Total Partners	5.05	.54	39
2	Senior Partners	3.51	.32	39
	Junior Partners	1.17	.23	39
	Total Partners	4.69	.40	39
3	Senior Partners	3.11	.27	45
	Junior Partners	3.86	.47	45
	Total Partners	6.98	.60	45
4	Senior Partners	3.88	.39	35
	Junior Partners	2.34	.25	35
	Total Partners	6.22	.46	35

Table 3: Poisson regression analyses of VC firm size and composition

The unit of observation is firm-period. The dependent variable in column (1) is the number of senior partners in the firm, in columns (2) and (3) the dependent variable is the number of junior partners, and in column (4) the total number of partners in the firm. *Senior partners' experience* is the average number of years of experience of the senior partners in the firm at that period. *Number of Seniors* is the number of senior partners in the firm. *Investment Trend* is the weighted average of *Trend IT* and *Trend LS*, based on the number of investments the firm made in IT versus LS in that period (*Trend IT* and *Trend LS* are the proportional change between the previous sample period and the current sample period in the total number of investments made by California VC firms in Information Technology (IT) and Life Science (LS) companies). Standard errors are clustered on firm identification. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels respectively. Coefficient standard errors are in parenthesis.

	Dep. Variable			
	(1)	(2)	(3)	(4)
	Num. of Seniors	Num. of Juniors	Num. of Juniors	Num. of Partners
Senior Partners' Experience	.124***	.039		.082***
	(.021)	(.032)		(.022)
Number of Seniors			.115***	
			(.028)	
Investment Trend	.157	.901***	.966***	.493***
	(.190)	(.245)	(.251)	(.182)
Period Dummies	Yes	Yes	Yes	Yes
Constant	.365*	-.174	-.405	.825***
	(.210)	(.283)	(.282)	(.199)
Obs	156	156	156	156

Table 4: Probit Regression of Partners' Spin-out

The unit of observation is partner-period. The sub-sample includes junior partner i's period t observation only if the partner is also observed in the full sample in period $t+1$. The dependent variable is a spin-out dummy which is equal to one if the partner is a member of a different firm in period $t+1$ and the firm with which he was affiliated in period t continued to operate in period $t+1$. *Continuing Partners* is the number of partners in period t in partner i's firm who stay in the industry in period $t+1$. *Investment Trend* is the weighted average of *Trend IT* and *Trend LS*, based on the number of investments the firm made in IT versus LS in that period (*Trend IT* and *Trend LS* are the proportional change between the previous sample period and the current sample period in the total number of investments made by California VC firms in Information Technology (IT) and Life Science (LS) companies). The marginal effects of the coefficients are reported. The standard errors of the Probit regression coefficients are in parenthesis. *, **, and *** denote their statistical significance at the 10%, 5%, and 1% levels, respectively. The probability to spin-out when the independent variables are equal to their mean value in specifications (1) and (2) are .051 and .041, respectively. There are 412 junior partners who are observed in the industry also in the following period, and 27 of them (7%) spin-out.

	(1)	(2)
Continuing Partners	.012***	.008**
	(.042)	(.046)
Investment Trend		.034
		(.606)
Period Dummies	Yes	Yes
Obs	412	368