Heejin Woo
Management and organization, Marshall School of Business, University of Southern California
March 30, 2012

NBER Entrepreneurship Working Group
National Bureau of Economic Research
NBER, Cambridge, MA 02138

Dear NBER Entrepreneurship Research Boot Camp

I am writing to apply for the 5th NBER Entrepreneurship Research Boot Camp (ERBC) which will be held from July 18 to July 21, 2012. I am a doctoral student at Marshall School of Business, University of Southern California, and pursuing Ph. D. degree in Strategic Management.

To support my application, please find enclosed:

(1) A cover letter for this application
(2) My curriculum vitae
(3) An essay on my motivation to the boot camp
(4) A writing sample
    - Paik, Y., and Woo, H., "*Economic Downturn and Financing Innovative Startup Firms*"

You should be also receiving a letter of recommendation from Professor Nandini Rajagopalan who is my advisor shortly.

My research interests are entrepreneurship and corporate governance. In a research project with Yongwook Paik, one of faculty members in my department, we study how macro-economic environment affects venture capitalists' financing. In the study, we argue that the nature of the economic downturn can cause differential effects on the investment pattern. More specifically, we find that venture capital firms invest more in early-stage companies than in later-stage companies when the amount of capital flowing into the market increases. We also find that venture capital firms invest less in early-stage companies than in later-stage companies during an economic downturn associated with the real sector and that they invest more in early-stage companies than in later-stage companies during an economic downturn associated with the financial sector. The enclosed essay details my current and future research projects in more detail.

I am very interested in this NBER Entrepreneurship Research Boot Camp and hope to have the opportunity to learn more about the field and meet scholars in the field through this opportunity. Please do not hesitate to contact me if you have any questions about my application or require further information. I look forward to hearing from you.

Sincerely,

Heejin Woo

USC
UNIVERSITY
OF SOUTHERN
CALIFORNIA

**Marshall School of Business**

Department of Management and Organization

March 30, 2012

To: NBER Entrepreneurship Research Boot Camp Selection Committee

I am very pleased to support our doctoral student, Heejin Woo's application to attend the 2012 NBER Entrepreneurship Research Boot Camp. I am his primary advisor in the doctoral program but he also works with other faculty in my department on different research projects. Heejin is in the second year of our program and is very interested in the entrepreneurship research area. He already has two projects at advanced stages and one of these projects (with Assistant Professor Yongwook Paik) has been awarded the 2012 Greif Research Award, attesting to its quality and potential for publication in a top-tier journal. Because we do not have a formal program in entrepreneurship, Heejin will greatly benefit from attending your rigorous research-focused program. Heejin is very motivated to do a dissertation in the area of entrepreneurship and is, to that end, already collaborating with faculty with similar research interests. He is extremely motivated and hard working and has done exceptionally well in the doctoral program in the two years to date.

I am collaborating on two empirical papers with Heejin (in the area of CEO succession) and he has shown remarkable theoretical maturity and empirical astuteness in both projects. I am confident that both papers will result in journal-quality submissions before the end of the academic year. However, his primary passion is clearly in entrepreneurship and that is where he needs to be exposed to cutting edge knowledge and research methods. Because we do not have a doctoral program in entrepreneurship he is not getting as much as he should by way of formal training in that area. I believe the NBER boot camp is precisely what he needs at this stage to build a solid foundation for his empirical work in entrepreneurship especially because the topic he is interested in, corporate venture capital, has an impressive set of literatures in finance and economics and I know the NBER boot camp is geared towards a finance and economics audience. Heejin will benefit immensely from a deep dive into the finance and economics literatures in entrepreneurship so that he can truly build a multi-theoretic understanding of this field in general, and of venture capital in particular.

In conclusion I strongly recommend Heejin Woo and hope you will grant him the opportunity to participate in and learn from the NBER entrepreneurship boot camp. If you have any further questions or I can provide additional information please feel free to email me at nrajagop@marshall.usc.edu or call me 213-740-0750.

Sincerely,

*Nandini Rajagopalan*

Nandini Rajagopalan
Capt. Henry W. Simonsen Chair in Strategic Entrepreneurship &
Professor of Management & Organization
Marshall School of Business, Univ. of Southern California

University of Southern California
Bridge Hall 306
Los Angeles, California 90089-0808
Tel: 213 740 0728
Fax: 213 740 3582
web page: www.marshall.usc.edu/mor/

**CURRICULUM VITA**
March 2012


# HEE JIN WOO

Marshall School of Business, University of Southern California
3670 Trousdale Parkway, BRI 306, Los Angeles, CA 90089-0808
Phone: (213) 344 – 9724 / Email: heejin.woo.2015@marshall.usc.edu


## EDUCATION

- Marshall School of Business, University of Southern California, Los Angeles, CA
  - Ph.D. student in Management and Organization (Strategic Management)
- Carlson School of Management, University of Minnesota, Minneapolis, MN
  - Master of Arts in Human Resources and Industrial Relations, May 2010
- Korea University Business School, Seoul, Korea
  - Bachelor of Business Administration, February 2005

## RESEARCH INTEREST

Entrepreneurship; Venture Capital; Corporate governance (Shareholders, CEO, Board of directors); Diversification; Merger & acquisitions; Inter-organizational relations

## WORKING PAPERS

- "Economic Downturn and Financing innovative startup firms" with Yongwook Paik
  (2012 Greif Center Faculty Research Awards; Accepted in the Faculty Research Development Workshop sessions at 2012 Atlanta Competitive Advantage Conference)
- "Exit decision of Corporate Venture Capitalists"; Status: first draft completed.

## WORK IN PROGRESS

- "Corporate Venture Capital Investment and a Venture's Strategic Alliances", Status: preparation for the manuscript.
- "Institutional change and Bank president selection: Evidence from 1887 to 1930 in the bank industry" with Qingyuan (Lori) Yue and Nandini Rajagopalan; Status: preparation for the manuscript.
- "How the board of directors learns from experience" with Jerayr (John) Haleblian and Nandini Rajagopalan; Status: data collection.

## DOCTORAL CONSOSIUM

- Smith Entrepreneurship Research Conference, University of Maryland, April 2012.
- Atlanta Competitive Advantage Conference Ph.D. Student Paper Development Workshop, Georgia State University, May 2012.

## WORKING EXPERIENCE

- HR Manager, SK Telecom, Seoul, Korea, 2005 – 2008; Managed Collective Bargaining, Labor-Management Conference and developed negotiation strategies
- Intern, New Telephone Corporation, Vladivostok, Russia, Jul – Aug 2004; Managed Korean mobile telecommunication industry benchmarking project

- Assistant Coordinator, North Shore Multicultural Society, North Vancouver, Canada, Nov – Dec 2003; Led outreach improvement project and children's education workshop

**DOCTORAL COURSEWORKS**

**At University of Minnesota (during Master degree)**

| | |
|---|---|
| Seminar in Organizations Theory | Andrew H. Van de Ven |
| Seminar in Strategy Content | Myles Shaver |
| Social Network Analysis: Theory and Methods | David Knoke |
| Statistical Methods II: Regression | Robert delMas |

**At University of Southern California (during PhD degree)**

| | |
|---|---|
| Seminar in Strategic Management | Nandini Rajagopalan & Kyle Mayer |
| Research Methods | Jennifer Overback |
| Applied Econometrics | Cheng Hsiao |
| Industrial Organization | Guofu Tan |
| Organization Theory | Peer Fiss |
| Seminar in Organizational Behavior | Peter Kim |
| Quantitative Methods and Statistics II | Timothy Biblarz |
| Regression and Generalized Linear Models | Peter Radchenko |
| Organizations and Communication Technologies | Janet Fulk |

**Application Essay – Heejin Woo (Heejin.woo.2015@marshall.usc.edu)**
Marshall School of Business, University of Southern California

**Motivation to the NBER Entrepreneurship Research Boot Camp**

My motivation to study entrepreneurship comes from my philosophy in academia. By studying entrepreneurship, I want to contribute to our society by helping practitioners such as business persons and policy makers find better ways to create value in society. I believe entrepreneurship is the key theme that can create values innovatively in our economy. Entrepreneurial trials are the efforts to make our economy more efficient and they also enable us to increase our utility level from creative innovation. In a wider perspective, entrepreneurship is a critical source to create jobs and improve productivity.

To realize this academic goal, I have studied Entrepreneurship actively. First, in the study that I am working with Yongwook Paik, an assistant professor in my department, we examine how fluctuations in the amount of capital flowing into venture funds affect the financing of innovative startup companies and how economic downturns affect such financing. We argue that the nature of the economic downturn can cause differential effects on the investment pattern. We find that venture capital firms invest more in early-stage companies than in later-stage companies when the amount of capital flowing into the market increases. We also find that venture capital firms invest less in early-stage companies than in later-stage companies during an economic downturn associated with the real sector and that they invest more in early-stage companies than in later-stage companies during an economic downturn associated with the financial sector. This study contributes to the entrepreneurship literature by demonstrating how macroeconomic factors affect venture capital investment decisions. The study also delineates the implications of seeking market entry via venture capital financing by entrepreneurial companies.

Second, I am interested in corporate venture capital (CVC). Previous studies show that corporate venture capitalists add value to start-up companies (e.g., Ivanov and Xie 2010, Park and Steensma 2012). Corporate venture capital firms can provide start-ups with technological and R&D support, product development assistance, manufacturing capacities, and access to marketing and distribution channels. However, so far little is known about '*how*' corporate venture capital investment can substantially contribute to the invested venture firms. In my second year paper, I investigate how CVC investment affects the invested startups' strategic alliances. In the pharmaceutical industry, I find that pharmaceutical corporations' investment in a startup is positively associated with the startup's strategic alliances. And interestingly, this relationship is mitigated when the startup is a pharmaceutical venture. This finding suggests that even though CVC investment can positively affect the invested venture's strategic alliances, the effect can be contingent on the venture's industry. Furthermore, I find a positive relationship between a venture's strategic alliance and its performance. This finding suggests the interorganizational benefits from CVC investment can be a source of value creation in CVC investment in startups. This study contributes to fill the research gap that has not examined the black box of '*how*' corporate venture capital investment can create value on ventures' performance.

As a strategy student, in my future research, I want to study what factors affect entrepreneurial firms' strategic decisions and how those factors impact the venture firms' performance. To achieve my research direction, I believe this NBER Entrepreneurship Research Boot Camp will be tremendously beneficial for the following reasons:

First, since my PhD program does not have entrepreneurship-focused coursework, this boot camp will help me better understand the entrepreneurship field broadly. PhD seminars deal with diverse topics and so learning a specific topic is limited. However, this topic specific research camp will allow me to concentrate on the topic intensively.

Second, although there are other entrepreneurship-related conferences that can help me learn what others are working on in the field, they are focused only on specific current studies. Meanwhile, this boot camp will give me an opportunity to discuss the entrepreneurship topic with seminal works in the field and to learn how the field has evolved.

Third, my research interests are corporate governance and entrepreneurship. Venture capital financing, which is one of the main topics in the boot camp, can be the overlap of two fields in that startups are significantly influenced by venture capital investors on their corporate governance issues such as board member composition and investor relations. Understanding venture capital financing issues better will help both my entrepreneurship study and corporate governance study.

Finally, networking with faculty participants and doctoral students from other schools will help me learn more about the field and how other scholars see and approach the field.

I am familiar with Economics and Finance broadly. I have studied Economics by taking several classes including Econometrics courses. Also, several courses that I have taken dealt with entrepreneurship topics such as innovation and organization creation. Thus, I am sure that I can benefit from the boot camp and at the same time I can contribute to the discussion in sessions.

**References**

Ivanov, Vladimir I, and Fei Xie. 2010. "Do Corporate Venture Capitalists Add Value to Start-Up Firms? Evidence from IPOs and Acquisitions of VC-Backed Companies." *Financial Management* 39(1):129–152.

Park, H.D., and H.K. Steensma. 2011. "When does corporate venture capital add value for new ventures?" *Strategic Management Journal*.

# Writing Sample

# Economic Downturn and Financing Innovative Startup Companies

Yongwook Paik[1]
Marshall School of Business
University of Southern California
3670 Trousdale Parkway, BRI 306
Los Angeles, CA 90089-0808
Yongwook.Paik@marshall.usc.edu

and

Heejin Woo
Marshall School of Business
University of Southern California
3670 Trousdale Parkway, BRI 306
Los Angeles, CA 90089-0808
Heejin.Woo.2015@marshall.usc.edu

## ABSTRACT

This study examines how fluctuations in the amount of capital flowing into venture funds affect the financing of innovative startup companies and how economic downturns affect such financing. We argue that the nature of the economic downturn can cause differential effects on the investment pattern. We find that venture capital firms invest more (less) in early-stage companies than in later-stage companies when the amount of capital flowing into the market increases (decreases). We also find that venture capital firms invest less in early-stage companies than in later-stage companies during an economic downturn associated with the real sector and that venture capital firms invest more in early-stage companies than in later-stage companies during an economic downturn associated with the financial sector. This study contributes to the entrepreneurship literature by demonstrating how macroeconomic factors affect venture capital investment decisions. The study also delineates the implications of seeking market entry via venture capital financing by innovative startup companies.

**Keywords:** Venture Capital, Entrepreneurial Finance, Fundraising, Innovative Startup Companies, Economic Downturn, Recession, Business Cycle

[1] Corresponding author. Email: Yongwook.Paik@marshall.usc.edu or phone: 213-740-7646.

## 1. INTRODUCTION

How do fluctuations in the amount of capital flowing into venture funds affect the financing of innovative startup companies, and how do economic downturns affect such financing? This question has significant implications for academics as well as practitioners, including venture capital firms and entrepreneurs, as we have just experienced a time dubbed The Great Recession, the most severe recession since the 1930s. Venture capital firms play a central role in financing innovative companies[2] (Hellman and Puri 2000, Kortum and Lerner 2000) and these companies' commercialization strategies (Hsu 2006, Nanda and Rhodes-Kropf 2012a, b). Hence, understanding how venture capital firms respond to fluctuations in the amount of capital flowing into venture funds and to economic downturns has substantial implications for innovative entrepreneurial firms seeking market entry through venture capital financing (Hellman and Puri 2000).

The literature regarding entrepreneurship and venture capital has borrowed heavily from corporate finance literature (Brealey and Myers 1984, Aghion and Bolton 1992, Dewatripont and Tirole 1994) and has largely relied on agency theory (Jensen and Meckling 1976) and the prevalence of asymmetric information (Akerlof 1970, Myers and Majluf 1984) in understanding the relationship between venture capital firms and entrepreneurs. One strand of literature has produced a great deal of research and focuses on the decision-making process of venture capital firms designing an optimal contract to alleviate moral hazard problems *ex post* selection of a startup company. For example, regarding entrepreneurial firms, Berglöf (1994), De Bettignies (2008) and Hellmann (1998) offer insight on financial contracting that provides an optimal allocation of control rights between venture capital firms and entrepreneurs to mitigate any moral hazard problems. Using evidence from boards of directors, Lerner (1995) examines the role of venture capitalists as monitors of private firms. Casamatta (2003) analyzes the joint effort of an entrepreneur and a venture capital firm to maximize the productivity of an investment project and argues that common stocks or convertible bonds can be used to implement an optimal incentive structure. Schmidt (2003) uses a sequential model, and Hellmann (2006) builds a model with double moral hazard to show why convertible securities can provide such an optimal incentive mechanism in venture capital contracts.

A second strand of the literature focuses on the decision-making process of venture capital firms selecting startup companies. The extant literature has examined how venture capital firms assess startup companies (Tyebjee and Bruno 1984, Macmillan et al. 1985, Shepherd 1999) by considering various economic and social characteristics of the founding team and the venture. Studies find that prior

[2] Throughout this paper, we use the term "firms" to refer to venture capital firms and use the term "company" to refer to an entrepreneurial company seeking venture capital investment.

experience in firm foundation, the educational attainment of the founders and social ties with venture capital firms can facilitate venture capital financing (Shane and Cable 2002, Shane and Stuart 2002, Baum and Silverman 2004, Hsu 2007). Studies also show that investment in costly signals (Amit et al. 1990), such as patents, serves as a strong indicator of quality (Hsu and Ziedonis 2011) and that personal connection, such as common ethnicity, drives matching of venture capital firms and startups (Bengtsson and Hsu 2010). These studies show that bridging information gaps between venture capital firms and startup companies is the most critical driver of venture capital financing and the matching of startup firms and venture capital firms. Eckhardt et al. (2006) draw from evolutionary economics to examine why some new ventures are more likely than others to be successfully awarded capital from external sources. Eckhardt et al. (2006) model venture financing as a staged selection process in which two sequential selection events systematically winnow the population of ventures and influence which ventures receive financing. For a venture to receive external financing, its founders must first self-select its venture as a candidate for external funding, and then, a financier must select it for investment in the second stage. The selection criteria differ in each stage. This strand of literature shows that heterogeneity across startup firms primarily drives the venture capital financing decision-making process.

However informative these prior studies are in understanding the relationship between venture capital firms and innovative firms, they still leave us wondering the extent to which external factors that are exogenous to both venture capital firms and entrepreneurial companies play a role. Because exogenous external factors affect all firms at every stage of the decision process, we cannot draw on the literature previously mentioned to shed light on their effects. The first strand of literature that we mentioned only sheds light on optimal contract design *given* the venture being selected by a venture capital firm, and the second strand of literature sheds light only on how venture capital firms initially screen ventures using factors that are *different* across startup companies. Despite the importance of external factors, such as economic cycles and fluctuations in the amount of capital flowing into venture funds, on venture capital investment decisions, external factors remain relatively understudied. This study aims to fill this gap in the literature by examining the effect of fluctuations in the amount of capital flowing into venture funds and the effect of economic downturns on the investment pattern of venture capital firms. The study also reveals how early-stage, innovative startup companies are consequently affected by the change in investment patterns of venture capital firms.

A growing body of literature examines how macro factors—such as the business cycle (Eesley et al. 2012), capital influx into venture funds (Gompers and Lerner 2000, Nanda and Rhodes-Kropf 2012b) or public market signals (Gompers et al. 2008)—affect venture capital firms or innovative startup companies. Eesley et al. (2012) find that innovative companies that were started during a recession have a performance advantage, and Gompers and Lerner (2000) show that an influx of capital into venture funds

increases the valuation of these funds' new investments, which is consistent with the theory that competition for a limited number of attractive investments causes rising prices. Nanda and Rhodes-Kropf (2012b) document that companies receiving their initial funding from venture capital firms during a period with abundant capital flowing into the market are more likely to fail but, conditional on success (going public), are valued more highly, have more patents and have more citations to their patents. Gompers et al. (2008) show that venture capitalists with the most industry experience increase their investments the most when public market signals, measured by industry Q and IPO activity, become more favorable. Adding to these studies, our study finds that venture capital firms invest more (less) in early-stage companies than in later-stage companies when the amount of capital flowing into the market increases (decreases). We also find that venture capital firms invest less in early-stage companies than in later-stage companies during an economic downturn associated with the real sector and invest more in early-stage companies than in later-stage companies during an economic downturn associated with the financial sector. These findings provide practical implications for the timing of market entry by innovative startup companies seeking venture capital financing. Our theoretical argument adds to the growing body of literature by showing that the cost of sorting and selecting new early-stage companies and the prospect of a favorable exit (e.g., IPO) play crucial roles in explaining the internal mechanism of venture capital investment patterns.

## 2. THEORY AND HYPOTHESES

The process venture capital firms use in raising capital and structuring funds is complex and has profound implications for the entrepreneur financing a company through venture capital (Sahlman 1990, Gompers and Lerner 2004). Limited partnership is the dominant form for venture funds. A venture capital firm serves as a financial intermediary and raises capital from limited partners, such as pension funds, insurance companies and endowments, and invests in innovative startup companies that are in either *early-stage* or *later-stage* and have high-growth potential (Hellman and Puri 2000, Gompers and Lerner 2004)[3]. We define early-stage companies as companies seeking first-round seed money or startup capital to get their venture off the ground. We define later-stage companies as companies that have already been funded by an investor in their early round but are seeking an additional round of financing for the purposes of growth and expansion. We use this distinction because the most common feature of venture capital investment involves financing young innovative companies in discrete stages over time, which

[3] Because venture capitalists are compensated by fixed management fees and carried interest (typically 20-25%), which shares net profit with limited partners beyond a hurdle rate (or after achieving a target IRR), venture capitalists will only consider investing in "high-growth" startup companies that can generate returns in excess of the hurdle rate.

includes periodically reevaluating the prospect of the venture (Gompers 1995, Bergemann and Hege 2005, Bergemann et al. 2011). Staging capital infusion allows venture capital firms to gather more information, monitor the progress of the firm and reduce agency costs (Jensen and Meckling 1976, Tyebjee and Bruno 1984, Gompers 1995, Shepherd 1999, Casamatta 2003, Cornelli and Yosha 2003). Hence, though this study treats the venture capital financing decision as a two-stage process for simplicity, the process actually has many stages.

When a venture capital firm selects an early-stage, innovative startup company from a pool of candidates, it engages in a costly selection process of due diligence before making any investment commitment (Tyebjee and Bruno 1984). At this stage, information asymmetry regarding the venture's prospect is severe because entrepreneurs have private information about their projects (De Bettignies 2008). Moreover, the probability of success is fairly low at this stage and likely to be lower than what the probability of success is for a more mature later-stage company. However, once the venture capital firm invests in the company, it has more interactions with it. These interactions provide information to the investors, and the venture capital firm adds value to the company through extensive mentoring and business referrals (Gorman and Sahlman 1989, Lerner 1995, Hsu 2004). As a result, the company matures, reduces uncertainty and becomes professionalized (Hellmann and Puri 2002). During this process, the venture capital firm learns more about the entrepreneur, learns more about the company and reduces informational friction. The venture capital firm also acquires a certain portion of control and ownership by investing in a company in the form of equity financing. The venture capital firm is thus able to extensively investigate and monitor the startup company (Hsu 2004, De Bettignies 2008).

When a venture capital firm invests in a later-stage company, an investor can evaluate the company's prospects more easily than he could evaluate the prospects of an entirely new, early-stage startup company because informational friction has been reduced[4]. A later-stage company that has matured and reached certain milestones has less uncertainty than a new, early-stage company that has a limited track record and many milestones to be accomplished. In essence, early-stage companies present a riskier investment than later-stage companies to venture capital investors.

We now consider how the macroeconomic environment can affect venture capital funding patterns. When there is an economic upturn or downturn, flows of capital into the market increase or decrease, respectively, resulting in an investment cycle (Gompers et al. 2008). Venture capital firms can more easily raise funds during "good times" and have more difficulty raising funds during "bad times" (Gompers and Lerner 2004). Conventional wisdom suggests that the influx of abundant capital into the

[4] In this context, it does not matter whether the same venture capital firm invests in both the early-stage and later-stage of the company in question.

market creates "money chasing deals," in which too much capital is seeking a limited number of attractive investments, resulting in higher valuation and more "junk" and "me-too" ventures (Gompers and Lerner 2000). This theory implies that more money in the market will result in more deals being funded. Conversely, less money in the market leads to fewer deals being funded. Furthermore, Nanda and Rhodes-Kropf (2012a) argue that the abundance of capital during periods of heated activity in the financing of startups may also allow investors to experiment more effectively. Their study argues that financing risk—the risk that future funding will not be available even if the expected value of the project, if fully funded, has not changed—plays a central role in the commercialization and diffusion of technology. Consistent with this argument, Nanda and Rhodes-Kropf (2012b) document that companies receiving their initial funding from venture capital firms during a period with abundant capital flowing into the market are more likely to fail but, conditional on success (going public), are valued more highly, have more patents and have more citations to their patents. This observation suggests that venture capital firms are shifting the type of startups that investors finance towards those that are riskier and innovative, i.e., projects that would not have been funded during "normal times." Hence, as early-stage companies present a riskier investment than later-stage companies to venture capital investors, we would expect venture capital firms to invest *more* (less) in early-stage companies than in later-stage companies when the amount of capital flowing into the market increases (decreases). Thus, we propose the following hypotheses.

*HYPOTHESIS 1a. Venture capital firms invest more in early-stage companies than in later-stage companies when the amount of capital flowing into the market increases.*

*HYPOTHESIS 1b. Venture capital firms invest less in early-stage companies than in later-stage companies when the amount of capital flowing into the market decreases.*

While an economic downturn leads to a decline in the amount of capital flowing into the venture community (Gompers and Lerner 2004) and, according to our previous discussion, reduces the level of investment by venture capital firms in early-stage companies relative to later-stage companies, the nature of the economic downturn, we argue, can have differential effects on how venture capital firms shift their investment patterns. We classify economic downturns into two types depending on the fluctuation of the amount of capital flowing into the venture capital market and how the public equity market responds

during this period[5]. There can be either i) a period in which the flow of capital into the market decreases and the public equity market signal *deteriorates*, or ii) a period in which the flow of capital into the market decreases but the public equity market signal *improves,* though there could be an initial decline in the public equity market at the beginning of any economic downturn. The key distinction separating these two scenarios hinges on whether the public equity market recovers during these two types of economic downturns. Because the public equity market, such as the NASDAQ, dictates the market for IPOs, which is the preferred exit strategy for venture capital firms, this distinction will lead to different insights.

As raising capital becomes more challenging for venture capital firms during economic downturns, venture capital firms end up with less capital available for investing purposes. When they have tight budget constraints, venture capital firms need to balance investments across different stages of companies to construct and manage a strong pipeline of projects to maximize return on investment. When the public market signal deteriorates, the valuations of companies decrease. The public equity market may consistently deteriorate if investors are largely unenthusiastic about companies' performances or about the future prospect of the market as a whole, which is often caused by an adverse supply shock or the bursting of an economic bubble. When sales do not meet investor expectations or the cost of producing goods increases (or both), investors become disappointed regardless of whether expectations were unrealistic or the cost of raw materials drastically increased (e.g., oil shock). An economic downturn of this type is associated with the real sector[6], as opposed to the financial sector.

An unfavorable public equity market implies that the exit value, via an IPO or acquisition, of a company backed by a venture capital firm decreases during this period. Hence, venture capital firms may choose to refinance companies that are mature enough to exit but need to wait longer until the public equity market again becomes favorable for exit. This strategy leaves less capital to invest in early-stage companies and signals a delayed exit. In addition, the necessary amount of investment committed to later-stage companies is typically greater than the amount necessary for early-stage companies because of the increase in scale of the venture's operation[7]. Venture capital firms thus may be left with limited capital for

[5] By public equity market, we mean the "stock market" as measured by indices such as the Dow, NASDAQ, or the S&P 500.

[6] The "real sector" refers to the part of the economy that is concerned with actually producing goods and services, as opposed to the part of the economy that is concerned with buying and selling on the financial market (Financial Times Lexicon).

[7] This assumption is confirmed in our sample. In our sample, the average amount of early-stage funding, which includes both "seed money" and "startup capital," was approximately $1.8 million, while the average amount of later-stage funding was approximately $3.2 million. The difference between the two means was statistically significant at any conventional level (t-test=26.67).

investment in early-stage companies. Moreover, the task of sorting and selecting a promising early-stage company becomes ever more challenging for venture capital firms when the market loses faith in the real sector in which the venture capital firms actively invest. New startup companies may find it more challenging to find investors, customers or collaborative partners in such an environment. Increased uncertainty for early-stage startup companies may imply an increase in failure rate (not just delayed maturation), especially when companies expect several initial years of negative earnings. Therefore, venture capital firms prefer to refinance later-stage companies until the public equity market again becomes favorable for IPO rather than to invest in new early-stage companies because of increased uncertainty and increased cost of selection. This result reinforces the shift in financing patterns and suggests shying away from investing in early-stage companies during an economic downturn associated with the real sector. Thus, we propose the following hypothesis.

*HYPOTHESIS 2. Venture capital firms invest less in early-stage companies than in later-stage companies during an economic downturn associated with the real sector.*

When an economic downturn is *not* driven by the real sector but possibly by the financial sector[8], the flow of capital into the market decreases, but the public equity market signal eventually improves[9]. The public equity market signal recovers quickly because there is no fundamental change in the prospects of companies, excluding financial institutions. Aside from the financing risk (Nanda and Rhodes-Kropf 2012a, b) associated with the decline in the amount of capital flowing into the venture community, there is less adverse change in the cost of sorting and selecting a promising startup company and less additional risk of finding customers or collaborative partners during an economic downturn associated with the financial sector than during an economic downturn associated with the real sector. Instead, a decline in the amount of capital flowing into the venture community will lower the valuation of startup companies (Gompers and Lerner 2000). It thus becomes cheaper to finance early-stage companies. This result implies that venture capital firms can invest in a greater number of early-stage deals at a discount using the same amount of capital. In addition, unlike an economic downturn associated with the real sector, an economic downturn associated with the financial sector allows the public equity market to recover quickly and allows later-stage companies to exit favorably without much injection of capital for a prolonged exit process. Hence, rather than using such additional capital to invest in later-stage companies, venture capital firms can benefit more from investing in a greater number of early-stage startup companies to maintain a strong pipeline of projects. Thus, we propose the following hypothesis.

[8] Financial crisis, banking crisis, savings and loan crisis, credit crunch, etc.

[9] This is confirmed by our data.

*HYPOTHESIS 3. Venture capital firms invest more in early-stage companies than in later-stage companies during an economic downturn associated with the financial sector.*

## 3. DATA AND METHODOLOGY

### Data

To test our hypotheses, we used the Thomson Financial Venture Economics database to construct a sample of innovative companies receiving venture capital financing from 1987 to 2010. These data have been broadly used in academic studies on venture capital (Gompers 1995, Dushnitsky and Lenox 2005, Hsu 2006, Chatterji 2009, Nanda and Rhodes-Kropf 2012b). Our sample includes investments made by independent venture capital firms (VCs), corporate venture capital firms (CVCs), bank affiliated groups, and others. These other investments are made mostly by individuals, angel groups, or government-affiliated programs[10]. Firms that have received financing exclusively from individual investors, federally chartered Small Business Investment Companies and corporate development groups are not included in the dataset (Gompers and Lerner 2000). We want to examine how venture capital firms invest differently depending on the economic environment, so we use venture capital firm year as our unit of analysis. An investment in later-stage startup companies may or may not have been initially financed by the focal venture capital firm during the venture's first round of financing. Though our study does not have a minimum requirement concerning the number of years a venture capital firm has operated, firms that invested only one year during the entire sample period will be dropped when we add lagged variables into our regression analysis. In the end, we end up with unbalanced panel data that have 3,836 venture capital firms and 29,732 venture capital firm year observations.

### Variable Description

**Dependent Variable.** We count the number of investments in early-stage startup companies and later-stage startup companies to construct our dependent variable. We count how many early-stage and later-stage investments each venture capital firm made in a given year. The Venture Economics database categorizes a startup company's financing as Startup/Seed, Early Stage, Later Stage, Expansion, Buyout/Acquisition, and Other. We classify the first two as "Early-stage investment" and the remaining categories as "Later-stage investment." To illustrate the overall trend in the venture capital market, Figure 1 shows the number of investments in early-stage startup companies and later-stage startup companies

[10] Independent VCs (68.14%), CVCs (12.80%), bank-affiliated groups (7.66%) and others (11.40%).

aggregated across venture capital firms by year. For each venture capital firm, we construct a ratio ($r$) of the number of early-stage investments to the total number of investments (i.e., the sum of number of investments in early-stage and later-stage startup companies) made in a given year. As the ratio varies between 0 and 1, we measure how much a venture capital firm focuses on early-stage investments relative to later-stage investments. To illustrate the overall trend in the venture capital market, Figure 2 shows the ratio of number of early-stage investments to total investments aggregated across venture capital firms by year (solid line). The dependent variable in our regression analyses, *Early Ratio Count,* is, of course, at the venture capital firm level (not aggregate) and is a log transformation of the ratio because the ratio itself is bounded between 0 and 1. Specifically, we use the following transformation to allow our dependent variable to vary between [-∞, ∞] and interpret our coefficient estimates accordingly.

$$Early\ Ratio\ Count = log\left[\frac{r}{1-r}\right]$$

**Independent Variables**. We use the volatility in the aggregate amount of capital flowing into the venture community, adjusted for inflation, to test how volatility affects venture capital firms' investment decision-making patterns. Specifically, we use the growth rate in the amount of capital flowing into venture capital funds as our independent variable, called *Capital Growth Rate*. We construct the growth rate by aggregating the amount of funds raised across venture capital firms by year[11], and we compute it as the change in amount of funds raised compared with the previous year's amount, divided by the amount of funds raised in the previous year. Estimating the effect of *Capital Growth Rate* on our dependent variable will allow us to test Hypothesis 1.

Next, we define economic downturns for the purpose of this study by utilizing our measure of volatility in the amount of capital flowing into the venture community. We identify periods where the capital flowing into the market shrinks (yielding a negative growth rate) for two consecutive periods. We do not define economic downturns by a one-period decline in capital flowing into the market because our *Capital Growth Rate* uses annual data and will display no variation within the period when it is interacted with the *Capital Growth Rate*[12]. As shown in Figure 3, these periods correspond to years 1990 to 1991, 2001 to 2002, and 2009 to 2010. These three periods show reduction in the amount of capital flowing into the market for two consecutive periods and closely correspond to the NBER classification of an economy-

[11] For most venture capital firms, capital is raised sparsely across years, which leads to several years between successive fundraising activities.

[12] We use alternative definitions as a robustness check, and they all show qualitatively similar results.

wide recession[13] with some lag. The three periods correspond, respectively, to what are colloquially known as the "savings and loan crisis," "dot-com crash," and the "financial crisis" (Akerlof and Shiller 2009)[14]. We construct dummy variables for each period, namely, *S&L crisis*, *Dot-com crash*, and *Financial crash*, respectively[15]. We also note that the public equity market during the sample period was volatile. We measure these market signals by the Dow, S&P 500, and the NASDAQ indices[16]. Figure 3 shows the overall trend in capital flowing into the venture capital funds measured by aggregate fundraising activity (solid line) and the three public equity market indices, normalized using the 1987-level and adjusted for inflation. Figure 3 illustrates that the level of venture capital fundraising closely follows the pattern of the broader market indices. In fact, we find correlations between fundraising and S&P, Dow, and NASDAQ of 0.73, 0.67 and 0.71, respectively. In essence, our definition of economic downturn aligns with the NBER classification as well as stock market volatility. However, when we look closely at the "savings and loan crisis" period, the three public equity market signals eventually improve (1991-level is higher than 1989-level) after an initial decline, but the fundraising activity shrinks for two consecutive years. Similarly, during the "financial crisis" period, all three public equity market indices improve, while the fundraising activity shrinks for two consecutive years. From these results, we see that these two periods can be classified as economic downturns associated with the financial sector. On the other hand, when we look at the period of the "dot-com crash," we notice that fundraising activity declines for two consecutive periods and all three public market indices decline for two consecutive periods as well. These results suggest that this period can be classified as an economic downturn associated with the real sector. Therefore, in order to test Hypotheses 2 and 3, we estimate the effect of

[13] While the conventional wisdom defines recession in terms of two consecutive quarters of decline in real GDP, the NBER does not define a recession in this manner. Rather, NBER uses several market signals to determine the dates of peaks and troughs of a business cycle. According to NBER, there were three official recessions during our sample period (July 1990 - Mar 1991, Mar 2001 - Nov 2001, and Dec 2007 - Jun 2009).
http://www.nber.org/cycles/cyclesmain.html

[14] "The S&L crisis was ultimately responsible for a considerable amount of the economic turmoil that disturbed the economy during the recession of 1990-1991…it affected the stock market and our trust in the whole financial sector…along with [the recession that began in December 2007] there was a loss of confidence in the financial sector" Akerlof and Shiller (2009).

[15] We use an alternative definition for *Financial crash* that includes years 2008 to 2010 to pick up the effect of the subprime mortgage crisis, and the results are qualitatively similar (results available upon request).

[16] The correlation between the Dow and S&P 500 is 0.97, the Dow and NASDAQ is 0.91 and S&P 500 and NASDAQ is 0.94.

the interaction terms *S&L crisis* × *Capital Growth Rate*, *Dot-com crash* × *Capital Growth Rate* and *Financial crash* × *Capital Growth Rate* on our dependent variable.

**Control variables.** We include additional time-varying variables in our regression analyses to control for alternative explanations that might account for the observed pattern. Because more experienced venture capital firms might have differential access to investment opportunities in both early-stage and later-stage startup companies, we control for venture capital firm experience by constructing a measure that is consistent with prior studies (Gompers et al. 2010). More experienced firms might have easier access to fundraising or may be able to sort and select early-stage firms better than less experienced firms. At the same time, more experienced firms might have a stronger network in the venture community that may enable them to have better access to later-stage companies that were initially funded by other venture capital firms. We use the variable *VC Experience* to represent the log of the total number of investments made by a venture capital firm prior to the time of investment in question, a practice that follows prior studies (Gompers et al. 2010). We include this variable as a control without knowing *a priori* whether it has a positive or negative effect on our dependent variable.

We also control for venture capital firms' degree of specialization or diversification. Venture capital firms that are specialized in certain industries may face industry-specific waves of investment opportunities, while a diversified firm may face a more balanced flow of investment opportunities. We construct a measurement of the degree of portfolio diversification in terms of industries in which the venture capital firm invested, *VC Specialization*, which is similar to the Herfindahl-Hirschman Index (HHI). Following Gompers et al. (2008), we classify startup companies into nine industries – Biotech & Healthcare, Business & Industrial, Business Services, Communications & Electronics, Consumer, Energy, Financial Services, Internet & Computer, and Others. Then, we use the following formula to construct our measure.

$$VC\ Specialization_{it} = \sum_{j=1}^{9} s_{jt}^2$$

where $s_{jt}$ is the share of startup companies in industry $j$ that firm $i$ invested in during year $t$. Hence, if this index is one, the venture capital firm made investments in only one industry category in that year. We also include a lagged dependent variable as our independent variable to mitigate the omitted variables problem and to adjust for serial correlation in our regression analyses (Wooldridge 2002).

**Method**

Because we believe unobserved firm heterogeneity can be correlated with our explanatory variables, we use the fixed-effects panel data regression model in our analyses. In all of our regression models, Hausman specification tests support our choice of fixed-effects models over random-effects models (Hausman 1978)[17]. However, as firm fixed-effects models condition on within-firm variation only, we also conducted robustness checks with random-effects models and found no substantive differences in the results. Fixed-effects models are not without their drawbacks. Fixed-effects models rely only on time-varying variables and may frequently have too many cross-sectional units of observations, requiring too many dummy variables for their specification. Too many dummy variables may sap the model of a sufficient number of degrees of freedom for adequately powerful statistical tests. Moreover, a model with many such variables may be plagued with multicollinearity, which increases standard errors and thereby drains the model of the statistical power to test parameters[18].

Robust standard errors and clustering at the venture capital firm level are used throughout our regression analyses. We attempt to estimate a regression model of the following general form:

$$\begin{aligned} \textit{Early Ratio Count}_{it} = {} & \beta_0 + \beta_1 \textit{Capital Growth Rate}_t \\ & + \beta_2 \textit{S\&L crisis} + \beta_3 \textit{Dot-com crash} + \beta_4 \textit{Financial crash} \\ & + \beta_5 \textit{S\&L crisis} \times \textit{Capital Growth Rate}_t \\ & + \beta_6 \textit{Dot-com crash} \times \textit{Capital Growth Rate}_t \\ & + \beta_7 \textit{Financial crash} \times \textit{Capital Growth Rate}_t \\ & + \beta_8 X_{it} + a_i + \varepsilon_{it} \end{aligned}$$

where $X_{it}$ is a set of control variables for firm $i$ in year $t$, $a_i$ is the firm fixed effect, and $\varepsilon_{it}$ is the error term, which is clustered by firm. Because our sample period has only three economic downturns, our main empirical strategy is to use a large sample of cross-sectional venture capital firms, observe how each firm responded during these economic downturns and aggregate the effect across firms instead of using a time series model.

Table 1 shows our variable definitions with summary statistics, and Table 2 shows the pairwise correlation matrix of the variables used in this study. Because we use panel data, Table 1 presents descriptive statistics of the mean value of the variables within venture capital firms (Shaver 2011). The column "mean" presents the mean value of the within-firm mean. Namely, we first take the average value of the variable for a firm across the years in the sample. Then, we average these values and present them

[17] Prob>$\chi^2$=0.000 in all regressions.

[18] Available at http://www.nyu.edu/its/pubs/connect/fall03/yaffee_primer.html

in the table. The column "St.d." presents the mean value of the within-firm standard deviation. We calculate the standard deviation for a firm across the sample years and then average these values.

## 4. EMPIRICAL RESULTS

Table 3 presents our main regression results, using the dependent variable *Early Ratio Count*. Note that the direction our dependent variable moves is equivalent to the direction that early ratio *r* moves. Specification (1) shows that *Capital Growth Rate* is positively associated with investing more in early-stage startup companies than in later-stage startup companies. This result implies that more capital flowing into the market, or more aggregate fundraising activity, leads to the financing of more early-stage startup companies than later-stage companies. Conversely, less capital flowing into the market leads to fewer early-stage startup companies being financed than later-stage companies. Our result is consistent across all specifications in Table 3 with the inclusion of all independent variables and control variables. The coefficient is statistically significant in all specifications. Hence, our data is consistent with Hypotheses 1a and 1b.

Because the dependent variable is a nonlinear function of early ratio *r*, the marginal effect of the estimated coefficient on *r* is not visibly clear from Table 3. Instead, we use the mean value of the variables to illustrate the marginal effect. For example, using the mean value of the early ratio r, we assume there is an increase in capital growth rate by one standard deviation (=0.345). Then, the dependent variable increases by 0.345×0.358=0.124 according to specification (1) in Table 3. Using an inverse log-transformation, and assuming that the early ratio was at its mean value, we find that the early ratio increases from 0.314 (the mean value) to 0.341. In other words, if 100 companies were being funded in a given year, approximately 34 of them—instead of 31 of them—would be newly funded early-stage companies. This result shows a 9% increase in the financing of early-stage startup companies. We believe these numbers are economically significant.

To test Hypothesis 2, we look at the estimated coefficient of the interaction term in specification (3). The estimated coefficient is *positive* and statistically significant. Given that the capital growth rate is *negative* during the "dot-com crash" period, the interaction term implies that less capital flowing into venture funds leads to a decline in the early ratio. Public market signals also are deteriorating during this period, which suggests an economic downturn associated with the real sector. Hence, our finding implies that venture capital firms invest in fewer early-stage companies during an economic downturn associated with the real sector. Therefore, the data is consistent with Hypothesis 2.

Using the mean value of our explanatory variables and the mean value of the capital growth rate during economic downturns (-46.65%), we find that the marginal effect of the interaction term in

specification (3) yields a decrease in the early ratio from 0.314 to 0.044, which is a decrease of 86% in the financing of early-stage startup companies. Hence, the marginal effects are economically significant.

To test Hypothesis 3, we look at specifications (2) and (4). In specification (2) of Table 3, we find that the coefficient of the interaction term is *negative* and statistically significant. The capital growth rate during the "savings and loan crisis" is *negative*, which implies that, during an economic downturn associated with the financial sector, less capital flowing into the market leads venture capital firms to invest more in early-stage startup companies. Similarly, in specification (4), we find that the coefficient of the interaction term is again *negative* and statistically significant. This result implies that the decline in capital flowing into venture funds during the financial crisis increased the number of early-stage startup companies being financed by venture capital firms. Both the "savings and loan crisis" and the "financial crisis" periods display quick improvement in public equity market signals. Our findings are consistent with the fact that venture capital firms finance more early-stage firms because it becomes cheaper to purchase equity in early-stage companies during an economic downturn associated with the financial sector than during other times. Moreover, venture capital firms do not need to inject much capital for a prolonged exit process for later-stage companies. Hence, our data is consistent with Hypothesis 3.

Again, using the mean value of our explanatory variables and the mean value of the capital growth rate during economic downturns (-46.65%), we find the marginal effect of the interaction term in specification (2) yields an increase in the early ratio from 0.314 to 0.720, which is an increase of 129% in the financing of early-stage startup companies. The marginal effect of the interaction term in specification (4) yields an increase in the early ratio from 0.314 to 0.999, which is a 218% increase in the financing of early-stage startup companies. Hence, the marginal effects are economically significant.

Specification (5) shows inclusion of all interaction terms in our regression model. The coefficients have a qualitatively similar pattern as in specifications (1)-(4) and support all Hypotheses (1a, 1b, 2 and 3). The Lagged dependent variable is positively associated with the current dependent variable and is statistically significant, which implies that the current early ratio follows the pattern of the previous period with a dampening effect (approximately 0.078~0.082). *VC Experience* and *VC Specialization* both show negative effects and are statistically significant. These results are consistent with the fact that, because of their stronger network in the venture community, more experienced venture capital firms have better access to later-stage companies that were initially funded by other investors. Network and syndication is an important factor that drives venture capital investment decisions (Lerner 1994, Brander et al. 2002, Hochberg et al. 2007). More specialized firms have fewer opportunities than well-diversified venture capital firms to invest in early-stage startup companies because more specialized firms are susceptible to waves of industry-specific investment opportunities.

As a robustness check, we propose another way to test the mechanism behind our hypothesis because our sample has only one economic downturn associated with the real sector. If venture capital firms shift their investment patterns and begin favoring investments in later-stage companies because of an increase in the cost of sorting and selecting early-stage startup companies, we should be able to observe venture capital firms investing in fewer early-stage companies than later-stage companies when there is more entrepreneurial activity because of an increase in the cost of sorting and selecting, all else being equal. This scenario differs from a simple increase in the number of entrepreneurs being funded because there is more capital flowing into the market because of increased opportunities during a period when there is more entrepreneurial activity. Rather, with the same amount of capital available, more entrepreneurial activity will make it more costly (and possibly unlikely) to select the most promising project and would make investors benefit more from investing in more mature, later-stage companies. Increased competition for early-stage companies also makes them less likely to succeed. Therefore, we construct a measure *Entrepreneurship Activity* by using data from the Kauffman Index of Entrepreneurial Activity, which is available only from 1996 through 2010. Hence, we are forced to restrict our sample period to 1996 to 2010 when this variable is introduced in our analyses. Table 4 shows our results. The estimated coefficient on *Entrepreneurship Activity* is negative and statistically significant. This result implies that when there are more entrepreneurs, all else being equal, it is costlier for investors to select the most promising projects. The result is consistent with the main mechanism behind Hypothesis 2. We do lose some statistical power with a shorter sample period because of the inclusion of this variable, but the results are qualitatively similar to the results in Table 3. In essence, our empirical analyses support our hypotheses.

## 5. CONCLUSION

This study examines how fluctuations in the amount of capital flowing into venture funds affect the financing of innovative startup companies and how economic downturns affect such financing. We hypothesize that venture capital firms invest more (less) in early-stage companies than in later-stage companies when the amount of capital flowing into the market increases (decreases). This results because early-stage companies present a riskier investment than later-stage companies and because investors can "experiment" with riskier and innovative projects that would not have been funded during "normal times" when there is more capital available (Nanda and Rhodes-Kropf 2012a). We also argue that the nature of the economic downturn can have differential effects on the investment pattern. We hypothesize that venture capital firms invest less in early-stage companies than in later-stage companies during an economic downturn associated with the real sector and invest more in early-stage companies than in later-stage companies during an economic downturn associated with the financial sector. During an economic

downturn associated with the real sector, the public equity market consistently deteriorates because investors are largely unenthusiastic about companies' performances or about the future prospects of the market as a whole. Hence, venture capital firms prefer, because of increased uncertainty and increased cost of selection, to refinance later-stage companies until the public equity market again becomes favorable for IPO rather than investing in new, early-stage companies. On the other hand, during an economic downturn associated with the financial sector, the public equity market recovers and improves quickly because there is no fundamental change in the prospect of companies even though the amount of capital flowing into the venture community decreases and the valuation of companies is lowered (Gompers and Lerner 2000). Hence, venture capital firms can invest in more early-stage deals at a discount without injecting much capital into later-stage companies for a prolonged exit process. We find that our empirical analyses are largely consistent with the hypotheses.

Our study contributes to the entrepreneurship and venture capital literature by being one of the first studies to consider how macroeconomic factors affect venture capital investment decisions, a largely understudied area in the literature. Our study adds to the growing debate on how external factors exogenous to the entrepreneurial company and venture capital firm affect them. For example, Eesley et al. (2012) find that innovative companies that were founded during a recession have a performance advantage and suggest that entrepreneurs may need to consider where their companies are in the economic cycle at the time of their founding when making strategic decisions. Regarding the importance of venture capital funding for innovative firms, our study suggests that innovative firms may have to consider the nature of the economic cycle to even successfully enter the market. This study also complements the findings of Hsu (2004), which finds that entrepreneurs prefer financing from reputable venture capital firms than from others when they have multiple financing offers. Our study suggests that entrepreneurs can carefully choose the timing of venture capital financing by considering macroeconomic business cycles to maximize their chance of getting multiple offers. We also provide a theoretical mechanism regarding how venture capital firms shift their investment patterns depending on the amount of capital flowing into the market and the nature of economic downturns. Our empirical findings based on this theoretical argument are largely consistent with the financing risk theory proposed by Nanda and Rhodes-Kropf (2012a) and the empirical findings of Nanda and Rhodes-Kropf (2012b) and Gompers et al. (2008), but we also explain why the nature of the economic downturn can have differential effects on the investment patterns of venture capital firms. Here, the cost of sorting and selecting new early-stage companies and the prospect of a favorable exit (e.g., IPO) play a crucial role in showing the internal mechanism of venture capital firm investment patterns.

Our study provides practical implications for resource allocation in innovative startup companies. For example, our study implies that innovative startup companies seeking market entry during the recent

financial crisis may have had a better chance of securing financial resources from venture capital firms than their counterparts that were entering the market during the recession following the "dot-com crash[19]." This result suggests that entrepreneurs should not be discouraged from starting a new, innovative business seeking venture capital during an economic downturn associated with the financial sector. The literature notes that market entry timing is an important strategy as well as an entrepreneurial skill (Gompers et al. 2010), and our study illuminates how entrepreneurs can be better informed for market entry. Furthermore, if we extend our theory and treat the staging of venture capital financing as a three-stage process, namely financing early-stage companies (i.e., not yet financed), later-stage companies (i.e., mature enough to exit) and intermediate-stage companies (i.e., venture-backed companies far from exit), our theory implies that intermediate-stage companies that secured venture capital financing *prior* to the financial crisis may suffer when trying to secure another round of financing *after* the financial crisis because venture capital firms prefer to fund new, early-stage startup companies at a discount and let mature, later-stage companies exit but may become impatient with intermediate-stage companies—which require a lot more capital than early-stage companies—because of limited available capital.

Our study is not without limitations. First, our sample period has a limited number of economic downturns. While this limitation is beyond the researcher's control, ideally we should have more recessions during our sample period (for the purpose of research) or have reliable panel data with a longer time horizon. The oil shock of the 1970s provides a good setting for an economic downturn associated with the real sector, as the cost of production increased drastically across many industries. Unfortunately, the venture capital industry was not as well developed then as it is today, and the lack of reliable data for that period limits our ability to study it. It may be possible to test our theory in other countries. Second, our study does not consider the exact amount invested by venture capital firms. Hence, our study does not reveal the amount of financial resources being allocated to innovative companies depending on macroeconomic environment. To determine these figures, we would need to have capital disbursement data per financing round at the venture capital firm level for each company invested. Third, our study does not consider alternative sources of financing, such as loans from banks. Hence, to the extent that these institutions can provide alternative sources of financial resources to innovative firms, it is important to consider whether macroeconomic factors shift these alternative sources as substitutes or complements to entrepreneurs seeking resources. Future studies can explore these issues.

[19] Groupon.com is an example of an internet company that was founded in November 2008 that successfully secured venture capital financing for market entry, which may not have been easy immediately after the dot-com bubble.

References


Aghion, P., P. Bolton. 1992. An incomplete contracts approach to financial contracting. *Rev. Econom. Stud.*. **59**(3) 473-494.

Akerlof, G. A. 1970. The market for "lemons": Quality uncertainty and the market mechanism. *Quart. J. Econom*. **84**(3) 488-500.

Akerlof, G. A., R. J. Shiller. 2009. *Animal spirits: How human psychology drives the economy, and why it matters for global capitalism*. Princeton University Press.

Amit, R., L. Glosten, E. Muller. 1990. Entrepreneurial ability, venture investments, and risk sharing. *Management Sci*. **36**(10) 1233-1246.

Baum, J. A. C., B. S. Silverman. 2004. Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. *J. Bus. Venturing*. **19**(3) 411-436.

Bengtsson, O., D. H. Hsu. 2010. How do venture capital partners match with startup founders? , Unpublished Working paper.

Bergemann, D., U. Hege. 2005. The financing of innovation: Learning and stopping. *RAND J. Econom*. **36**(4) 719-752.

Bergemann, D., U. Hege, L. Peng. 2011. Venture capital and sequential investments. Cowles Foundation Discussion Paper No. 1682RR..

Berglöf, E. 1994. A control theory of venture capital finance. *J. Law, Econom.,Organ*. **10**(2) 247-267.

Brander, J. A., R. Amit, W. Antweiler. 2002. Venture-capital syndication: Improved venture selection vs. The value-added hypothesis. *J. Econ. & Mgmt. Strategy*. **11**(3) 423-452.

Brealey, R. A., S. C. Myers. 1984. *Principles of corporate finance*. McGraw-Hill.

Casamatta, C. 2003. Financing and advising: Optimal financial contracts with venture capitalists. *J. Finance*. **58**(5) 2059-2085.

Chatterji, A. K. 2009. Spawned with a silver spoon? Entrepreneurial performance and innovation in the medical device industry. *Strategic Management J*. **30**(2) 185-206.

Cornelli, F., O. Yosha. 2003. Stage financing and the role of convertible securities. *Rev. Econom. Stud.* **70**(1) 1-32.

De Bettignies, J.-E. 2008. Financing the entrepreneurial venture. *Management Sci*. **54**(1) 151-166.

Dewatripont, M., J. Tirole. 1994. A theory of debt and equity: Diversity of securities and manager-shareholder congruence. *Quart. J. Econom*. **109**(4) 1027-1054.

Dushnitsky, G., M. J. Lenox. 2005. When do firms undertake r&d by investing in new ventures? *Strategic Management J*. **26**(10) 947-965.

Eckhardt, J. T., S. Shane, F. Delmar. 2006. Multistage selection and the financing of new ventures. *Management Sci*. **52**(2) 220-232.

Eesley, C. E., D. H. Hsu, E. B. Roberts. 2012. Bringing entrepreneurial ideas to life. *The Wharton School, Management Department Working Paper (October 2011).* .

Gompers, P., A. Kovner, J. Lerner, D. Scharfstein. 2008. Venture capital investment cycles: The impact of public markets. *J. Financial Econom*. **87**(1) 1-23.

Gompers, P., A. Kovner, J. Lerner, D. Scharfstein. 2010. Performance persistence in entrepreneurship. *J. Financial Econom*. **96**(1) 18-32.

Gompers, P., J. Lerner. 2000. Money chasing deals? The impact of fund inflows on private equity valuation. *J. Financial Econom*. **55**(2) 281-325.

Gompers, P. A. 1995. Optimal investment, monitoring, and the staging of venture capital. *J. Finance*. **50**(5) 1461-1489.

Gompers, P. A., J. Lerner. 2004. *The venture capital cycle*. MIT Press, Cambridge, Mass.

Gorman, M., W. A. Sahlman. 1989. What do venture capitalists do? *J. Bus. Venturing*. **4**(4) 231-248.

Hausman, J. A. 1978. Specification tests in econometrics. *Econometrica*. **46**(6) 1251-1271.

Hellman, T., M. Puri. 2000. The interaction between product market and financing strategy: The role of venture capital. *Rev. Finan. Stud.*. **13**(4) 959-984.

Hellmann, T. 1998. The allocation of control rights in venture capital contracts. *RAND J. Econom*. **29**(1) 57-76.
Hellmann, T. 2006. Ipos, acquisitions, and the use of convertible securities in venture capital. *J. Financial Econom*. **81**(3) 649-679.
Hellmann, T., M. Puri. 2002. Venture capital and the professionalization of start-up firms: Empirical evidence. *J. Finance*. **57**(1) 169-197.
Hochberg, Y. V., A. Ljungqvist, Y. Lu. 2007. Whom you know matters: Venture capital networks and investment performance. *J. Finance*. **62**(1) 251-301.
Hsu, D. H. 2004. What do entrepreneurs pay for venture capital affiliation? *J. Finance*. **59**(4) 1805-1844.
Hsu, D. H. 2006. Venture capitalists and cooperative start-up commercialization strategy. *Management Sci*. **52**(2) 204-219.
Hsu, D. H. 2007. Experienced entrepreneurial founders, organizational capital, and venture capital funding. *Res. Pol.* **36**(5) 722-741.
Hsu, D. H., R. H. Ziedonis. 2011. Strategic factor markets and the financing of technology startups: When do patents matter more as signaling devices? , Unpublished Working paper.
Jensen, M. C., W. H. Meckling. 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. *J. Financial Econom*. **3**(4) 305-360.
Kortum, S., J. Lerner. 2000. Assessing the contribution of venture capital to innovation. *RAND J. Econom*. **31**(4) 674-692.
Lerner, J. 1994. The syndication of venture capital investments. *Finan. Manage.*. **23**(3) 16-27.
Lerner, J. 1995. Venture capitalists and the oversight of private firms. *J. Finance*. **50**(1) 301-318.
Macmillan, I. C., R. Siegel, P. N. Subbanarasimha. 1985. Criteria used by venture capitalists to evaluate new venture proposals. *J. Bus. Venturing*. **1**(1) 119-128.
Myers, S. C., N. S. Majluf. 1984. Corporate financing and investment decisions when firms have information that investors do not have. *J. Financial Econom*. **13**(2) 187-221.
Nanda, R., M. Rhodes-Kropf. 2012a. Financing risk and innovation. *Harvard Business School Entrepreneurial Management Working Paper No. 11-013.*
Nanda, R., M. Rhodes-Kropf. 2012b. Investment cycles and startup innovation. *Harvard Business School Entrepreneurial Management Working Paper No. 12-032.*
Sahlman, W. A. 1990. The structure and governance of venture capital organizations. *J. Financial Econom*. **27**(2) 473-521.
Schmidt, K. M. 2003. Convertible securities and venture capital finance. *J. Finance*. **58**(3) 1139-1166.
Shane, S., D. Cable. 2002. Network ties, reputation, and the financing of new ventures. *Management Sci*. **48**(3) 364-381.
Shane, S., T. Stuart. 2002. Organizational endowments and the performance of university start-ups. *Management Sci*. **48**(1) 154-170.
Shaver, J. M. 2011. The benefits of geographic sales diversification: How exporting facilitates capital investment. *Strategic Management J*. **32**(10) 1046-1060.
Shepherd, D. A. 1999. Venture capitalists' assessment of new venture survival. *Management Sci*. **45**(5) 621-632.
Tyebjee, T. T., A. V. Bruno. 1984. A model of venture capitalist investment activity. *Management Sci*. **30**(9) 1051-1066.
Wooldridge, J. M. 2002. *Econometric analysis of cross section and panel data*. The MIT press.

Table 1. Variable definitions and summary statistics within firms.

| Variable | Definition | Mean | St.d. | Min | Max |
|---|---|---|---|---|---|
| Dependent variables | | | | | |
| *Early Ratio Count* | Ratio of number of early-stage investments to total number of investments by a VC firm in a given year. We use a log-transformation of this ratio in our regression models. | 0.314 | 0.303 | 0 | 1 |
| Independent variables | | | | | |
| *Capital growth rate* | Growth rate of capital flowing into the market $\frac{\text{Fundraising at (t)} - \text{Fundraising at (t} - 1)}{\text{Fundraising at (t} - 1)}$ | 0.133 | 0.345 | -0.79 | 1.06 |
| *S&L crisis* | =1 if a given year is 1990 or 1991 | 0.027 | 0.091 | 0 | 1 |
| *Dot-com crash* | =1 if a given year is 2001 or 2002 | 0.133 | 0.214 | 0 | 1 |
| *Financial crash* | =1 if a given year is 2009 or 2010 | 0.110 | 0.224 | 0 | 1 |
| Controls | | | | | |
| *Lagged Early Ratio Count* | *Early Ratio Count* at (t-1) | 0.247 | 0.255 | 0 | 1 |
| *VC Experience* | Log of total number of investments made by the VC firm prior to a given year t | 1.733 | 1.491 | 0 | 7.63 |
| *VC Specialization* | A modified Herfindahl-Hirschman Index that measures the degree of diversification in terms of industry classification of companies a venture capital invested in during year t | 0.669 | 0.272 | 0.13 | 1 |
| *Entrepreneurship Activity* | Kauffman Index of Entrepreneurial Activity | 0.364 | 0.031 | 0.31 | 0.44 |

Note: Because we use panel data, Table 1 presents descriptive statistics of the mean value of the variables within venture capital firms (Shaver 2011). The column "mean" presents the mean value of the within-firm mean. Namely, we first take the average value of the variable for a firm across the years in the sample. Then, we average these values and present them in the table. The column "St.d." presents the mean value of the within-firm standard deviation. We calculate the standard deviation for a firm across the years in the sample and then average these values.

Table 2. Pairwise correlation matrix

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| (1) Early Ratio Count | 1 | | | | | | | |
| (2) Capital Growth rate | 0.0172 * | 1 | | | | | | |
| (3) S&L Crisis | -0.0307 * | -0.1634 * | 1 | | | | | |
| (4) Dot-com crash | -0.0127 * | -0.5701 * | -0.083 * | 1 | | | | |
| (5) Financial crash | 0.0363 * | -0.4014 * | -0.0657 * | -0.1116 * | 1 | | | |
| (6)) Lagged_Early Ratio Count | 0.3290 * | -0.0502 * | 0.0139 * | 0.0746 * | 0.0054 | 1 | | |
| (7) Log VC Experience | -0.1241 * | -0.0920 * | 0.0494 * | -0.0514 * | 0.1086 * | -0.0325 * | 1 | |
| (8) VC Specialization | 0.0944 * | 0.0026 | -0.1020 * | 0.0764 * | 0.0078 | 0.0683 * | -0.5980 * | 1 |
| (9) Entre_ activity | -0.0329 * | -0.4472 * | . | -0.3590 * | 0.6223 * | -0.0679 * | 0.1925 * | -0.0523 * |

Note: * means statistical significance at the 5% level or better.

Table 3. Fixed Effect Regression Model

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| *Capital growth rate* | 0.358** | 0.298* | 0.542*** | 0.533*** | 1.019*** |
| | (0.153) | (0.159) | (0.211) | (0.156) | (0.252) |
| *S&L crisis* | | -1.989*** | | | -1.665*** |
| *(Dummy)* | | (0.389) | | | (0.395) |
| *Capital growth rate* | | -3.703*** | | | -4.413*** |
| *× S&L crisis* | | (1.002) | | | (1.023) |
| *Dot-com-crash* | | | 3.726*** | | 3.912*** |
| *(Dummy)* | | | (0.922) | | (0.923) |
| *Capital growth rate* | | | 4.910*** | | 4.351*** |
| *× Dot-com-crash* | | | (1.386) | | (1.397) |
| *Financial crash* | | | | -27.209*** | -26.943*** |
| *(Dummy)* | | | | (5.510) | (5.507) |
| *Capital growth rate* | | | | -52.205*** | -52.525*** |
| *× Financial crash* | | | | (10.261) | (10.250) |
| *Lagged* | 0.080*** | 0.080*** | 0.078*** | 0.082*** | 0.079*** |
| *Early ratio count* | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| *VC Experience* | -2.824*** | -2.872*** | -2.789*** | -2.942*** | -2.933*** |
| | (0.165) | (0.166) | (0.167) | (0.172) | (0.173) |
| *VC Specialization* | -15.705*** | -15.684*** | -15.797*** | -15.630*** | -15.745*** |
| | (1.022) | (1.021) | (1.019) | (1.021) | (1.017) |
| *Constant* | 5.405*** | 5.605*** | 5.214*** | 5.619*** | 5.398*** |
| | (0.852) | (0.855) | (0.865) | (0.859) | (0.874) |
| *N* | 25,896 | 25,896 | 25896 | 25,896 | 25,896 |
| R2 (within) | .0472 | .0481 | .0480 | .0488 | .0508 |

Note: Values in parentheses are standard errors. Standard errors are clustered at the venture capital firm level and corrected for heteroscedasticity using the Huber-White robust standard errors. The superscript denotes statistical significance of coefficients at the following levels: * p<.10, ** p<.05, *** p<.01.

Table 4. Fixed Effect Regression Model with Entrepreneurship activity

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Entrepreneurship* | -12.215*** | -11.714* | -21.104*** | -16.658*** |
| *Activity* | (3.413) | (6.204) | (3.556) | (6.218) |
| *Capital growth rate* | 0.160 | -0.037 | 0.394** | 0.570 |
| | (0.177) | (0.443) | (0.179) | (0.463) |
| *Dot-com-crash* | | 2.266* | | 1.978 |
| *(Dummy)* | | (1.258) | | (1.261) |
| *Capital growth rate* | | 4.015*** | | 2.629* |
| *× Dot-com-crash* | | (1.474) | | (1.484) |
| *Financial crash* | | | -27.498*** | -27.261*** |
| *(Dummy)* | | | (5.458) | (5.476) |
| *Capital growth rate* | | | -54.720*** | -54.110*** |
| *× Financial crash* | | | (10.172) | (10.196) |
| *Lagged* | 0.046*** | 0.046*** | 0.046*** | 0.046*** |
| *Early ratio count* | (0.010) | (0.010) | (0.010) | (0.010) |
| *VC Experience* | -3.049*** | -3.107*** | -3.131*** | -3.166*** |
| | (0.186) | (0.189) | (0.188) | (0.190) |
| *VC Specialization* | -15.638*** | -15.604*** | -15.594*** | -15.586*** |
| | (1.121) | (1.121) | (1.117) | (1.118) |
| *Constant* | 10.606*** | 10.638*** | 13.818*** | 12.220*** |
| | (1.422) | (2.448) | (1.474) | (2.459) |
| *N* | 20,620 | 20,620 | 20,620 | 20,620 |
| R2 (within) | .0495 | .0500 | .0531 | .0532 |

Note: Values in parentheses are standard errors. Standard errors are clustered at the venture capital firm level and corrected for heteroscedasticity using the Huber-White robust standard errors. The superscript denotes statistical significance of coefficients at the following levels: * p<.10, ** p<.05, *** p<.01.

Figure 1. Number of investments in early-stage startup companies and later-stage startup companies aggregated across venture capital firms by year.

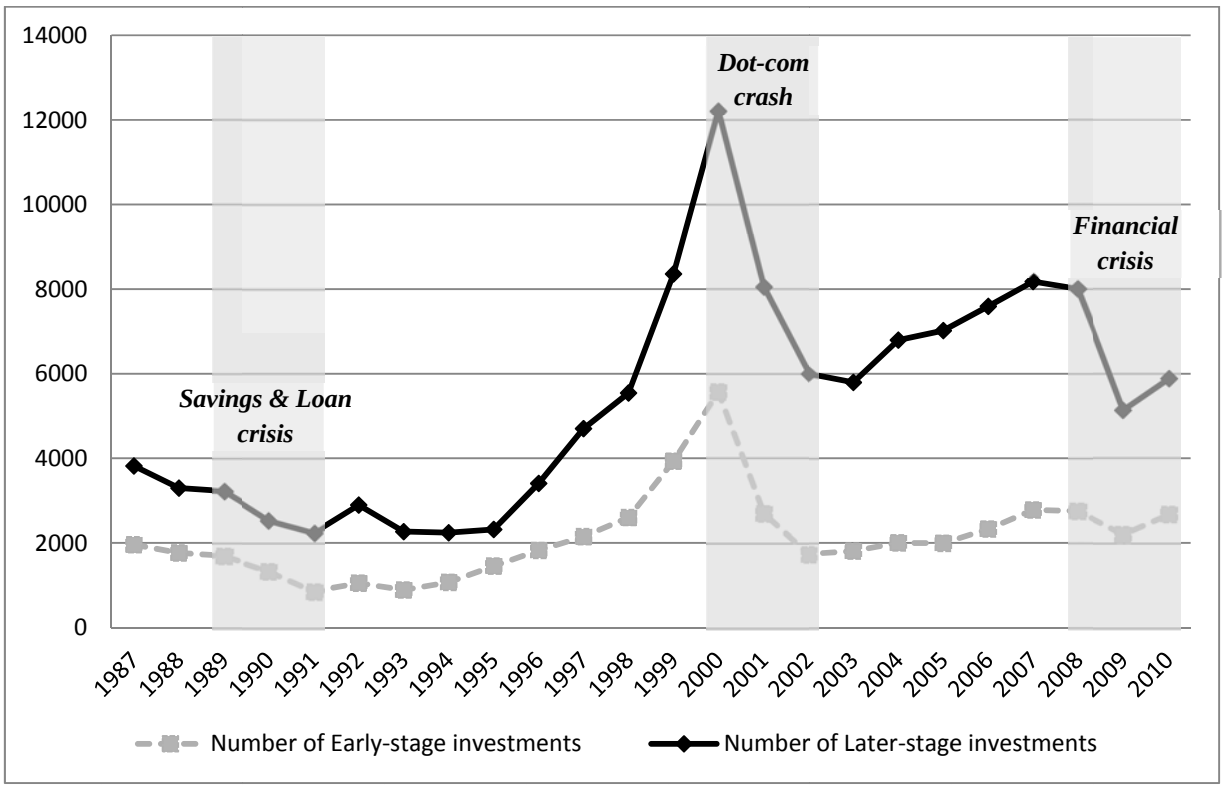


Figure 2. Ratio of the number of early-stage investments to total investments aggregated across venture capital firms by year (IVC vs. CVC comparison).

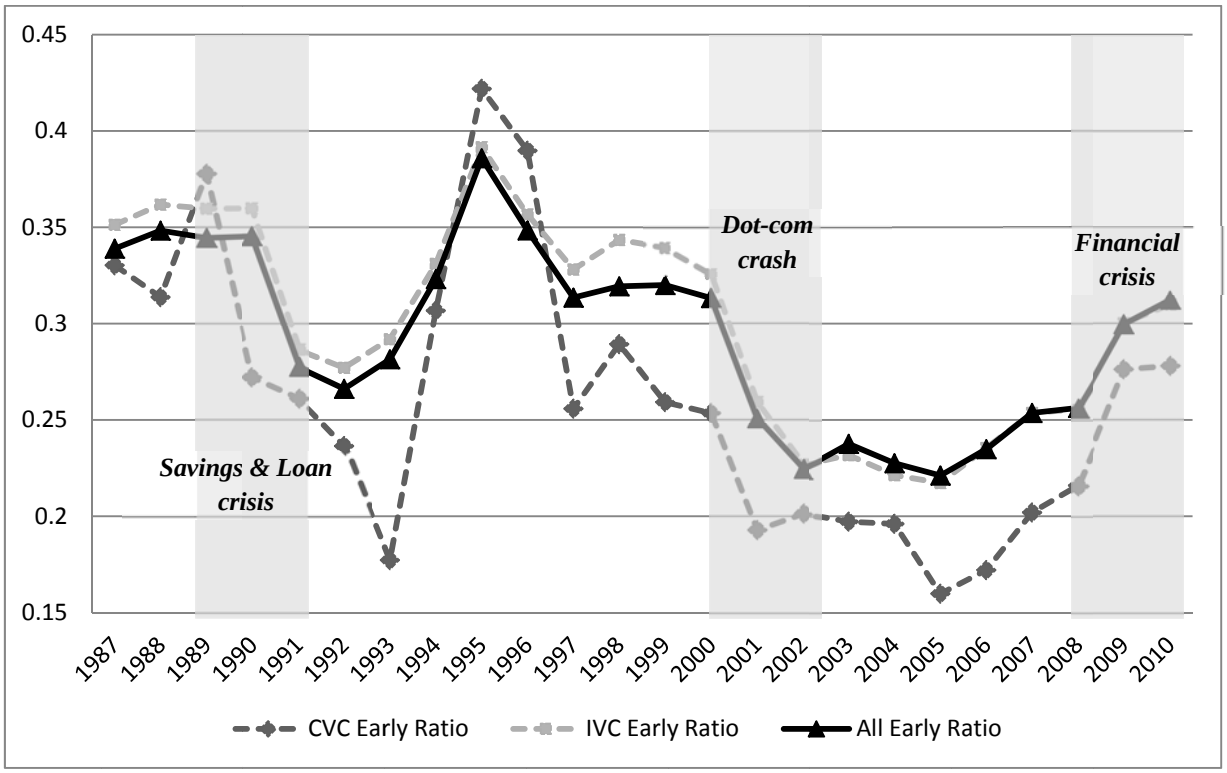


Figure 3. Venture capital fundraising activity and public equity market indices normalized using the 1987-level and adjusted for inflation.

