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The Determinants of Success in Venture Capital Finance

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THE DETERMINANTS OF SUCCESS IN VENTURE CAPITAL FINANCE

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Dedication

I dedicate this dissertation to my always loving and supportive wife, Alissa. You have been my inspiration from the beginning of this amazing journey and I couldn't have done it without you.

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Table of Contents

List of Figures vii
List of Tables viii
Abstract ix
Chapter 1: Introduction 1
Chapter 2: Dataset and Data Considerations 7
Chapter 3: Essay 1
"Does Venture Capital Portfolio Size Matter?" 15
Abstract 15
1. Introduction 16
2. The Venture Capital Industry 19
3. Data Analysis 23
4. Conclusion 36
Chapter 4: Essay 2
"*An Empirical Analysis of the Role of Distance and Location in Venture Capital Financing"* 38
Abstract 38
1. Introduction 39
2. Data Analysis 43
3. Conclusion 56
Chapter 5: Essay 3
"Specialization versus Diversification in Venture Capital Investing" 58
Abstract 58
1. Introduction 59
2. Data Analysis 62
3. Conclusion 74
Chapter 6: Conclusion 75
References 78
Vita 80

List of Figures

Figure

[1] Portfolio Success Rates by Year 1978-1997 9
[2] Venture Capital Performance/Commitments 1978-2002 26

List of Tables

Table

[1] Sample description by year (a) 12
[2] Summary statistics 13
[3] Sample description by year (b) 24
[4] Investment outcomes by year (a) 25
[5] Fund inflows' influence on average portfolio size 29
[6] Univariate analyses, portfolio size effects 30
[7] Multivariate analyses of fund success rates, portfolio size effects 35
[8] Sample description by year (c) 43
[9] Investment outcomes by year (b) 46
[10] Univariate analysis, distance effects 48
[11] Univariate analysis, network effects 49
[12] Multivariate analysis of portfolio company success rates [IPO or Acquisition] 54
[13] Sample description by year (d) 63
[14] Investment outcomes by year (c) 64
[15] Univariate analyses of specialization versus diversification 66
[16] Multivariate analyses of specialization versus diversification 67

Abstract

The determinants of success in venture capital financing are explored in this manuscript. 1247 venture capital funds formed over a twenty-year time period are empirically analyzed with results that support theoretical research from extant finance and economics literature. Venture capitalists' choices of portfolio size, distance from portfolio firms, location, and to some extent, level of diversification in their investment portfolio, are all significant factors in explaining the success rates of venture capital funds. These results are robust even when controlling for other characteristics of venture funds and entrepreneurial firms, such as the stage of development and industry of the portfolio firms, which may affect success rates of venture capitalist portfolios.

Chapter 1: Introduction

To most people outside of the industry, the realm of venture capital finance is enigmatic. This is a consequence of the private nature of the field. Most of the venture capital investment activity in the United States is carried out by independent private partnerships that are under no obligation to publicly disseminate information regarding their investment portfolios. Thus, there is a lack of both aggregate and fund-level data available for research opportunities. Because of this lack of publicly available information, the area has not been studied to the extent of other disciplines in financial economics.

While the paucity of historical data is a problem, progress has been made in the past couple of decades along this front. Two competing databases have been developed, VentureXpert by the Securities Data Corporation (SDC), and VentureSource by VentureOne. Both are primarily designed for investors' use, which creates problems for researchers that may seek a different set of information from the typical investor. Limitations of the SDC database will be discussed in chapter 2 of this manuscript. A more important problem for many is the prohibitively high cost of both databases. The VentureSource database is only available to qualified investors (limited partners) in private equity funds or to corporate development groups. While the SDC's VentureXpert database is available for academic research on a yearly subscription basis, their rates are difficult to justify for most researchers.

Having access to the VentureXpert database, I chose to analyze an aspect of venture capital investing that has received only cursory attention in the literature: the determinants of success in venture capital investing. Much of the related literature throughout the past decade has focused on descriptions of how venture capitalist organizations function and how their relationships with limited partners and entrepreneurs develop over time. In this dissertation, I have attempted to sort out the determinants of successful venture capital investing based upon much of the literature that has focused on the venture capitalist-entrepreneur relationship. Since there has been very little theoretical research on this subject, I have partitioned my analysis into three essays that draw upon theory from extant finance and economics literature.

The first essay, *Does Venture Capital Portfolio Size Matter?*, is the only essay of the three that is based directly upon theoretical research within the subject of venture capital investing. Kanniainen and Keuschnigg (2003) develop a theoretical model suggesting that a trade-off exists in venture capital investing between portfolio size and the extent of the managerial advice that venture capitalists can offer the entrepreneurs of firms in their portfolios. It is not unreasonable to posit that such a trade-off exists. Venture capitalists typically take an active role in the management of the entrepreneurial firms in their portfolios, often sitting on the board of directors and usually assisting in key strategic decisions of these firms, even contributing to the operational decision-making process in some cases. The ramifications of such a trade-off are that venture capitalists face explicit costs when expanding the number of portfolio firms in which they choose to invest. As they commit more time to other projects, entrepreneurs will rationally allocate smaller shares of their firms to the venture capitalists and thereby decrease the returns to the venture capitalists from successful venture investments. These

adjustments in contract terms would result in lower returns per investment, though not necessarily lower returns for the entire portfolio of venture investments.

Given the fact that the managerial advice of venture capitalists is so important to the entrepreneurial firms' chances of success, it also stands to reason that the likelihood of success for the portfolio of firms will fall as the venture capitalists add companies to their portfolio. At some point, as venture capitalists add entrepreneurial firms to their portfolios, they will be forced to allocate less time to their existing portfolio of firms if they are to continue to increase their portfolio size. This issue is particularly important if macroeconomic conditions persuade limited partners to increase investment capital available to venture capitalists. Given additional investment capital, venture capitalists must choose to invest more money in each portfolio firm, increase the number of firms they invest in, or do both.

I first establish that the supply of venture capitalists is not elastic. Venture capitalists have a unique skill set, and typically a network of contacts, that take time to develop. High returns to venture capitalists provide incentives for potential entrants, but because of the high costs of entry and the time it takes to develop the necessary skills and contacts, it is unlikely that potential entrants can take advantage of market conditions in the short run. Because of this, it is not unexpected that during periods of increased fundraising by venture capitalists, I find that average portfolio size increases significantly.

I then investigate the effects of a larger portfolio size on venture capitalist portfolio success rates in a univariate and multivariate framework. I conclude that portfolio size is an important explanatory variable when controlling for various fund level factors, including: fund age, fund size, and several portfolio company characteristics, including stage of development and industry. The empirical evidence presented in chapter 3 is consistent with the model developed

by Kanniainen and Keuschnigg (2003) that suggests the existence of a trade-off between venture capitalist portfolio size and the extent of managerial advice available to portfolio firms.

The impact of distance and location on success rates in venture investing is examined in chapter 4. The nature of the subject matter in this chapter lends itself to analysis from the perspective of the portfolio companies' success, rather than from the venture capitalists' portfolio success rates. This is because of the way in which distance and location influence the investment relationship. Lerner (1995) demonstrates that venture capitalists tend to monitor their portfolio of investments less as the distance between them grows. This should have a negative impact on entrepreneurial firm success rates, all else equal. The empirical evidence supports the hypothesis that distance matters in venture capital investing.

Bygrave and Timmons (1992) examine the importance of network externalities in venture investing. The external benefits of operating a business in areas where venture capital is concentrated, such as Silicon Valley, California or Route 128 in Massachusetts, are difficult to quantify, but they are tangible nonetheless. Companies in the supply chain are more likely to be nearby, as are potential customers and support services. Network externalities should increase the likelihood of success for entrepreneurial firms, and consequently the role of location is likely to be an important determinant of success for firms receiving venture capital. This hypothesis is supported by the results of my analysis in chapter 4. This essay, as well as the last essay, relies upon related finance and banking theory due to the lack of theoretical work in the field of venture capital.

The final essay in this dissertation deals with the choice of the degree of diversification in venture capitalist portfolios. In many ways the results of this final analysis are the most interesting because of the fact that the results support a strategy of diversification by stage of

development, while prior research by Norton and Tenenbaum (1993) suggests that venture capitalists prefer to specialize by both industry and stage of development of portfolio firms. My results are inconclusive regarding the decision to specialize or diversify across industries.

The rationale for diversifying the venture capitalists' portfolios is to eliminate, or at least minimize, unsystematic risk. Specialization, on the other hand, may give venture capitalists a comparative advantage in investing in a particular industry or stage of development. If the skill set, and network of contacts, is unique for different industries and stages of development, and if these skills and contacts are costly to acquire, then specialization should dominate. More directly, if specialization should dominate, then those venture capitalists that choose to diversify should achieve lower success rates, everything else equal. Contrary to expectations, I find that venture capitalists that diversify across portfolio company stage of development are more successful than those that specialize. The evidence suggests that the level of diversification across industry is irrelevant to portfolio success rates.

There must be a rational explanation for venture capitalists to choose specialization over diversification, despite the lack of analytical evidence to support this strategy. The results may be influenced by the appearance of a diversified portfolio by some specialized funds in the sample. A venture fund may still hold shares in a firm as it moves beyond the early stages of development yet have little involvement in the activities of the firm. In other words, a fund could specialize in early stage ventures, maintain a lead role in the development of early stage firms until later rounds of investment, and then hand over the effective control of the firm to a venture fund specializing in later stage firms, while retaining shares of these firms. If the fund contributes any capital at these later stages, the investment round will be recorded in the SDC database as a later stage investment. Thus, an appearance of diversification across stages may be

due simply to the fact that the early stage venture investors hold shares and provide capital for the same portfolio firms at later stages of development in order to cash out at IPO or firm acquisition. I discuss other potential explanations for these results in chapter 5.

In the next chapter I will describe the data used throughout this dissertation. I also discuss limitations of the SDC data in a broad sense, as well as in the specific case of the problems encountered in the writing of this manuscript. Although there are many issues that could be clarified if appropriate data were available, there are some interesting results in each of the following chapters. Chapters 3, 4, and 5 contain the three essays outlined above while a final chapter offers some concluding remarks.

Chapter 2: Dataset and Data Considerations

A general concern about the SDC VentureXpert database is that all of the data is self-reported by the venture capitalists themselves. This exposes any analysis of the data to inherent biasness, specifically selection bias. Venture capitalists may withhold information on funds that underperform, report inflated values for key variables, or somehow otherwise misrepresent their performance or descriptive statistics. Further complicating this problem, there is no apparent standardized system of providing data to the SDC. This concern is particularly relevant to the analysis in chapter 3 regarding venture capitalist portfolio size effects on success rates. The number of venture capitalists per fund is calculated based upon the number of executives reported by the funds to the SDC. Some funds appear to overstate this number by including employees with administrative titles, while others may understate this number by only reporting the general partners of the venture fund.

This data is not subject to outside auditing because the funds are private partnerships. Thus, knowing that potential investors may purchase access to the database, venture capitalists have the incentive to withhold bad information while exaggerating good information. It seems likely that the effect of this bias should be minimal for my purposes because the SDC data does not include access to individual investment or fund-level performance data. While this data would be preferred for a study such as this, without it there is less concern about the potential

bias. As for the bias introduced by misreporting and lack of standardization, it is likely that these effects are minimized in a sample as large as the one studied here. Data from 1247 venture funds with a total of 25,027 investments form this dataset.

The lack of individual investment return data is presumed to be a much bigger problem than the potential bias associated with self-reported data. Without this data, or at a minimum the fund-level returns data, it is difficult to say with certainty whether a venture investment was a success or a failure. Portfolio companies that go public are associated with high returns, as are those that are acquired to a lesser extent, but it is possible that some of the investments that exit by IPO or through acquisitions provide returns that would not be considered successful by anyone other than the entrepreneurs involved (who typically have a very limited capital investment). On the other hand, there are some cases where entrepreneurs buy out venture investors, resulting in positive returns for the venture funds but appearing to be a failure when reported to the SDC as a privately held firm. Lack of returns data also affects the interpretation of success for funds that primarily limit their investments to early stage portfolio companies. I control for this somewhat by including an indicator variable in my multivariate analyses, but this is unlikely to capture the entire effect. Venture capitalists that specialize in early stage ventures may have significantly lower success rates as defined herein, but the returns for each successful exit are greatly amplified the earlier the venture capitalists get involved in an investment.

A successful exit is defined throughout the dissertation as a venture investment that has either been acquired or gone public through an initial public offering (IPO). I run all regressions using IPOs as the only defined successful exit as well. A commonly cited 1988 Venture Economics study entitled, *Exiting Venture Capital Investments*, finds that IPOs generate the

greatest returns to venture investors by a large margin, followed by acquisitions.[1] As mentioned previously, fund level returns data would be a preferred measure of success, but the data is unavailable. Figure 1 demonstrates the success rates of the sample venture funds by year.

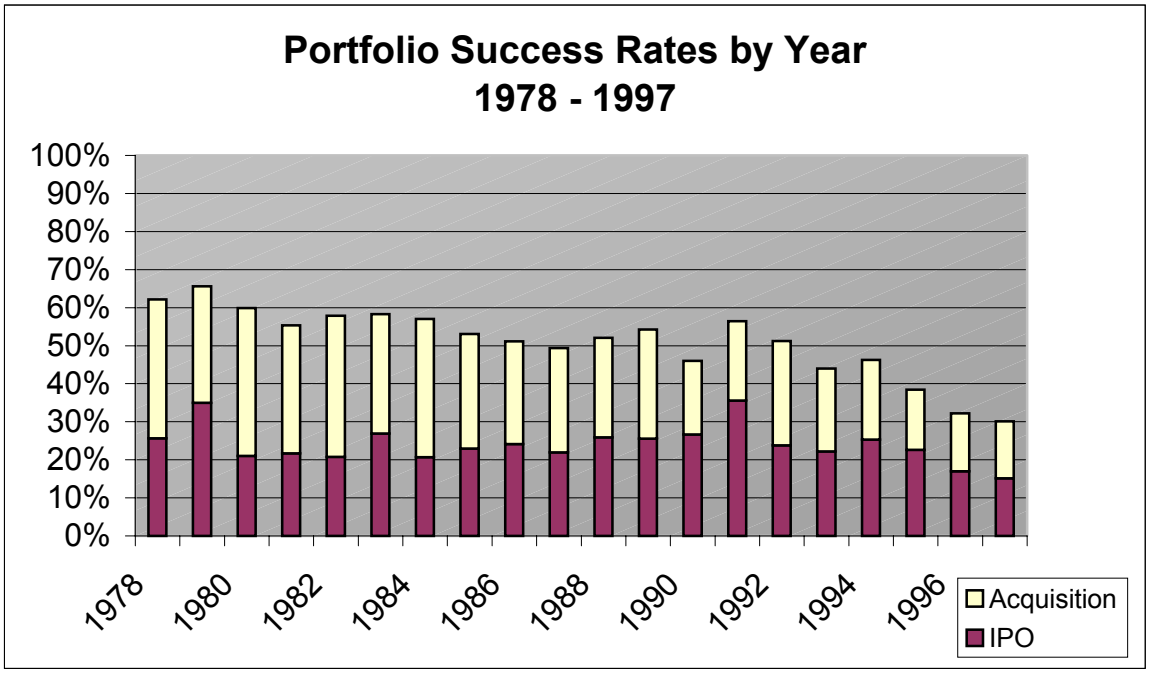

Figure 1
Portfolio success rates over the twenty-year sample period. Entrepreneurial firms in registration for an initial public offering are included as IPO firms.

Because venture investments take time to develop, it is necessary to allow for a reasonable passage of time before writing off a poor investment. Venture capitalists typically will leave poor investments on the books until the fund dissolves, thus firms that are still privately held after several years have passed are considered failed investments. Following the work of Gompers and Lerner (1998a, 2000), I use a cut-off of five years, which leaves a sample period from 1978 to 1997. Approximately half of the venture investments in the VentureXpert database provide data regarding the year of investment resolution (success or failure). I calculate the difference between the fund year and year of exit for the sample investments. After dropping

[1]A $1 investment in a firm that goes public provides a 295% average return over an average of 4.2 years. The next

outliers and those with negative values, I find that the median time to IPO is 5 years. When I partition the data into the first 10 years versus the latter 10 years, I find that the mean over the last 10 years falls to 4, while the first 10 years has a median time to IPO of 7 years. This is consistent with popular press accounts of the fall in the time to IPO in the booming markets of the late 1990s. The data for all exits (successful or otherwise) follow a similar trend, with an overall median of 6 years, a median of 5 years for the latter 10-year period, and a 7-year median time to exit for the first 10 years of the sample period. This indicates that there is a bias introduced for the funds formed in the mid-90s. In order to control for the fact that some of the venture investments initiated in the mid-90s will be considered failed investments because they remain private firms as of July 2003, in unreported regressions, I include a dummy variable for those funds that were formed in 1994, 1995, 1996 and 1997. This variable is insignificant in all regressions, even if defined to include 1993 or drop 1994, while other variables remain significant.

Much of the following analysis relies upon the fact that venture capitalists are active investors. Portfolio size is expected to be an important factor in explaining the success rates of venture capitalists because the ability to actively manage a portfolio of firms should fall as the number of investments rises. Similarly, distance is expected to play a significant role in the success of venture investments because time constraints dictate the extent of active portfolio management. Finally, the rationale for specialization over diversification is because large fixed costs of developing contacts and specialized skills should make it difficult for venture capitalists to actively manage firms in different industries or stages of development. All of these issues would ideally be studied using investment-level data. As a proxy for investment level data, I take averages across funds. While this does prove informative, there are issues that arise because of

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best payoff is 40% over 3.7 years, on average, to investments in acquired firms.

the lack of access to investment-level data, principal among them being the lack of knowledge about how the investments are distributed within each fund.

A fund may consist of specialists in various industries, giving the appearance of a diversified portfolio when averaging across the fund. Likewise, one or two partners in a venture firm may be responsible for many investments as part of syndications where others take the lead (active) role in the management of the entrepreneurial firms. This would give the appearance of overinvestment by the venture fund even though it is not necessarily true. Without knowing exactly how each venture investment is structured, and how involved the venture capitalists are in those investments, it is difficult to isolate the impact of the variables of interest in this dissertation. Some of these problems are just due to a lack of information; others are due to a lack of details in the information reported to the SDC.

Despite all of these limitations, the volume of data alone allows for a useful analysis. As mentioned above, there are 1247 funds reporting data over a twenty year time period in the final dataset. This data was culled from the SDC VentureXpert database in the summer of 2003. It represents only those venture capitalists that operate in the United States, that are organized as independent private partnerships, and that limited their investments to U.S. entrepreneurial firms.[2] Table 1 provides descriptive statistics of the data by year. The data in Table 1 is presented

[2] The data used in chapter 4 is further limited to only those venture capitalists in the continental United States, investing in continental U.S. entrepreneurial firms to avoid the distortion added by investments in Hawaii or Alaska. Chapter 5 data is reduced to 1099 funds when the dataset is limited to only those funds with at least 3 portfolio companies.

Table 1. Sample description by year (a)

The sample represents all U.S. venture funds, investing in U.S. firms, that are organized as independent private partnerships, have non-missing data for the time period studied and are found in the SDC VentureXpert Database in July 2003. Fund inflows are total commitments to venture funds by investors, measured in millions of 1997 dollars. The total number of portfolio companies for any given year overstates the total number of companies receiving venture capital due to the fact that many venture investments are syndicated and therefore, more than one fund may have an investment role in any portfolio firm. Total venture capitalists are proxied by the total number of executives reported by the funds to SDC.

Fund Year	Number of Funds	Total Portfolio Companies	Fund Inflows $millions	Total Venture Capitalists
1978	14	623	$294.30	181
1979	11	313	227.20	167
1980	26	892	703.80	342
1981	45	1,453	1,135.40	436
1982	53	1,518	1,345.00	496
1983	76	1,900	2,027.50	686
1984	84	2,295	2,593.40	966
1985	57	1,428	1,684.90	634
1986	56	1,206	1,855.40	503
1987	73	1,527	2,807.70	817
1988	64	1,129	3,627.20	650
1989	75	1,206	2,679.10	840
1990	40	603	2,038.10	474
1991	33	404	1,235.30	348
1992	53	1,034	2,851.90	730
1993	65	977	3,295.60	711
1994	72	1,068	4,169.40	775
1995	105	1,444	6,525.90	1,184
1996	87	1,549	7,217.10	1,063
1997	158	2,458	14,756.80	1,922
Total	1247	25,027	63,071.00	13,925
Yearly Average	62.35	1251.35	3153.55	696.25

by year to illustrate the yearly fluctuations in some of the key variables of interest in chapter 3. The total number of portfolio companies receiving venture capital and the number of venture capitalists in the sample steadily rises through the 80s, and then they fall off in 1990 – 1991,

Table 2. Summary statistics

The sample represents all U.S. venture funds, investing in U.S. firms, that are organized as independent private partnerships, have non-missing data for the time period studied and are found in the SDC VentureXpert Database in July 2003. PORTFOLIO SIZE is the number of portfolio companies per venture fund divided by the number of executives per fund. FUND SIZE is the total commitments in millions of 1997 dollars. PORTFOLIO COMPANY AGE is the number of years that the portfolio company was incorporated at the time of the venture investment. FUND AGE is the number of years the venture capitalist firm was in operation at the time of the fund formation. FUND NUMBER is the number of prior funds the venture firm had raised plus one. HIGH-TECH % is the percentage of the funds' portfolio companies that are classified as information technology firms. HOT MARKET % is the percentage of the funds' total IPOs that occurred in a hot market (a year is classified as a hot market if there were more than 600 IPOs in that year). DISTANCE is the distance in miles between venture capitalists and the entrepreneurial firms in their portfolios. EARLY STAGE % is the percentage of the funds' portfolio companies that are early stage investments. MA OR CA % is the percentage of the funds' portfolio companies that are located in Massachusetts or California.

Independent Variable	Mean	Median	Standard Deviation
PORTFOLIO SIZE	3.7	1.8	7.7
FUND SIZE	50.6	28.0	70.8
PORTFOLIO COMPANY AGE	1.0	1.0	3.8
FUND AGE	6.7	4.0	7.4
FUND NUMBER	3.2	2.0	3.4
HIGH-TECH %	59.4%	62.9%	0.30
HOT MARKET %	47.2%	44.4%	0.24
DISTANCE	850.2	348.7	982.5
EARLY STAGE %	37.7%	33.3%	0.34
MA OR CA %	50.9%	54.1%	0.30

before rising again over the next six years. The number of venture funds and yearly fund inflows follow a similar pattern, though there is more volatility in the 80s. Summary statistics for other variables of interest are provided in Table 2.

Venture capitalists in the sample oversee an average of 3.7 portfolio companies, and a typical venture fund invested in either California or Massachusetts, with a focus on high-tech firms. The average percent of the funds' IPOs occurring during hot IPO markets is 47.2%, giving support to the perception that venture capitalists are able to time the markets since only one-quarter of the years in the sample are identified as hot IPO market years. The median percentage

of the fund invested in early stage firms is 33.3%, suggesting that many of the funds in the sample have a significant number of investments in early stage ventures, though their stake in the early stage portfolio firms is more likely to be a small percentage of the total capital invested.

This illustrates the sometimes-deceptive nature of the data in the SDC database. Without more detailed data at the fund level or investment level, there will be some doubt about the significance of the ensuing analyses. As mentioned prior, the volume of data should allow for meaningful analysis. However, future research is warranted regarding each of the topics discussed herein, given the numerous concerns about the data currently available from the SDC.

Chapter 3: "*Does Venture Capital Portfolio Size Matter?*"

Abstract

The influence of portfolio size on venture capitalists' success rates is examined in this manuscript. I demonstrate that venture capitalists exhibit a tendency to increase the number of portfolio investments following periods of growth in commitments from limited partners. Subsequently, I find that the increase in portfolio size is negatively related to venture capitalists' rates of success across a sample of 1247 venture funds spanning a twenty-year time period.

1. *Introduction*

There was extraordinary growth throughout the 90s in venture capital investments; from $4.3 billion in capital committed in 1990 to nearly $100 billion in 2000.[3] This pattern in commitments corresponds with a general cycle of increased fund inflows from investors, following periods of high returns in the industry, which has developed over the past 25 years. These periods of increasing supply in capital are typically followed by a downturn in the cycle where returns plummet and subsequent investment is curtailed. A common theory says that the cycle is inevitable due to "too much capital chasing too few good projects" (Fenn, Liang and Prowse, 1997). As more low quality projects are funded, probability of failure increases, which leads to lower returns to a portfolio of venture capital investments. Naturally, investors scale back fund inflows as returns fall and fewer projects receive funding. Since fewer projects are funded, the quality of those projects is higher and eventually patient investors are rewarded with high returns (thus sparking the next wave of increased fundraising).[4]

While the cyclical nature of the venture capital industry is evident, understanding the underlying causes of the venture capital cycle is more difficult. Kanniainen and Keuschnigg (2003) contribute to this understanding by suggesting that the supply of venture capitalists is relatively inelastic in the short run. In other words, the limiting factor behind the downturn in the cycle is not the lack of good projects, but a paucity of experienced venture capitalists. Anecdotal evidence supports this idea, which implies that the venture capital industry may be slower to

[3] Source: Securities Data Corporation's (SDC) VentureXpert database. These figures are in constant 1997 dollars and represent commitments to U.S. venture capitalists organized as limited partnerships that invested in U.S. firms.
[4] Gompers and Lerner (1999, 2001) provide a detailed account of research relating to the venture capital industry.

completely adjust to shifts in either demand for or supply of venture investment dollars.[5] If barriers to entry exist in the venture capital industry, then only two distinct outcomes are possible if fund commitments increase and these commitments are fully invested: venture capitalists increase the average amount of total financing in their portfolio companies, or they increase the total number of portfolio investments.

I speculate that over the past 20 years and in response to increases in capital flows, venture capitalists have increased both the total investment per portfolio firm, and the number of investments per venture portfolio. The focus of this manuscript is on the latter development. In this essay, I seek to establish whether the evidence supports this idea and if so, how venture capital portfolio success rates have been influenced. I suspect that an important consequence of investing in too many portfolio companies is that portfolio success rates will fall. This follows from the fact that venture capitalists do more than simply provide capital to high-risk, start-up firms. More importantly, they provide monitoring services, industry contacts, guidance in corporate strategy, and other support services for entrepreneurs. Kanniainen and Keuschnigg (2002, 2003) hypothesize that a trade-off exists between the number of companies in a venture capitalist's portfolio and the extent of the managerial advice that the venture capitalist is able to offer. The implications of such a tradeoff are that an optimal portfolio size exists, and deviations from the optimal should affect the success rates of the portfolio firms. The goal of this study is to empirically verify whether or not there is evidence of this trade-off, manifesting through decreased portfolio success rates.

Kanniainen and Keuschnigg (2002, 2003) focus on the marginal costs and marginal benefits of increasing venture capitalists' portfolio size. In their view, the marginal cost of

[5] Paul Gompers and Josh Lerner have repeatedly referred to industry accounts of difficulty both in raising a limited partnership with no track record, and in grooming associates to become partners. See Gompers and Lerner (1996,

investing in too many portfolio companies can be measured in terms of ownership stake in the entrepreneurial firm, rather than necessarily an increase in the risk of failure of portfolio firms. As venture capitalists add firms to their portfolios, entrepreneurs rationally anticipate the level of managerial advice they are likely to receive from the venture capitalists and divide the shares of the firm accordingly. In other words, the cost of overinvestment may be in lower returns per investment, rather than in lower likelihood of success per investment. It is likely that pricing and other contract terms adjust to market fluctuations in the venture industry; however, it is unlikely that entrepreneurs and venture capitalists are able to fully adjust for the potential value lost in monitoring benefits. Regardless of the extent of pricing adjustments, if venture capitalist monitoring has positive value, then there should be a decreased likelihood of a portfolio company's successful acquisition or initial public offering if the venture capitalist has overextended and invested in too many firms.

Alternatively, the data may support the idea that in the short run, the marginal cost of monitoring additional portfolio companies is low enough to allow for an increase in the size of venture capital portfolios with limited downside risk. The likelihood of failure may be less influenced by the ability of incumbent venture capitalists to effectively monitor portfolio firms, than by entry of less experienced venture capitalists that may choose to fund inferior projects. In other words, selecting the best projects to invest in may be more important to the success of a venture capitalist than the ability to provide proper oversight to the portfolio firms.

A related idea is that entrepreneurial firms require less managerial support during periods of high volume of initial public offerings (IPOs), or "hot IPO" periods.[6] Ritter (1991) labels these periods "windows of opportunity," when it is easier to access public markets via IPOs.

1999) for more.

[6] See Lowry and Schwert (2002) and Lowry (2003) for recent analyses of IPO cycles.

Venture backed firms tend to go public more quickly during these periods which typically coincide with rapid growth in the stock market indices. The most recent boom in the market had firms going public after only one-to-two years in a venture capital portfolio, as opposed to the three-to-five year historical norm. Since IPOs generate the greatest returns for venture capitalists (Gompers, 1995), it follows that these "windows of opportunity" also reflect periods of increased fundraising for venture capitalists.[7] Easier access to public markets could counter the effects of investing in too many portfolio firms, at least in terms of the probability of successfully bringing entrepreneurial firms public. Lerner (1994) shows that seasoned venture capitalists are better able to take advantage of these "hot markets" to take portfolio companies public at market peaks. This is consistent with Gompers' (1996) grandstanding hypothesis in which inexperienced venture capitalists may not wait to time IPOs optimally in order to establish a reputation for bringing entrepreneurial firms public. I will attempt to sort through these effects and establish whether or not portfolio size is relevant to venture capitalist success rates.

This paper proceeds as follows. Section 2 discusses the venture capital industry and current related literature. Section 3 describes the data and reviews the results of the empirical testing. A final section concludes the paper.

2. *The Venture Capital Industry*

Prior research has established the unique role of venture capitalists in mitigating the asymmetric information problems of funding young, high-risk firms (Chan, 1983; Gorman and

[7] Gompers (1995) cites a 1988 Venture Economics study which states that portfolio companies that eventually go public yield an average of 59.5% annual returns to venture capitalists.

Sahlman, 1989; Sahlman, 1990; Black and Gilson, 1998).[8] Typical bank financing is generally not available for those firms in an early stage of development (start-ups) that do not have tangible assets or positive cash flows.[9] While venture capital financing is obviously important to young firms unable to secure bank loans, it is the monitoring and support provided by venture capitalists that distinguish them from other sources of financing. This support frequently includes helping to raise additional funds, forming company strategy, and management recruitment, among other functions (Gorman and Sahlman, 1989). Monitoring of portfolio firms commonly involves a seat on the board of directors and regular visits to the entrepreneurial firms, as well as facilitating customer and supplier relationships.

It takes time to develop the necessary skills for successful venture investing and thus, it is not unreasonable to assume that the supply of venture capitalists is inelastic in the short run.[10] If this is true, then all else equal, during periods of increased venture capital fundraising, venture capitalists are likely to invest in more portfolio companies than they can effectively supervise.[11] Gompers and Lerner (2000) examine the impact of fund inflows on firm valuations. They show that although portfolio firm valuations are significantly influenced by capital inflows, increases in fundraising do not appear to affect the success rates of these firms. However, the analysis of success rates by Gompers and Lerner is limited in both scope and depth. Their data covers only five years of venture investments and the investigation into the effects of fund inflows on success

[8] See Sahlman (1990) for a detailed analysis of the mechanisms used to control information asymmetries in venture capital organizations.

[9] Triantis (2001) suggests that the defining characteristic of venture capital contracts that allows VCs to fill the financing gap left by banks is the use of equity-linked convertible securities. Fixed interest payments of straight debt would be prohibitively high for these types of firms. The use of convertible preferred stock or debt allows for the substitution of a share of future gains in firm value for the interest payments of straight debt.

[10] Gompers and Lerner (1996) look at the short run effect of inelastic supply of venture capitalists on the total compensation they receive. Increased fundraising leads to less restrictive covenants (which provides an increase in private benefits accruing to the venture capitalists) or else a direct increase in monetary compensation in the form of higher fees or a greater percentage of the carried interest. Further, Gompers and Lerner (2000, p.295) state that venture capital organizations refrain from adding partners proportionally as capital under management grows.

rates is restricted to a single univariate comparison across time periods. Nevertheless, Gompers and Lerner conduct a thorough investigation into the effects of fund inflows on private equity valuations, and they show that periods of increased fundraising are followed by higher valuations at all stages of investment. As Lerner (2002) explains, the consequences of higher valuations include less monitoring control over portfolio firms through staged capital commitments and potentially less screening of potential investments through syndication.

In related research, Gompers and Lerner (1998a) document the importance of strategic fit in corporate venture capital investment success rates. Corporate venture capital funds are similar to independent partnerships in most ways besides organizational and compensation structure.[12] Gompers and Lerner (1998a) focus on the effectiveness of corporate venture investing relative to the more common, independent private partnerships. Their results document that corporate venture capitalists are at least as successful as their counterparts at independent organizations, particularly when the corporate venture investments exhibit some degree of complementarity between the corporation and the entrepreneurial firms. Santhanakrishnan (2003) studies the impact of complementarity on corporate venture success and further identifies the support provided by corporate venture capitalists as the mechanism through which complementarity influences the performance of portfolio firms. Consistent with the results of Gompers and Lerner (1998a), he finds that strategic fit between the entrepreneurial firms and corporate venture capitalists drives an overall increase in the likelihood of successful exits for investments by corporate venture capitalists (relative to those by independent venture capitalists.)

Thus far, Kanniainen and Keuschnigg (2002) are the only researchers to address the relationship between success rates and portfolio size, but their paper is theoretical in nature. They

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[11] In order to fully invest the fund commitments, the venture capitalists must invest more per portfolio company, increase the size of their portfolio, or some combination of these two.

suggest that the number of firms in a venture capitalist's portfolio should influence portfolio success rates, but focus their attention on a marginal cost versus marginal benefit analysis of changes in portfolio size. I seek to empirically test whether or not portfolio size is a significant determinant of successful venture investing. In a related paper, Cumming (2001) examines the determinants of portfolio size and finds that funds that raise more capital have larger portfolios. He does not investigate the relationship between portfolio size and success rates of portfolio firms; but he does provide support for the theory developed by Kanniainen and Keuschnigg (2002, 2003) that a trade-off exists between portfolio size and the extent of managerial advice per firm. Nevertheless the trade-off between the number of firms and managerial advice may only be important if there are significant consequences on the success rates of entrepreneurial firms because of the trade-off.

Alternatively, I may find that other factors dominate the cost of diminished guidance. If venture capitalists are adept at timing the expansion of their portfolios, then it may be possible to maintain prior success rates despite distributing less advice to each portfolio firm. I seek to fill this gap in the literature by empirically analyzing the changes in average portfolio size over a twenty year time period and how these changes affect the venture capitalists' ability to successfully exit their investments.[13]

The determinants of venture capitalists' portfolio success rates have not been explored in the literature. While Gompers and Lerner (1998a, 2000) and Santhanakrishnan (2003) have studied some of the influences of success from the entrepreneurial firms' perspective, no prior research has focused on the factors that drive the success of venture investment portfolios. In the

[12] See Gompers and Lerner (1998a) or Hellman (2002) for a more detailed account of corporate venture investing.
[13] Typically a successful exit is one in which the company has been taken public via an IPO or else been acquired by another firm. This will be more formally defined in section 3 of this paper.

next section I will describe the data and empirically test for evidence that venture capitalists tend to overextend themselves when capital inflows increase.

3. *Data analysis*

It is useful to first establish if there is any evidence that venture capitalists have a tendency to increase their average portfolio size during periods of increased fundraising. I will describe the data set before I proceed to the analysis.

3.1. *Sample description*

A sample of 1247 U.S. venture capital funds, formed between January 1978 and December 1997, was drawn from the Securities Data Corporation (SDC) VentureXpert database.[14] The sample was limited to independent private partnerships that raised funds specifically for investment in U.S. portfolio companies and it represents all funds maintained in the SDC database with non-missing data on fund size and other fund characteristics.[15] Table 3 provides descriptive statistics of the data by year. It is apparent that the key variables of interest in this essay exhibit a cyclical pattern with local peaks in the mid-80s and notable minimums in the early nineties. The mid- to late-90s had global maximums for the sample period for the number of funds, number of venture capitalists, portfolio companies and fund inflows.

[14] The VentureXpert database has records as far back as 1962; however, data collection was not a primary focus before mid-1977 for Venture Economics (subsequently acquired by SDC).

[15] Private partnerships account for the vast majority of all venture capital raised over the time period of interest and have emerged as the dominant organizational form in the industry (approximately 80% of commitments in recent years.)

Table 3. Sample description, by year (b)

The sample represents all U.S. venture funds, investing in U.S. firms, that are organized as independent private partnerships, have non-missing data for the time period studied and are found in the SDC VentureXpert Database in July 2003. Fund inflows are total commitments to venture funds by investors, measured in millions of 1997 dollars. The total number of portfolio companies for any given year overstates the total number of companies receiving venture capital due to the fact that many venture investments are syndicated and therefore, more than one fund may have an investment role in any portfolio firm. Total venture capitalists are proxied by the total number of executives reported by the funds to SDC.

Fund Year	Number of Funds	Total Portfolio Companies	Fund Inflows $millions	Total Venture Capitalists
1978	14	623	$294.30	181
1979	11	313	227.20	167
1980	26	892	703.80	342
1981	45	1,453	1,135.40	436
1982	53	1,518	1,345.00	496
1983	76	1,900	2,027.50	686
1984	84	2,295	2,593.40	966
1985	57	1,428	1,684.90	634
1986	56	1,206	1,855.40	503
1987	73	1,527	2,807.70	817
1988	64	1,129	3,627.20	650
1989	75	1,206	2,679.10	840
1990	40	603	2,038.10	474
1991	33	404	1,235.30	348
1992	53	1,034	2,851.90	730
1993	65	977	3,295.60	711
1994	72	1,068	4,169.40	775
1995	105	1,444	6,525.90	1,184
1996	87	1,549	7,217.10	1,063
1997	158	2,458	14,756.80	1,922
Total	1247	25,027	63,071.00	13,925
Yearly Average	62.35	1251.35	3153.55	696.25

Following Gompers and Lerner (1998a, 2000) and Santhanakrishnan (2003), a venture capital investment is classified as a success if the portfolio company was acquired or if the company went public through an IPO (or was in registration for a public offering).[16] Table 4

[16] A 1988 Venture Economics study entitled *Exiting Venture Capital Investments* finds that a $1 investment in a firm that goes public provides a 295% average return over an average of 4.2 years. The next best payoff is 40% over 3.7 years, on average, to investments in acquired firms. Gompers and Lerner (2000) include only those acquisitions at more than 2 times valuation as successful exits. SDC does not maintain the valuation data needed to make that distinction.

shows the distribution of investment outcomes across the twenty-year sample period. In most years, companies receiving venture capital were more likely to remain private than any other outcome. This is considered a failed investment and these companies are commonly referred to as "the living dead."[17] Venture capitalists' portfolio success rates are calculated as the ratio of

Table 4. Investment outcomes by year (a)

The table presents outcomes for the sample portfolio companies by year. The total number of portfolio companies for any given year overstates the total number of companies receiving venture capital due to the fact that many venture investments are syndicated and therefore, more than one fund may have an investment role in any portfolio firm. Less than 0.5% of the total number of portfolio companies do not fall into any of these categories due to name change, withdrawn IPO registration, or unknown status.

Fund Year	Total Portfolio Companies	Initial Public Offering Complete (or IPO filing)	Acquired	Still Private	Defunct
1978	623	25.0%	35.2%	34.3%	5.3%
1979	313	25.2	38.0	30.0	6.4
1980	892	23.7	36.1	33.7	6.5
1981	1,453	21.8	34.0	36.8	7.1
1982	1,518	20.7	35.7	37.7	5.9
1983	1,900	26.0	31.3	36.5	6.5
1984	2,295	22.6	34.5	35.7	6.9
1985	1,428	25.5	26.4	43.7	4.6
1986	1,206	24.1	30.2	40.2	5.1
1987	1,527	25.1	27.7	43.2	3.6
1988	1,129	28.9	29.9	39.8	2.3
1989	1,206	27.3	29.7	38.9	4.1
1990	603	29.1	25.7	43.1	3.6
1991	404	33.3	27.4	36.9	4.9
1992	1,034	28.4	26.9	43.8	2.1
1993	977	24.9	26.4	45.4	4.2
1994	1,068	24.1	22.1	50.9	4.4
1995	1,444	21.4	20.8	54.8	5.9
1996	1,549	19.4	18.7	61.4	3.9
1997	2,458	16.8	17.2	62.2	5.9
Average	1,251	23.4	27.0	40.8	4.7
Std. Dev.	563	6.6	8.5	12.8	1.8

[17] From Gorman and Sahlman (1989, p. 237), "Much more common is the phenomenon know (sic) euphemistically among venture capitalists as 'the living dead,' a phrase that refers to venture-backed companies that have failed to meet expectations but that nonetheless squeeze out a stable, independent existence."

successful venture investments over the total number of portfolio firms. Though it is possible that these investments will ultimately be acquired or even go public, the most likely result will be that the investments will be written off for a loss at the termination of the venture capitalists' partnership with the limited partners.

3.2. *Univariate results*

The principal issue addressed in this essay is whether venture capitalists' investment success rates are dependent on the number of entrepreneurial firms in the venture capitalists' portfolios. More specifically, following periods of increased fundraising, do venture capitalists

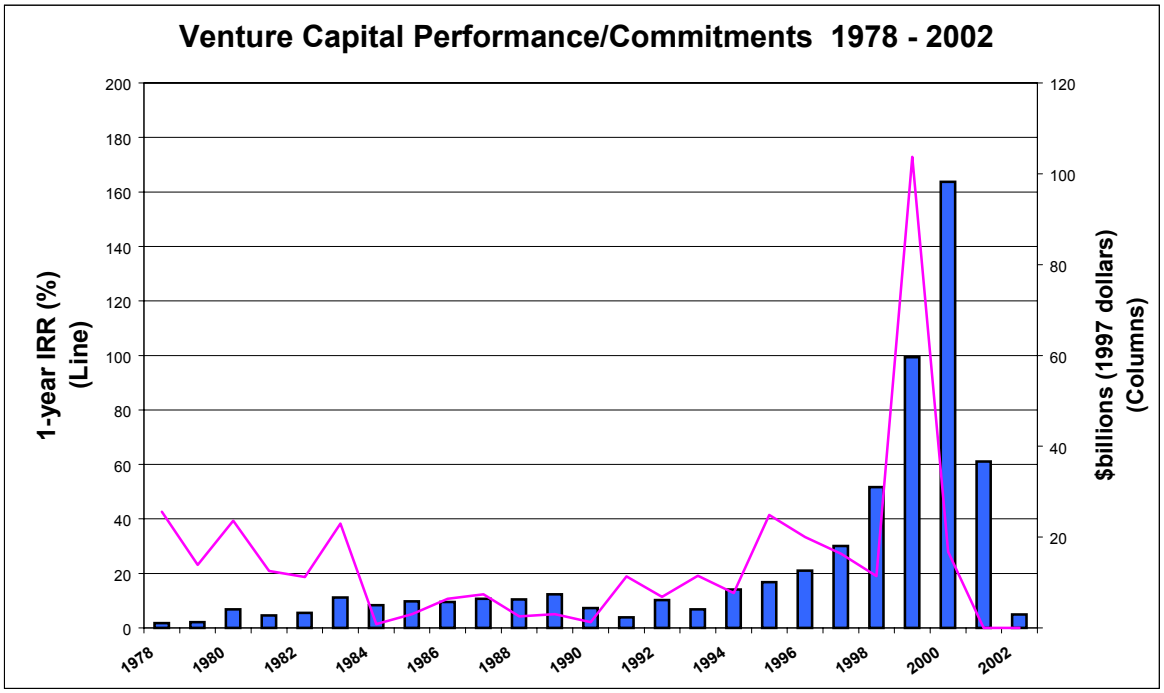

Figure 2

Commitments are defined as the amount of money pledged to venture capital funds in a given year. The data represents all commitments to venture capital funds raised by independent private partnerships in the U.S. that invest in U.S. firms reported to the SDC. Returns data are yearly, pooled internal rates of return (IRR) based on cash flows from/to investors net of all management fees, partnership expenses, and the fund managers' carried interest. Returns for 2001 and 2002 are negative.

overextend themselves by investing in too many firms? I seek to answer this question by examining venture capitalists' fund level data. It appears that periods of high returns are generally followed by periods of increased fundraising (see figure 2). The effects of increased fundraising on venture capitalists' investment behavior are less clear, and the potential consequences of changes in the risk levels of venture investments have not been fully addressed.

An examination of venture capitalist investment behavior would ideally be carried out using portfolio level data. This data is only available to the venture capital firms themselves; that is, venture capitalists aggregate investment data across whole funds before reporting the information to the SDC. Fund level data is therefore averaged across the number of venture capitalists at each fund for the purposes of this analysis.

Before I look at the influence of portfolio size on venture capitalist success rates, I first attempt to establish the existence of two observable facts. First, that the supply of venture capitalists is relatively inelastic in the short run. Given the significant barriers to entry in the venture capital industry, due to the need for a substantial accumulation of a unique set of job skills and a network of business contacts, I expect to find that the short run supply of venture capitalists is relatively inelastic. Second, that venture capitalists tend to increase the size of their portfolios following periods of increased fund inflows. As fund inflows increase, venture capitalists can either invest more in each portfolio company or increase the size of their portfolios. I expect that both outcomes will be observed over the time period under investigation.

As a measure of the elasticity of supply of venture capitalists, I calculate the percentage change in quantity of venture capitalists raising funds from year-to-year divided by the percentage change in aggregate 1-year internal rate of return (IRR). Since (potential) venture capitalists themselves have limited information regarding individual fund performance, it is

reasonable to assume that positive growth in aggregate returns would provide incentive for potential venture capitalists to enter the industry.[18] The average one-year elasticity of supply over the sample period is 0.84. This confirms the commonly asserted notion that the supply of venture capitalists is not elastic, at least in the short run.

The idea that the short run supply of venture capitalists is inelastic is assumed by Gompers and Lerner (2000) and Kanniainen and Keuschnigg (2002, 2003), and has received no argument in the literature. Gompers and Lerner (2000) further assume that venture capitalists refrain from overextending themselves during periods of increased inflows. The authors show that for their sample there is a tendency to increase the valuations for the portfolio companies, though they do not consider the alternative outcome of increasing portfolio size.

While Kanniainen and Keuschnigg (2002, 2003) focus on a marginal cost and marginal benefit analysis to establish a tradeoff between managerial advice and portfolio size, they also suggest that venture capitalists have a tendency to invest in too many portfolio companies following periods of increased fundraising. Panel A of Table 5 shows a comparison between average portfolio sizes in years with positive growth in fund commitments per venture capitalist versus years with negative growth in inflows. The mean number of investments per venture capitalist is 3.58 in those years that experienced a fall in fund commitments, while the average portfolio size is 4.95 when commitments increased. In other words, the average venture capitalist tends to invest in an average of 1.37 more entrepreneurial firms in years where more investment dollars are made available, compared to the prior year. Table 5 also reports the results of a univariate regression of portfolio size on average fund inflows per venture capitalist. The coefficient on my variable for fund inflows is positive and significant, providing further evidence

[18] As opposed to potential venture capitalists lured into the industry by inside knowledge of particular fund returns.

Table 5. Fund inflows' influence on average portfolio size

In Panel A, the sample is divided into funds created in years following positive growth in commitments per venture capitalist and years following negative growth in commitments per venture capitalist. Results of a Mann-Whitney U Test confirm that the difference in means is significant. Panel B shows the results of a univariate regression with average fund portfolio size as the dependent variable and average inflows per venture capitalist as the independent variable. P-values are in parentheses.

Panel A: Mean portfolio size in years with growth in investment dollars vs years with declining fund commitments

Fund Inflows per VC	Number of Funds	Mean Portfolio Size	Standard Deviation
Positive Growth	534	4.95	8.19
Negative Growth	565	3.58	8.02
Z-stat, Mann-Whitney U Test for independence:			-3.18 (0.001)

Panel B: Portfolio size regressed on fund commitments per venture capitalist

	Coefficient	t-stat
Intercept	3.35	15.03 (0.000)
Growth in Commitments	0.04	5.38 (0.000)

that venture capitalists increase their portfolio size as investors increase the supply of investment dollars. In other words, there is a tendency for the average portfolio size to increase when the venture capital industry raises more capital.

Given that venture capitalists show a propensity to increase the size of their investment portfolio during periods of increased fundraising, I seek to establish how this trend affects the likelihood of success for the portfolio companies. Since success rates are defined across portfolios, my dependent variable is a ratio defined as the total number of successful investments divided by the total number of companies in a venture fund portfolio. Because the data are not normally distributed, I use nonparametric tests of correlation between success rates and portfolio size.

Panel A of Table 6 reveals evidence of a tenuous relationship between venture capital portfolio size and success, though only for the definition of success that includes acquisitions. For the definition of success that includes acquisitions and IPOs, the correlation coefficient between success and portfolio size is 0.058, and it is significant at the 10% level. For IPOs only, there is no significant correlation. These correlation coefficients imply that a positive relationship exists between the number of portfolio companies per venture capitalist and the success rates of venture investments. This evidence contradicts the theoretical predictions of

Table 6. Univariate analyses of fund success rates

Panel A shows a correlation matrix with two measures of success and two measures of portfolio size. Portfolio success rates are: a) percentage of portfolio funds where a successful exit is defined as the portfolio company going public through an IPO (or registration for an IPO) or acquistion of the portfolio company, and b) percentage of portfolio funds where a successful exit is defined as the portfolio company going public through an IPO (or registration for an IPO). Portfolio size is given by the number of portfolio firms in each fund divided by the number of executives reported to the SDC. Correlation coefficients are Spearman's nonparametric correlation estimates. Panel B reports the results of OLS and two-limit tobit regressions of success rates on portfolio size. P-values are in parentheses.

Panel A: Correlations between portfolio success and size

	Success Rates (IPO or acquisition)	Success Rates (IPO only)	Portfolio Size
Success Rates (IPO or acquisition)	1 (0.000)	0.67 (0.000)	0.058 (0.056)
Success Rates (IPO only)		1 (0.000)	-0.010 (0.743)
Portfolio Size			1 (0.000)

Panel B: Portfolio success regressed on portfolio size

	OLS	**Tobit**
	Independent Variable: Portfolio Size	
Success Rates (IPO or acquisition)	0.0009 (0.267)	0.0009 (0.255)
Success Rates (IPO only)	-0.0004 (0.508)	0.0001 (0.983)

Kanniainen and Keuschnigg (2002); however, the significant coefficient is small in absolute terms and there is no significant relationship between the IPO only measure of success and portfolio size. It may be the case that the relationship is significant because more successful venture capitalists are more likely to get good projects, and therefore may be in a better position to increase the size of their portfolio. This will be taken into account in my multivariate analysis. For further insight, univariate regressions are carried out using both ordinary least squares (OLS) and a two-limit tobit model specification. Panel B reports the results of both models, which demonstrate a lack of any significant relationship between portfolio size and portfolio success rates.

I suspect that the ambiguity of these results may be driven by the fact that many other factors could influence the success rates of venture capital portfolios. Venture capitalists may change their investment strategy during periods of growth in fund inflows, as well as increase the average number of investments.[19] In the next section I will examine the effects of portfolio size on success rates in a multivariate framework in order to control for other factors that may influence venture capitalist success.

3.3. *Multivariate results*

While Gompers and Lerner (2000) find that the portfolio firms' probability of success may be independent of fund inflows, they suggest that venture capitalists change their investment approach during periods of increased fundraising. The authors show that portfolio companies have higher valuations during these periods, and the higher valuations are not due to changing

[19] As Gompers and Lerner (2000) suggest; though they show empirically that there is no tendency to shift investments to later stage firms during periods of high inflows. We draw a similar conclusion from our sample.

company characteristics. According to their analysis, venture capitalists tend to increase the amount of capital committed to firms when faced with growth in investment dollars. They also find that firms receive more money at each round of investment. These changes in investment strategy should result in higher-risk portfolios and therefore, lower success rates. When firms receive more capital at each round, a key monitoring device may be stripped from the venture capitalist if portfolio firms require less total rounds because of this change.

Gompers (1996) suggests that the entry of young, less experienced venture capitalists leads to a rush to take portfolio companies public. This "grandstanding" hypothesis is supported by empirical evidence and is caused by a need to establish a positive reputation in order to raise new funds. Inexperienced venture capitalists cannot credibly signal their ability to investors unless they have a track record of successfully bringing firms to IPO. Gompers interprets the cost of bringing a firm to IPO early as either a smaller equity stake in the firm or greater underpricing at the IPO. Another potential cost lies in the success rates of the other portfolio companies in the venture capitalist's fund. If bringing just one firm public early gives a new venture capitalist the ability to raise a follow-on fund, then it may be in the interest of the venture capitalist to focus his managerial advice on one or two of the best prospects in the portfolio.[20] This implies that the venture capitalists' overall portfolio success rates should fall, all else equal. Seasoned venture capitalists should have more success than those who are inexperienced, whether due to the grandstanding actions of inexperienced venture capitalists or improvements in human capital (development of network, better ability to conduct due diligence, etc.) over time. Age of the venture capitalists' firm when the funds are raised, and fund sequence number (1 for the venture capitalists' first fund, 2 for the second, etc.) will control for venture capitalists' experience.

[20] Gompers (1996, p. 137) provides anecdotal evidence that substantiates this possibility.

Older portfolio companies should be more likely to succeed, particularly if they are in the later stage of development, as much of the uncertainty concerning future revenues ought to be resolved over time. Therefore, my model will consider the average number of years since incorporation for the portfolio of firms as a control variable. Reputation may be important for the success rates of the venture capitalists' investments, if entrepreneurs with better projects seek out venture capitalists with better reputations. Gompers and Lerner (1998b) suggest that venture capitalists with good reputations are able to raise more total funds and larger funds. Total fund commitments will be used as a proxy for venture capitalist reputation. Industry effects may influence the results if some industries are known to have a higher risk/return profile. Portfolio companies are classified by the SDC into one of three general industries: information technology, non-high technology, or medical/health/life science. The percentage of the portfolio that consists of information technology companies will be used to control for any possible industry effects.

Gompers and Lerner (2000) find evidence that portfolio companies located in Massachusetts and California are more likely to have increased valuations around periods of growth in inflows. A large percentage of venture investment takes place in these locations and an even greater percentage of venture funds are located in these two states. I expect that being located in MA or CA could increase portfolio success rates either because of network effects or because of the lower monitoring costs associated with investment in portfolio firms that are located in the same state as the venture capitalist. A dummy variable set equal to one if the venture fund is located in either of these two states, and zero otherwise, will control for this effect.

I also control for the investment focus of the venture capitalists. Funds that focus on seed or early stage investment should have less success than those funds that invest in later stage or expansion stage firms. Seed and early stage portfolio companies may consist of little more than an idea or a prototype, while later stage and expansion stage companies typically are in production and theoretically much closer to a successful exit. A dummy variable is created that equals one if the fund focus is reported as either seed or early stage, and zero otherwise. Finally, if exit through IPO is easier during "hot markets", increases in success rates may be due to the easy access to the public markets, rather than optimal portfolio size or any other factor. I use the ratio of IPOs that occurred in a hot market to total IPOs as a control for market conditions. For my purposes, a hot market is defined as a year in which more than 600 IPOs occurred.[21]

The multivariate analysis is conducted using a two-limit tobit model. Given the fact that my dependent variable is a ratio, and therefore bounded by zero and one, the tobit specification is appropriate. Table 7 presents the results of the multivariate regressions. Most of the explanatory variables are significant in all of the models, except for the coefficients on my fund seed or early stage focus indicator variable. In all specifications, the number of investments per venture capitalist has a statistically significant negative impact on the success rate of venture portfolios. Marginal effects demonstrate the economic significance of this effect. The marginal effects, calculated at the mean of all other independent variables, range from -.0014 to -.0023, depending on the specification. This can be interpreted to mean that for every entrepreneurial firm added to a venture capitalist's portfolio, there is a decrease in the overall portfolio success rate of one- to two-thousandths of a percent. Though this sounds like a small figure, given the extraordinary sums of capital in the industry, as well as the reliance upon a small number of investments to

[21] This is the top 25% of years in our sample.

carry the overall portfolio returns, it could mean the difference between a profitable investment and a losing portfolio.

When I define success as IPO or acquisition, my proxy for the reputation of the venture capitalists, fund size, is negative and significant. My other independent variables are as predicted

Table 7. Multivariate analyses of fund success rates, portfolio size effects

This table reports the results of two-limit tobit regressions with successful exits defined as IPOs (or registration for an IPO) or acquisition or IPOs only. The dependent variable is the ratio of successful exits to total venture fund investments. Portfolio size is the number of portfolio firms per venture fund divided by the number of executives reported by the funds to SDC. Fund size is the total commitments in millions of 1997 dollars. Average portfolio company age is the average difference between the year the fund was created and the year each portfolio company was founded. Fund age is the difference between the year the fund was created and the venture capitalists' firm founding year. Fund number is the number of previous funds that the venture capital firm has raised previously plus one. High-tech is the percentage of the portfolio companies that are information technology firms. Hot market is the ratio of hot market IPOs to total IPOs (a year is classified as a hot market if there were more than 600 IPOs in that year). A dummy variable is set equal to one if the fund is located in MA

or CA and another dummy variable is set equal to one if the fund focused on seed or early stage investments. P-values are in parentheses.

	IPO or Acquisition		**IPO only**	
Intercept	.531 * (0.000)	.529 * (0.000)	.247 * (0.000)	.247 * (0.000)
Portfolio Size	-.00224 * (0.008)	-.00240 ** (0.013)	-.00179 ** (0.032)	-.00185 ** (0.027)
Fund Size	-.000204 ** (0.028)	-.000201 *** (0.062)	.0000962 (0.306)	.000118 (0.211)
Average Portfolio Company Age	.000264 * (0.000)	.000480 * (0.000)	.000712 ** (0.031)	.000709 ** (0.040)
Fund Age	.00265 * (0.003)		.00535 * (0.000)	
Fund Number		.00479 ** (0.035)		.00948 * (0.000)
High-tech	.0309 (0.162)	.0356 (0.168)	-.0707 * (0.002)	-.0657 * (0.004)
Hot Market	.000219 * (0.000)	.000235 * (0.000)	.000175 * (0.000)	.000170 * (0.000)
Fund in CA or MA	.0581 * (0.000)	.0680 * (0.000)	.0667 * (0.000)	.0664 * (0.000)
Seed or Early Stage Focus	-.0121 (0.345)	-.0115 (0.439)	.00846 (0.518)	.00924 (0.482)

*,**,*** indicates significance at the 1%, 5%, and 10% levels, respectively.

and significant, with the exception of the high-technology industry control variable. Portfolios that consist of older entrepreneurial firms are more likely to have higher success rates. My proxies for venture capitalist experience are positive and significant, implying that more experienced venture capitalists have higher success rates on average. My control variables for location and the effects of hot markets on success are significant and confirm my predictions. Funds that are located in Massachusetts or California are more likely to have higher success rates, as are funds that take advantage of IPO windows of opportunity.

The regression results are similar when the dependent variable is defined as success rates, considering only IPOs as a successful exit. Fund size is no longer significant and fund stage focus is still not a significant predictor of venture capitalists' success rates, but now there are significant industry effects. This can be explained by the fact that early and seed stage firms are less likely than later stage firms to reach an IPO due to the level of uncertainty surrounding their future. Specifying a dummy variable for later stage investments may capture this effect, but there are too few early stage investments that IPO for this variable to explain much of the success or failure of venture capitalist funds. Industry effects may be significant in this specification because of the reliance of high-tech firms on thriving IPO markets for success. In other words, high-tech firms may be looked at by venture capitalists as an all-or-nothing type of investment. The nature of this relationship warrants further examination.

4. *Conclusion*

The number of entrepreneurial firms in the venture capitalists' portfolios significantly affects portfolio success rates. This result is evident only when controlling for various other

influences on successful venture investing. The possibility that a trade-off exists as posited by Kanniainen and Keuschnigg (2003), that is, the entrepreneurs rationally anticipate that the venture capitalists will decrease their managerial influence and demand larger shares of their firms as compensation, is not necessarily ruled out by this analysis. However, I do find evidence that suggests that some optimal portfolio size exists. It would be useful to examine this issue using actual investment return data as well as individual investment contract information, rather than success rates based upon IPO or acquisition. Unfortunately, that data is fiercely protected by venture capitalists as recent news accounts report.[22]

This research contributes to the literature in two ways. First, I have presented evidence that venture capitalists have a tendency to increase their portfolio size in years following growth in fund inflows. This idea has received some attention in the literature, but has not been empirically tested. A further contribution is the examination of these changes in portfolio size on the success of venture investment portfolios. My results strongly suggest that portfolio size is an important determinant of venture capital portfolio success rates.

[22] As Daniel Gross reported for *Slate* magazine (September 17, 2003: http://slate.msn.com/id/2088544), several private equity funds are asking investors, including the University of California and the University of Michigan, to sell holdings rather than publicly divulge fund performance numbers. This issue arose in 2002 when the University of Texas Investment Management Company broke with tradition and published private equity returns.

Chapter 4: *"An Empirical Analysis of the Role of Distance and Location in Venture Capital Financing"*

Abstract

I examine the role of distance in venture capital investing. The majority of venture capital investment activity in the United States occurs in California and Massachusetts. However, growth in the industry over the past decade has led to an increase in activity outside of these areas. Alongside this development in venture investing outside of the traditional centers of activity, I find no tendency for the average distance between venture capitalists and portfolio companies to increase. I find evidence of network effects in California and Massachusetts and I also find that distance matters in venture investing. Firms that receive venture capital that are outside of California and Massachusetts, and firms that are farther away from the venture capitalists funding them, are less likely to achieve a successful exit. This result is robust even when controlling for other factors that influence the success of venture investments.

1. *Introduction*

Recent research by Peterson and Rajan (2002) has shown that distance between commercial banks and small business borrowers has become much less important due to improvements in information technology over time. They demonstrate a shift in the nature of small business lending from a focus on strict ex ante screening to less costly ex post monitoring. Firms in the venture capital industry provide capital to small businesses that are prohibitively risky for commercial banks. Venture capitalists do not typically have the benefit of prior relationships with entrepreneurs seeking venture capital as commercial banks may have with small businesses seeking loans, and they also tend to engage in a more active role in monitoring their investments. Because of this, it is less likely that technological improvements will allow for a similar shift from screening to monitoring in the venture capital industry.

Research in the venture capital field has emphasized the role of the venture capitalist in the ex post monitoring of their portfolio companies.[23] The extent of the monitoring role has been shown to be dependent upon the distance between venture capitalists and their investments. Lerner (1995) analyzes the differences in the monitoring intensity of venture capitalists when the distance to portfolio companies increases. He finds that venture capitalists are more likely to be board members of their portfolio firms if they are closer to the portfolio company. Because monitoring costs are higher the further away the firms are located, this conclusion is intuitive. The impact of these disparities in the monitoring of portfolio firms has yet to be analyzed. Because the monitoring role of the venture capitalist is considered to be so crucial to the

[23] See Gorman and Sahlman (1989) or Bygrave and Timmons (1992) for more on the role of venture capitalists in monitoring portfolio firms.

development of high-risk portfolio firms, my expectations are that portfolio firms that are further away from their nearest, associated venture firms will face a higher risk of failure.

This monitoring component of venture investing is the key difference between commercial bank lending and venture capital investing. Commercial banks have become more dependent on so-called, "hard" information in the monitoring of small business loans.[24] Hard information has become less costly to obtain in recent years due to advances in information technology, allowing for the role of distance to diminish in importance for commercial banking over time. While improvements in technology have made it less costly for distant firms to receive commercial bank financing, I predict that distance still matters for successful venture capital financing. Hard information may be helpful to venture capitalists in their monitoring role, but the traditional role of a venture capitalist in the development of portfolio companies requires frequent contact with firm management, through phone calls or visits to the firms, and often sitting on the board of directors, among other responsibilities. The nature of venture capital investing precludes a similar shift in focus from screening to less costly monitoring by use of hard information. The ex post monitoring of portfolio companies relies on the gathering and processing of soft information, as well as actively steering entrepreneurs in the right direction when necessary.

Butler (2002) examines the importance of distance in investment banking and demonstrates that soft information is still important to the municipal bond underwriting industry. Unlike commercial banks, investment banks have been unable to take full advantage of the recent changes in information technology. There is little need for ex post monitoring in investment banking, and improvements in the production of hard information may have limited benefits to the ex ante screening process. Thus, Butler concludes that local underwriters hold an

advantage over non-local underwriters, especially when underwriting high-risk or non-rated bonds. He interprets this result to show that local investment banks are better able to assess soft information, allowing them to charge lower underwriting fees and sell bonds at better yields.

1.1 *Network externalities*

Growth in venture capital investing in the 1990s was accompanied by some important changes in the industry, including the development of venture capital firms across the United States. In this essay I will look at the effects of the development of venture investing outside of the traditional centers of venture investment activity, Silicon Valley in California and Route 128 in Massachusetts. To be sure, these areas still dominate the investment activity that is tracked by the Securities Data Corporation. California and Massachusetts firms receiving venture capital accounted for $2.2 billion of the $4.2 billion in venture investments in the fourth quarter of 2002. There appear to be network benefits to operating venture capital firms near one another. Bygrave (1988) demonstrates the importance of information sharing between venture capitalists to the reduction of uncertainty concerning investments. The principal means of reducing risk is through the syndication of investments among a network of venture capital firms. Syndication allows a greater number of venture capitalists to screen potential investments, thus reducing the likelihood of investing in a poor project. Bygrave and Timmons (1992) further examine the importance of other network externalities that apparently influence venture investing. Venture capitalists often provide entrepreneurs a list of industry contacts to facilitate the development of the portfolio firm. These contacts may include accountants, lawyers, suppliers, and customers, relationships that are critical to the success of an entrepreneurial firm. It is not unreasonable to assume that

[24] Peterson (2002) defines hard information as information that may easily be reduced to numbers.

there are external benefits to operating a venture capital firm in regions of the country that are known to contain many such firms. These benefits may come in the form of a greater selection of industry contacts to choose from, or simply contacts that are amicable to the venture capitalists due to the volume of business that takes place between them. I will examine the importance of these potential network externalities alongside my exploration of the importance of distance in venture investing.

I will proceed with a detailed look at the empirical data in order to determine trends over the past 20 years regarding the distance between venture capitalists and their portfolio companies. It is expected that growth in the 1990s encouraged entry into the venture capital industry, and along with entry I expect that I will find geographic expansion of the industry into states with little prior venture activity. It is possible that I will see some changes in the distance between venture capitalists and portfolio firms over this time period because of the lack of an established venture capital industry in these states. Since entrepreneurs are aware of the strength of the industry in these two states, as well as their relative strengths in different industries, venture capitalists that operate in California and Massachusetts are inundated with proposals for investment.

Venture capitalists operating outside of Massachusetts and California may be forced to consider firms that are further from their offices because of the lack of good investment projects in close proximity. On the other hand, venture capitalists looking to expand into other parts of the country may chose to operate from California or Massachusetts to take some advantage of network externalities, but finance portfolio companies outside the state. In either case, any

increase in distance between venture firms and entrepreneurs should have consequences since monitoring intensity has been shown to fall as this distance increases.[25]

2. *Data analysis*

It is useful to first establish if there is any evidence that the distance between venture capitalists and their portfolio firms has changed over time. I can also determine whether there have been trends in venture investing outside of California and Massachusetts that run counter to these two crucial venture capital hubs. I will describe the data set before I proceed to the analysis.

2.1 *Sample description*

A sample of 10,092 continental U.S. companies that received venture capital funding between January 1978 and December 1997, was drawn from the Securities Data Corporation (SDC) VentureXpert database. The sample is limited to those portfolio companies that received venture capital from independent private partnerships in the U.S. and that report to the SDC.[26] Table 8 provides descriptive statistics of the sample by year. While there have been fluctuations from year-to-year, it is clear from the average distance statistic that there has been no tendency for the distance between venture capitalists and their investments either to increase or to decrease over the sample period.

[25] Lerner (1995) finds that a venture investor with an office within 5 miles of a portfolio company has a 47 percent probability of serving on the board, while a venture capitalist whose nearest office is 500 miles away has a 22 percent chance of serving as a director for that portfolio company.

Table 8. Sample description by year (c)

The sample represents all continental U.S. firms receiving venture capital from U.S. venture funds, organized as independent private partnerships, that have non-missing data for the time period studied and are found in the SDC VentureXpert Database as of July 2003. The total number of portfolio companies for any given year overstates the total number of companies receiving venture capital due to the fact that many venture investments are syndicated and therefore, more than one fund may have an investment role in any portfolio firm and many firms receive multiple rounds of venture funding. Average Distance is the yearly average distance in miles between venture capitalists and their investments (portfolio companies). All states includes all continental U.S. states while All States but CA or MA drops the portfolio companies from these two states from the sample. The final column gives the percentage of venture activity that lies outside of CA and MA for each year.

	All States		**All States but CA or MA**		
Fund Year	Total Portfolio Companies	Average Distance	Total Portfolio Companies	Average Distance	% outside CA & MA
1978	613	956	245	942	0.40
1979	340	725	129	852	0.38
1980	1,103	889	365	1,003	0.33
1981	1,496	895	583	918	0.39
1982	1,603	901	629	779	0.39
1983	1,928	923	874	724	0.45
1984	2,351	918	1,072	777	0.46
1985	1,221	782	647	717	0.53
1986	1,163	754	590	551	0.51
1987	1,420	778	793	690	0.56
1988	1,085	832	533	822	0.49
1989	1,141	751	466	798	0.41
1990	514	920	261	674	0.51
1991	373	868	158	954	0.42
1992	899	935	363	896	0.40
1993	912	852	474	761	0.52
1994	959	692	468	756	0.49
1995	1,384	892	548	946	0.40
1996	1,409	882	630	873	0.45
1997	2,384	786	1,172	789	0.49
Average	1,215	847	550	811	0.45
Std. Dev.	568	78	276	113	0.06

I speculate that more recent growth in venture activity has occurred outside of California and Massachusetts and if true, that I should find a difference in average distance between these portfolio companies and their respective venture firms. This is in fact not supported by the data.

[26] Private partnerships account for the vast majority of all venture capital raised over the time period of interest and have emerged as the dominant organizational form in the industry (approximately 80% of commitments in recent years according to Gompers (1998)).

There has been no tendency for venture activity outside of California and Massachusetts to increase at a faster rate than within these two states over the sample period. The average distance between portfolio firms and venture capitalists also appears to be unrelated to whether or not the portfolio firm is operating in either of these two states.

2.2 *Univariate analysis*

Ideally I would examine the actual returns from each investment in order to determine the relative success across my sample. This data is not publicly available, so I use the eventual outcome of the investments as a proxy. Following Gompers and Lerner (1998a, 2000) and Santhanakrishnan (2002), a venture capital investment is classified as a success if the portfolio company was acquired or if the company went public through an IPO (or was in registration for a public offering).[27] Table 9 shows the distribution of investment outcomes across the twenty-year sample period. In most years, companies receiving venture capital were more likely to remain private than any other outcome. This is considered a failed investment and these companies are commonly referred to as "the living dead."[28] While these firms may be successful from the viewpoint of the entrepreneurs involved, it is unlikely that the venture capitalists will earn any significant profit from the majority of this type of deal.

I first organize the dataset into pairs of venture capital funds and portfolio firms. I then focus my analysis on the pair with the shortest distance between offices. The closest venture

[27] Gompers and Lerner (1999, p.23) cite a 1988 Venture Economics study entitled *Exiting Venture Capital Investments* that finds that a $1 investment in a firm that goes public provides a 295% average return over an average of 4.2 years. The next best payoff is 40% over 3.7 years, on average, to investments in acquired firms. Gompers and Lerner (2000) include only those acquisitions at more than 2 times valuation as successful exits. SDC does not maintain the valuation data needed to make that distinction.

Table 9. Investment outcomes by year (b)
The table presents outcomes for the sample portfolio companies by year. The total number of portfolio companies for any given year overstates the total number of companies receiving venture capital due to the fact that many venture investments are syndicated and therefore, more than one fund may have an investment role in any portfolio firm. Less than 0.5% of the total number of portfolio companies do not fall into any of these categories due to name change, withdrawn IPO registration, or unknown status.

Fund Year	Total Portfolio Companies	Initial Public Offering Complete (or IPO filing)	Acquired	Still Private	Defunct
1978	623	25.0%	35.2%	34.3%	5.3%
1979	313	25.2	38.0	30.0	6.4
1980	892	23.7	36.1	33.7	6.5
1981	1,453	21.8	34.0	36.8	7.1
1982	1,518	20.7	35.7	37.7	5.9
1983	1,900	26.0	31.3	36.5	6.5
1984	2,295	22.6	34.5	35.7	6.9
1985	1,428	25.5	26.4	43.7	4.6
1986	1,206	24.1	30.2	40.2	5.1
1987	1,527	25.1	27.7	43.2	3.6
1988	1,129	28.9	29.9	39.8	2.3
1989	1,206	27.3	29.7	38.9	4.1
1990	603	29.1	25.7	43.1	3.6
1991	404	33.3	27.4	36.9	4.9
1992	1,034	28.4	26.9	43.8	2.1
1993	977	24.9	26.4	45.4	4.2
1994	1,068	24.1	22.1	50.9	4.4
1995	1,444	21.4	20.8	54.8	5.9
1996	1,549	19.4	18.7	61.4	3.9
1997	2,458	16.8	17.2	62.2	5.9
Average	1,251	23.4	27.0	40.8	4.7
Std. Dev.	563	6.6	8.5	12.8	1.8

capitalist is most likely to take the more active role in portfolio company development. I then take two separate approaches to see if distance affects the success rates of my sample portfolio companies.

First, the venture capitalist-portfolio firm pairs are classified as local if there is at least one venture investor that is in the same state as the portfolio firm. About half of the sample firms

[28] From Gorman and Sahlman (1989, p. 237), "Much more common is the phenomenon know (sic) euphemistically among venture capitalists as 'the living dead,' a phrase that refers to venture-backed companies that have failed to meet expectations but that nonetheless squeeze out a stable, independent existence."

have received venture capital from more than one fund. If the portfolio firms only receive venture funds from out-of-state venture capitalists, the relationship is considered non-local. Average success rates for pairs of entrepreneurial firms and venture investors that are local will be compared with those of non-local pairs. This approach follows that of Butler (2002) and suffers from the fact that a great deal of venture activity may occur within a large state, classified as local, and yet the venture capitalists could be hundreds of miles away from the portfolio firms. This approach has more resonance in the context of Butler's examination of distance in an investment banking setting because of the focus on the importance of soft information, local knowledge of state banking regulation, and potential political influence in underwriting public bond issues.

In the second approach I group the portfolio company-venture capitalist pairs into quartiles by actual distance[29]. The top quartile represents those portfolio companies that are within 12.90 miles of the nearest venture investor, while the bottom quartile encompasses pairs that are greater than 787 miles apart. This approach deals more directly with the question I am trying to answer as I speculate that venture investors are less likely to fully participate in the active monitoring of portfolio firms as the distance between them and their investments increases.

Table 10, Panel A shows that there is some evidence that the longer the distance between a portfolio company and it's closest venture capital investor, the less likely the portfolio company will be successful. While there is no difference between the likelihood of an IPO for the sample firms, portfolio companies in my sample were more likely to be acquired when at least one venture capitalist was located in the same state. The success rate for in-state pairs is

[29] A software program, called ZIPFind® Deluxe 5.0, was used to calculate the distance between postal codes of the portfolio company-venture capitalist pairs.

.024 higher than that of out-of-state pairs, which is statistically significant at the 5% level. Panel B shows the results when looking at actual distance.

Table 10. Univariate analysis distance effects

The table presents success rates for sample portfolio companies. Panel A shows the difference in the success rates for portfolio companies that have at least one in-state venture investor compared with the success rates for portfolio companies that do not have a single in-state venture investor. Panel B shows the difference in the success rates for portfolio company (PC) - venture capitalist (VC) pairs grouped by distance quartile. The first quartile consists of PC-VC pairs below 12.90 miles apart, the second quartile 12.90 - 110.91, the third 110.92 - 787.66, and the last quartile are pairs separated by more than 787.66 miles. P-Values are in parentheses.

Panel A: In-state versus Out-of-state PC-VC pairs

	In-state	Out-of-state	
Number of Pairs	5221	4871	
Success Rates (IPO only)	0.1712	0.1790	
t-test, Difference in Success Rates:			-1.029 (.304)
Success Rates (IPO or Acquisition)	0.4403	0.4163	
t-test, Difference in Success Rates:			2.434 (.015)**

Panel B: PC-VC pairs by distance quartile

	1st	2nd	3rd	4th
Number of Pairs	2540	2506	2523	2523
Success Rates (IPO only)	0.1854	0.1692	0.1645	0.1807
t-test, Difference in Success Rates between 1st and 4th quartile:				.432 (.666)
Success Rates (IPO or Acquisition)	0.4504	0.4461	0.4162	0.4023
t-test, Difference in Success Rates between 1st and 4th quartile:				3.463 (.001)***

The difference between the success rates of the top quartile versus the lowest quartile is once again insignificant for IPOs only, but significant for the measure of success that includes acquisitions. Firms receiving venture capital that are relatively close to the nearest venture investor are more likely to successfully IPO or be acquired than those that are relatively far away from the nearest venture investor. The firms in the top quartile were successful 45% of the time, as opposed to the firms in the bottom quartile success rate of 40%.

Since I am looking for evidence of network effects in the venture industry, I further classify the portfolio companies in my sample by state and Metropolitan Statistical Area (MSA). My ex ante conjecture is that success rates for entrepreneurial firms in Massachusetts and California will be higher than the average across all other states. This effect should be even more dramatic in a comparison between firms located in the Boston, San Jose, or San Francisco metropolitan regions, and those in all other areas of the country. These are the top three metropolitan regions in both total venture deals and total dollars invested, and are the traditional centers of venture investing in the United States.

Table 11. Univariate analysis network effects

The table presents success rates for sample portfolio companies. Panel A shows the difference in the success rates for portfolio companies that are located in California or Massachusetts versus those outside of these two states. Panel B shows the difference in the success rates for portfolio companies located in the top three Metropolitan Statistical Areas (MSAs) for venture investment dollars, Boston, San Jose and San Francisco versus portfolio companies outside of these areas. P-Values are in parentheses.

Panel A: California and Massachusetts versus all other states

	CA or MA	All other states	
Number of PCs	4725	5367	
Success Rates (IPO only)	0.1835	0.1675	
t-test, Difference in Success Rates:			-2.109 (.035)**
Success Rates (IPO or Acquisition)	0.4601	0.4012	
t-test, Difference in Success Rates:			-5.981 (.000)***

Panel B: Boston, San Jose and San Francisco versus all other MSAs

	Top 3 MSA	All other MSAs	
Number of PCs	2995	7097	
Success Rates (IPO only)	0.1866	0.1701	
t-test, Difference in Success Rates:			-2.002 (.045)**
Success Rates (IPO or Acquisition)	0.4604	0.4154	
t-test, Difference in Success Rates:			-4.181 (.000)***

Table 11 presents the results of these univariate analyses. Regardless of the measure of success, the data supports the theory that the long-established centers of venture activity in California and Massachusetts are more conducive to successful venture investing. Panel A shows that the rate of successful exit via IPO for firms receiving venture capital in Massachusetts and California is 18.4% versus 16.8% for portfolio companies in all other states. A *t*-test shows that the difference is significant at the 5% level. When considering acquisitions as successful exits, the effects are even more impressive: 46.0% versus 40.1%, significant at the 1% level. Similar results are reported in Panel B, which breaks down the portfolio companies by MSA. Entrepreneurial firms located in the Boston, San Jose, or San Francisco metropolitan regions are more likely to successfully IPO or be acquired.

Because there are likely many determinants of success in venture investing, I suspect that other factors may be driving the results of my univariate analysis. In the subsequent section, I will examine the effects of both distance and network effects on success in a multivariate framework in order to control for other factors that may influence the chances of a successful exit for portfolio companies receiving venture capital.

2.3 *Multivariate analysis*

Gompers and Lerner (2000) analyze success rates of firms receiving venture capital during periods of increased commitments and find that the portfolio firms' probability of success are independent of fund inflows. While they do not examine success rates in a multivariate framework, they do explore potential factors that may influence the *valuation* of venture investments. Gompers and Lerner (2000) examine the impact of fund inflows on venture capital

valuations. They are able to show that portfolio companies have higher valuations during periods of increased inflows, and the higher valuations are not due to changing company characteristics. According to their analysis, venture capitalists tend to increase the amount of capital committed to firms when faced with growth in investment dollars. Several of the factors used in their analysis will be used to control for any effects that they may have on portfolio company success rates. Other factors are based upon prior literature.

Gompers (1996) suggests that the entry of young, less experienced venture capitalists leads to a rush to take portfolio companies public. This "grandstanding" hypothesis is supported by empirical evidence and is caused by a need to establish a positive reputation in order to raise new funds. Inexperienced venture capitalists cannot credibly signal their ability to investors unless they have a track record of successfully bringing firms to IPO. Gompers interprets the cost of bringing a firm to IPO early as either a smaller equity stake in the firm or greater underpricing at the IPO. Another potential cost lies in the success rates of the other portfolio companies in the venture capitalist's fund. If bringing just one firm public early gives a new venture capitalist the ability to raise a follow-on fund, then it may be in the interest of the venture capitalist to focus his/her managerial advice on one or two of the best prospects in the portfolio.[30] This implies that the other firms in a venture portfolio should have less likelihood of success, all else equal. Regardless, seasoned venture capitalists should have more success than those who are inexperienced, whether due to the grandstanding actions of inexperienced venture capitalists or improvements in human capital over time. I use the average age of the venture capital firms investing in each portfolio company as a control for venture capitalists' experience.[31]

[30] Gompers (1996, p. 137) provides anecdotal evidence that substantiates this possibility.
[31] In cases where the SDC data is inconsistent, the fund age is set to zero.

Older portfolio companies should be more likely to succeed, particularly if they are later stage firms, as much of the uncertainty concerning future revenues ought to be resolved over time. Therefore, my model will consider the number of years since incorporation for the portfolio firms as a control variable for company age.[32] Reputation may be important for the success rates of the venture capitalists' investments, if entrepreneurs with better projects seek out venture capitalists with better reputations. Gompers and Lerner (1998b) suggest that venture capitalists with good reputations are able to raise more funds and larger funds. Total fund commitments will be used as a proxy for venture capitalist reputation. Industry effects may influence the results if some industries are known to have a higher risk/return profile. Portfolio companies are classified by the SDC into one of three general industries: information technology, non-high technology, or medical/health/life science. A dummy variable that is set equal to one if the company is in an information technology industry, and zero otherwise, will control for industry effects.

Finally, if exit through IPO is easier during "hot markets", increases in success rates may be due to the easy access to the public markets, rather than distance or any other factor. I use a dummy variable that equals one if the firm conducted an IPO in a hot market, and zero otherwise. For my purposes, a hot market is defined as a year in which more than 600 IPOs occurred.[33]

The multivariate analysis is conducted using logit regression. The dependent variable is set equal to one if the portfolio company was acquired or went public through an IPO.[34] The model to be tested is:

[32] The sample size drops from 10,092 portfolio companies to 8,273 in models including portfolio company age due to limited data availability.
[33] This is the top 25% of years in our sample.
[34] We also run all regressions with IPO only as the definition of success.

$$SUCCESS = \beta_0 + \beta_1 LOCAL/DISTANCE + \beta_2 FUND\_SIZE + \beta_3 CO\_AGE + \beta_4 FUND\_AGE + \beta_5 HIGH\_TECH + \beta_6 HOT\_MARKET + \beta_7 CA\_MA/TOP3\_MSA + \varepsilon$$

where,

SUCCESS	is a dummy variable set equal to one if the portfolio company was acquired or went public through an IPO, and zero otherwise;
LOCAL	is a dummy variable set equal to one if the portfolio company received capital from at least one venture fund located in the same state, and zero otherwise;
DISTANCE	is the distance in miles between the portfolio company and the nearest venture investor;
FUND_SIZE	is the average amount of money raised by the venture funds investing in the portfolio company;
CO_AGE	is the age of the portfolio company at the time of its initial investment;
FUND_AGE	is the average age of the venture funds investing in the portfolio company;
HIGH_TECH	is a dummy variable set equal to one if the portfolio company is an information technology firm, and zero otherwise;
HOT_MARKET	is a dummy variable set equal to one if the portfolio company IPO'd during a hot market, and zero otherwise;
CA_MA	is a dummy variable set equal to one if the portfolio company is located in California or Massachusetts, and zero otherwise;
TOP3_MSA	is a dummy variable set equal to one if the portfolio company is located in Boston, San Jose, or San Francisco.

Table 12 contains the results of my multivariate analysis. Regarding the impact of distance on portfolio company success, the multivariate results mirror my findings in the

Table 12. Multivariate analyses of portfolio company success rates [IPO or Acquisition]

This table reports the results of logit regressions with successful exits defined as IPOs (or registration for an IPO) or Acquisitons. Distance is the distance in miles between portfolio companies and the nearest venture investor. Same-state is a dummy variable equal to one if the portfolio company is located in the same state as at least one venture investor. Fund size is the log of the average total fund commitments in millions of 1997 dollars for each fund invested in the portfolio company. Portfolio company age is the difference between the year the portfolio company received initial venture funding and the year of incorporation (or zero if negative.) Average fund age is the average difference between the year each fund was created and the venture capitalist firms' founding year. High-tech is a dummy variable set equal to one if the portfolio company is an information technology firm. Hot market is a dummy variable equal to 1 if the portfolio company IPO'd in a hot market year (a year is classified as a hot market if there were more than 600 IPOs in that year). A dummy variable is set equal to one if the entrepreneurial firm is located in Massachusetts or California and

zero otherwise. Top3 MSA is a dummy variable set equal to onefor the top three venture capital Metropolitan Statistical Areas (MSAs), and zero otherwise. P-values are in parentheses.

	Independent variable: Portfolio Company Success				
Intercept	-1.099 (.0000)*	-.964 (.0000)*	-1.141 (.0000)*	-1.000 (.0000)*	-.940 (.0000)*
Distance	-.0000747 (.0041)*	-.0000669 (.0199)**			-.0000628 (.0296)**
Same state			.311 (.5050)	.0716 (.1467)	
Portfolio company age		.0154 (.0000)*		.0149 (.0000)*	.0149 (.0000)*
Average fund age	-.00405 (.1100)	-.00687 (.0168)**	-.00443 (.0804)***	-.00708 (.0136)**	-.00690 (.0162)**
Average fund size	.131 (.0000)*	.124 (.0000)*	.129 (.0000)*	.129 (.0000)*	.131 (.0000)*
High-tech	.226 (.0000)*	.196 (.0000)*	.227 (.0000)*	.205 (.0000)*	.208 (.0000)*
Hot market	3.023 (.0000)*	2.876 (.0000)*	3.024 (.0000)*	2.881 (.0000)*	2.881 (.0000)*
Fund in top 3 MSA				.116 (.0306)**	.128 (.0123)**
Fund in CA or MA	.176 (.0000)*	.204 (.0000)*	.168 (.0004)*		

*,**,*** indicates significance at the 1%, 5%, and 10% levels, respectively.

preceding univariate analysis. Distance is not a significant determinant of portfolio company success when limiting the definition of success to IPO only. However, when acquisitions are considered to be successful venture investments along with IPOs, distance is significantly related to entrepreneurial firm success. Entrepreneurial companies that are farther away from their nearest venture investors are less likely to succeed via IPO or acquisition.

These results are only significant when considering the actual distance between venture capitalists and portfolio firms. Using the local versus non-local approach of Butler (2003) gives no conclusive evidence that distance is an important factor in venture investing. This is not surprising given the concentration of venture activity in California and, to a lesser extent, Texas, where firms may be hundreds of miles away from their nearest venture investor yet be considered local if they are in the same state.

All of my other independent variables are significant and match my predictions with the exception of average fund age. This variable was predicted to be positive as a proxy for venture capitalist experience. One would reasonably expect that more experienced venture investors would drive higher success rates in portfolio firms. In one specification this variable is negative and insignificant, while in the others it is negative and significant. This may be due to the fact that many venture investments are syndicated and it is possible that taking the average fund age distorts the influence of venture experience on portfolio company success. Also, data in the VentureXpert database is often inconsistent or illogical. In this case, venture capitalists' fund age is biased downward because where the SDC data was inconsistent I set the fund age to zero rather than dropping the data. Despite problems with fund age as a predictor of portfolio company success, the other predictors are consistent with my ex ante expectations.

Portfolio company age is positive and significant, as is the average fund size. Whether or not average fund size is a reasonable proxy for venture capitalist reputation, it is highly significant in my regressions and captures some effect on venture portfolio company success. My indicator variables for both high technology firms and hot market years are also positive and highly significant. Controlling for these industry effects and market fluctuations enables me to take in a much clearer picture of how distance influences success.

The significance of my last two variables of interest substantiates the evidence of network effects found in the previous section. Considering the Boston, San Jose and San Francisco MSAs, or just the states of California and Massachusetts, firms receiving venture capital in these areas are more likely to be successful venture investments. These areas of the country lead the United States in venture activity year after year because there are positive network externalities present that influence the success rates for entrepreneurial firms.[35]

3. *Conclusion*

I set out to examine the role of distance in venture capital investing. I have found evidence that supports my predictions that distance is a significant determinant of venture capital portfolio company success. I did not find any evidence that distance between venture capitalists and their portfolio firms has changed over the time period under study, nor did I find evidence that a greater percentage of investment was taking place outside of the two major hubs of venture activity, California and Massachusetts. The development of the venture capital industry outside of these two states is an interesting topic for future research. Is it possible to replicate the success

of the venture markets in California and Massachusetts, and what areas of the country would make the ideal candidate for such a leap in both volume and success? Venture activity in these two states has been shown to be more likely to result in a successful IPO or acquisition for the entrepreneurial firm, so there are incentives for entrepreneurs to seek venture funding in these states first.

As a corollary to my findings on the importance of distance and location for venture investing, I have confirmed that at least several other factors have some ability to influence venture success rates. While these factors have been introduced as potential indicators of venture portfolio firm valuations (Gompers and Lerner, 2000), very little work has been done looking at the determinants of success in venture investing. I propose that the factors discussed in this paper are a good start for future research of this question.

[35] This is consistent with the findings of Florida and Smith (1993), who determine that capital mobility occurs, but it is not due to unimpeded capital markets, rather through the network structure of the venture capital industry. Their focus is on the geographic effects of the venture industry.

Chapter 5: *"Specialization versus Diversification in Venture Capital Investing"*

Abstract

I examine the benefits of a strategy of specialization versus diversification in venture capital investing. While modern portfolio theory demonstrates that a well-diversified portfolio will eliminate unsystematic risk, it may be impractical to achieve a well-diversified portfolio of venture capital investments due to market imperfections. Given the high risk-return profile, and the disproportionate information costs associated with venture investments, a strategy of specialization has come to dominate the industry. An analysis of venture capitalists' portfolio success rates suggests that this strategy may be flawed. I find that venture capitalists that diversify across portfolio company stage of development have greater success in bringing companies public and exiting their investments via acquisition. Diversification across industry appears to have no impact on venture fund success rates.

1. *Introduction*

Modern portfolio theory demonstrates that diversification across a portfolio of investments is an optimal approach to minimize unsystematic, or firm-specific, risk. In venture capital investing however, an alternative strategy of specialization in specific industries and stage of development of portfolio firms has been shown to dominate. Norton and Tenenbaum (1993) examine survey responses of 98 venture capitalists and show that venture capitalists involved in seed round financing are less diversified across firms and industries, and that venture capitalists are more likely to specialize in specific stages of development rather than diversify. Gupta and Sapienza (1992) find a similar tendency for early-stage venture firms to specialize in industry and geographic scope. Their findings are consistent with Bygrave (1987) and Sahlman (1990) who emphasize the importance of specialized information gathering and information sharing in the venture capital industry, as well as the development of networks of relationships. These networks allow venture capitalists to reduce investment uncertainty through syndication and are integral to the success of venture investments.

Specialization in venture investing has benefits in both the ex ante screening of potential investments, as well as in the ex post monitoring of portfolio firms. Specialized industry knowledge is costly to accumulate and the development of this knowledge may provide the venture capitalist with a competitive advantage over those who pursue a strategy of diversification. Perhaps more importantly, a venture capitalist that focuses on a particular industry is more likely to develop strong relationships within the industry that may facilitate the development of portfolio firms. These relationships may be beneficial because of the unique emphasis on active portfolio management found in venture capital investing. Venture capitalists

provide entrepreneurs with industry contacts such as accountants, patent lawyers, marketing consultants and suppliers, that aid in the growth of the firm. Venture capitalists may even get involved in operations-level decision-making of the firms in their portfolio, if warranted.[36] All of these activities require some level of human capital that is costly to acquire. I suggest that an adequate level of industry knowledge is very costly to acquire for successful venture investing in several, unrelated industries. In other words, the costs of diversifying a venture capital portfolio outweigh the risk-reducing benefits.

This may also hold for diversifying venture funds across portfolio company stage of development. It may be in the interest of the venture capitalists to have several portfolio companies close to going public (or acquisition) during any particular year. If venture capitalists can successfully time the market, then it may be possible to earn higher returns when market conditions are more favorable. Since it may take several years to get an entrepreneurial company ready for the public markets, having a portfolio of companies diversified across stage of development would allow the venture capitalists to take advantage of any windows of opportunity that may develop. However, it may be just as difficult to diversify across stage of development, as it is to diversify across industry. Firms receiving venture capital in the early stages of development may have as little as an idea for a product, while those firms in the later stages of development typically have full production of some product and sometimes have already achieved profitability. It is likely that firms in later stages of development should need a different set of managerial skills than the early stage firms. It may be overly costly to acquire the

[36] Jones and Rhodes-Kropf (2002) demonstrate that venture capitalist's exposure to idiosyncratic risk is necessary to alleviate principal-agent problems between the venture capitalists and limited partners, and this risk is priced even if screening costs alone are accounted for. They suggest that after-investment advice only exacerbates the pricing of idiosyncratic risk in venture investments. In either case, their model corroborates the evidence presented in this paper that the benefits of specialization outweigh the costs.

skills necessary to properly advise a portfolio of entrepreneurial firms diversified across stage of development.

An emphasis on specialization rather than diversification has also been documented in the commercial banking literature. Winton (1999) develops a model in which banks that enter new sectors encounter a higher risk of bank failure. He suggests that there may be gains to diversification when banks have moderate exposure to downside risk, but that specialization is preferred under low or high downside exposure. More recently, Delong (2001) finds that announcements of bank mergers that increase banking activity or geographic focus are followed by positive abnormal returns, while diversifying mergers do not create value. This is consistent with the results of Acharya, Hasan, and Saunders (2002), who examine the effects of focus versus diversification in bank loan portfolio risk and return and find that loan diversification may increase overall portfolio risk.

I will proceed by classifying my dataset into relatively diversified versus relatively specialized venture capital funds by industry and stage of development of portfolio firms. I will then examine the consequences of the impact of this diversification choice on venture fund success rates in a univariate and multivariate framework. I expect to find that venture capitalists that have pursued a strategy of specialization will produce more Initial Public Offerings (IPOs) and acquisitions than those who chose to diversify their portfolios across industry and/or stage of portfolio company development.

2. *Data analysis*

It is useful to look for trends in the data that support prior research concerning venture capitalist's diversification strategy. I will describe the data set before I proceed to the analysis.

2.1 *Sample description*

A sample of 1247 U.S. venture capital funds, formed between January 1978 and December 1997, was drawn from the Securities Data Corporation (SDC) VentureXpert database.[37] The sample was limited to independent private partnerships that raised funds specifically for investment in U.S. portfolio companies and it represents all funds maintained in the SDC database with non-missing data on fund size and other fund characteristics.[38] I drop funds that have invested in fewer than three portfolio companies in order to analyze the effects of diversification on portfolio success rates. This leaves me with a total of 1099 venture funds in my final sample. Table 13 provides descriptive statistics of the data by year.

The SDC VentureXpert database classifies portfolio companies into 10 industries and several stages of development. In order to analyze the level of diversification for the sample funds, I classify portfolio companies into one of three broad categories of stage of development: *early*, *middle* or *later*. *Early* stages include seed, early and startup stages, first or second stages

[37] The VentureXpert database has records as far back as 1962; however, according to Lerner (1995), data collection was not a primary focus before mid-1977 for Venture Economics (subsequently acquired by SDC).
[38] Private partnerships account for the vast majority of all venture capital raised over the time period of interest and have emerged as the dominant organizational form in the industry.

Table 13. Sample description by year (d)

The sample represents all U.S. venture funds, investing in U.S. firms, that are organized as independent private partnerships, have non-missing data for the time period studied and are found in the SDC VentureXpert Database in February 2003. Fund inflows are total commitments to venture funds by investors, measured in millions of 1997 dollars. The total number of portfolio companies for any given year overstates the total number of companies receiving venture capital due to the fact that many venture investments are syndicated and therefore, more than one fund may have an investment role in any portfolio firm. Total venture capitalists are proxied by the total number of executives reported by the funds to SDC.

Fund Year	Number of Funds	Total Portfolio Companies	Fund Inflows	Total Venture Capitalists
1978	14	623	$294.30	181
1979	11	313	227.20	167
1980	26	892	703.80	342
1981	45	1,453	1,135.40	436
1982	53	1,518	1,345.00	496
1983	76	1,900	2,027.50	686
1984	84	2,295	2,593.40	966
1985	57	1,428	1,684.90	634
1986	56	1,206	1,855.40	503
1987	73	1,527	2,807.70	817
1988	64	1,129	3,627.20	650
1989	75	1,206	2,679.10	840
1990	40	603	2,038.10	474
1991	33	404	1,235.30	348
1992	53	1,034	2,851.90	730
1993	65	977	3,295.60	711
1994	72	1,068	4,169.40	775
1995	105	1,444	6,525.90	1,184
1996	87	1,549	7,217.10	1,063
1997	158	2,458	14,756.80	1,922
Total	1247	25,027	63,071.00	13,925

are considered the *middle* stages, and *later* stages include the expansion and third stages as well as bridge financing.[39]

Ideally I would examine the actual returns from each investment in order to determine the relative success across my sample. This data is not publicly available, so I use the eventual outcome of the investments as a proxy. Following Gompers and Lerner (1998a, 2000) and Santhanakrishnan (2002), a venture capital investment is classified as a success if the portfolio

company was acquired or if the company went public through an IPO (or was in registration for a public offering).[40] Table 14 shows the distribution of investment outcomes across the twenty-

Table 14. Investment outcomes by year (c)
The table presents outcomes for the sample portfolio companies by year. The total number of portfolio companies for any given year overstates the total number of companies receiving venture capital due to the fact that many venture investments are syndicated and therefore, more than one fund may have an investment role in any portfolio firm. Less than .5% of the total number of portfolio companies do not fall into any of these categories due to name change, withdrawn IPO registration, or unknown status.

Fund Year	Total Portfolio Companies	Initial Public Offering Complete (or IPO filing)	Acquired	Still Private	Defunct
1978	623	25.0%	35.2%	34.3%	5.3%
1979	313	25.2	38.0	30.0	6.4
1980	892	23.7	36.1	33.7	6.5
1981	1,453	21.8	34.0	36.8	7.1
1982	1,518	20.7	35.7	37.7	5.9
1983	1,900	26.0	31.3	36.5	6.5
1984	2,295	22.6	34.5	35.7	6.9
1985	1,428	25.5	26.4	43.7	4.6
1986	1,206	24.1	30.2	40.2	5.1
1987	1,527	25.1	27.7	43.2	3.6
1988	1,129	28.9	29.9	39.8	2.3
1989	1,206	27.3	29.7	38.9	4.1
1990	603	29.1	25.7	43.1	3.6
1991	404	33.3	27.4	36.9	4.9
1992	1,034	28.4	26.9	43.8	2.1
1993	977	24.9	26.4	45.4	4.2
1994	1,068	24.1	22.1	50.9	4.4
1995	1,444	21.4	20.8	54.8	5.9
1996	1,549	19.4	18.7	61.4	3.9
1997	2,458	16.8	17.2	62.2	5.9

year sample period. In most years, companies receiving venture capital were more likely to remain private than any other outcome. This is considered a failed investment and these

[39] Bridge financing is a form of financing that typically is offered to portfolio companies that are expected to go public within a year.
[40] Gompers and Lerner (1999, p.23) cite a 1988 Venture Economics study entitled *Exiting Venture Capital Investments* that finds that a $1 investment in a firm that goes public provides a 295% average return over an average of 4.2 years. The next best payoff is 40% over 3.7 years, on average, to investments in acquired firms. Gompers and Lerner (2000) include only those acquisitions at more than 2 times valuation as successful exits. SDC does not maintain the valuation data needed to make that distinction.

companies are commonly referred to as "the living dead."[41] Venture capitalists' portfolio success rates are calculated as the ratio of successful venture investments over the total number of portfolio firms.

2.2 *Univariate analysis*

I first classify funds into those that specialize and those that are well-diversified across both industry and stage of development. Since I am only interested in the effects of a relatively diversified portfolio versus a relatively specialized portfolio, I divide my sample funds into quartiles based on the maximum percentage of fund investments that are in either one industry or in one general stage of development. I consider those venture capital funds that are in the bottom quartile to be well diversified, while the top quartile represents the specialized group. I confirm that venture capitalists have become more specialized by industry and stage of development in more recent years. Venture funds in the 1990s have a mean industry concentration of 42% versus 35% in years prior to 1990, and 29% versus 26% for stage of development. These differences are significant at the 1% level using a Mann-Whitney U test for independence of samples. It also appears that venture capitalists are more likely to focus on a single industry rather than a particular stage of development. Even though I have defined ten industry classes, there is an average of 39% of the sample funds' investments concentrated in only one industry. With only three broad categories of portfolio company stage of development defined, I find that the average of my measure of fund stage concentration is only 27%.

[41] From Gorman and Sahlman (1989, p. 237), "Much more common is the phenomenon know (sic) euphemistically among venture capitalists as 'the living dead,' a phrase that refers to venture-backed companies that have failed to

Table 15. Univariate analyses of specialization versus diversification

Panel A shows the average success rates for funds that are relatively specialized in a particular portfolio company industry versus those that are relatively diversified across industries. Panel B compares success rates for funds that are relatively specialized in a particular portfolio company stage of development versus those that are diversified across stages. Portfolio success rates are: a) percentage of portfolio funds where a successful exit is defined as the portfolio company going public through an IPO (or registration for an IPO) or acquistion of the portfolio company, and b) percentage of portfolio funds where a successful exit is defined as the portfolio company going public through an IPO only (or registration for an IPO). A Mann-Whitney U test is used to test for independence of the two samples for each comparison. P-values are in parentheses.

Panel A: Industry specialization vs. diversification

	Success Rates (IPO or acquisition)	Success Rates (IPO only)
Specialized VC funds	0.473	0.226
Diversified VC funds	0.498	0.232
Z-Score, Mann-Whitney U test	-2.172 (0.030)**	-1.630 (0.103)

Panel B: Stage of development specialization vs. diversification

	Success Rates (IPO or acquisition)	Success Rates (IPO only)
Specialized VC funds	0.428	0.193
Diversified VC funds	0.490	0.240
Z-Score, Mann-Whitney U test	-3.651 (0.000)*	-2.984 (0.003)*

I next compare average success rates for those funds that are specialized compared to those that are diversified. Table 15 contains the results of this analysis. Funds that specialize are less successful, on average, than my diversified groups. This is true whether or not I include acquisitions as successful exits and for both forms of specialization under investigation, though

meet expectations but that nonetheless squeeze out a stable, independent existen[ce."]

my results are more significant in the case of specializing in a particular stage of development. This preliminary evidence counters my predictions that the benefits of specialization outweigh the benefits of diversifying venture fund investments.

However, there is reason to suspect that other fund characteristics may be driving the results of this univariate analysis. In particular, Gupta and Sapienza (1992) focus on the determinants of the venture capitalists' industry diversification choice and find that early stage venture capitalists and smaller sized venture firms are more likely to specialize in an industry. Norton and Tenenbaum (1993) confirm the proposition that early stage venture funds are more likely to specialize by industry than later stage funds.[42] They posit that this is because portfolio companies in an early stage of development are more exposed to technical and/or product risk, and therefore, information costs will be higher and the need for specialized industry knowledge greater. In the next section, I will examine the effects of diversification strategy on success in a multivariate framework in order to control for this and other fund characteristics that may influence venture capitalists' success rates.

2.3 *Multivariate analysis*

Gompers and Lerner (2000) analyze success rates of firms receiving venture capital during periods of increased commitments and find that the portfolio firms' probability of success are independent of fund inflows. While they do not examine success rates in a multivariate framework, they do explore potential factors that may influence the valuation of venture

[42] We also find evidence supporting this position: mean industry concentration for early stage venture firms is 41% versus 37% for all other firms. This is significant at the 1% level under a Mann-Whitney U test for independence of samples.

investments. The authors show that portfolio companies have higher valuations during periods of increased inflows, and the higher valuations are not due to changing company characteristics.

Gompers (1996) suggests that the entry of young, less experienced venture capitalists leads to a rush to take portfolio companies public. This "grandstanding" hypothesis is supported by empirical evidence and is caused by a need to establish a positive reputation in order to raise new funds. Inexperienced venture capitalists cannot credibly signal their ability to investors unless they have a track record of successfully bringing firms to IPO. Gompers interprets the cost of bringing a firm to IPO early as either a smaller equity stake in the firm or greater underpricing at the IPO. Another potential cost lies in the success rates of the other portfolio companies in the venture capitalist's fund. If bringing just one firm public early gives a new venture capitalist the ability to raise a follow-on fund, then it may be in the interest of the venture capitalist to focus his managerial advice on one or two of the best prospects in the portfolio.[43] This implies that the venture capitalists' overall portfolio success rates should fall, all else equal. Seasoned venture capitalists should have more success than those who are inexperienced, whether due to the grandstanding actions of inexperienced venture capitalists or improvements in human capital over time. Age of the venture capitalists' firm when the funds are raised, and a dummy variable for whether the fund is the first fund raised by the venture capital partnership, will control for venture capitalists' experience.

Older portfolio companies should be more likely to succeed, particularly if they are later stage firms, as much of the uncertainty concerning future revenues ought to be resolved over time. Therefore, my model will consider the average number of years since incorporation for the portfolio of firms as a control variable. Reputation may be important for the success rates of the

[43] Gompers (1996, p. 137) provides anecdotal evidence that substantiates this possibility.

venture capitalists' investments, if entrepreneurs with better projects seek out venture capitalists with better reputations. Gompers and Lerner (1998b) suggest that venture capitalists with good reputations are able to raise more funds and larger funds. Total fund commitments will be used as a proxy for venture capitalist reputation. Industry effects may influence the results if some industries are known to have a higher risk/return profile. Portfolio companies are classified by the SDC into one of three general industries: information technology, non-high technology, or medical/health/life science. The percentage of the portfolio that consists of information technology companies will be used to control for any possible industry effects.

Gompers and Lerner (2000) find evidence that portfolio companies located in Massachusetts and California are more likely to have increased valuations around periods of growth in inflows. A large percentage of venture investment takes place in these locations and an even greater percentage of venture funds are located in these two states. I expect that being located in MA or CA could increase portfolio success rates either because of network effects or because of the lower monitoring costs associated with investment in portfolio firms that are located in the same state as the venture capitalist.

I also control for the investment focus of the venture capitalists. Funds that focus on early stage investments should have less success than those funds that invest in later stage or expansion stage firms. A dummy variable is created that equals one if the fund focus is reported as either early stage, and zero otherwise. Finally, if exit through IPO is easier during "hot markets", increases in success rates may be due to the easy access to the public markets, rather than optimal diversification strategy or any other factor. I control for the market influence on

success with the ratio of IPOs that occurred in a hot market to total IPOs. For my purposes, a hot market is defined as a year in which more than 600 IPOs occurred.[44]

The multivariate analysis is conducted using a two-limit tobit model. The dependent variable is the ratio of successful investments to total investments in the venture portfolio. Since the dependent variable is a ratio, the tobit model with limits of zero and one is the appropriate choice. An investment is considered successful if the portfolio company was acquired or went public through an IPO.[45] The model to be tested is

$$
\begin{aligned}
&SUCCESS = \\
&\beta_0 + \beta_1 FOCUS + \beta_2 PORTFOLIO\_SIZE + \beta_3 FUND\_SIZE \\
&+ \beta_4 CO\_AGE + \beta_5 FUND\_AGE / FUND\_NUMBER \\
&+ \beta_6 HIGH\_TECH + \beta_7 HOT\_MARKET + \beta_8 CA\_MA \\
&+ \beta_9 EARLY\_STAGE + \varepsilon
\end{aligned}
$$

where,

SUCCESS	is the ratio of successful investments over total investments; an investment is considered successful if the portfolio company was acquired or went public through an IPO, and zero otherwise;
FOCUS	is the maximum concentration of the venture fund in one industry or stage, i.e., how focused the fund is;
PORTFOLIO_SIZE	is the number of portfolio companies per venture capitalist;
FUND_SIZE	is the total amount of money raised by the venture fund;
CO_AGE	is the average age of the portfolio companies at the time of investment;
FUND_AGE	is the age of the venture fund;
FUND_NUMBER	is the number of prior funds raised by the venture capitalists plus one;

[44] This is the top 25% of years in our sample.
[45] We also run all regressions with IPO only as the definition of success.

HIGH_TECH	is the percentage of portfolio firms that are information technology firms;
HOT_MARKET	is a the percentage of IPOs that occurred in a hot IPO market;
CA_MA	is a dummy variable set equal to one if the fund is located in California or Massachusetts, and zero otherwise;
EARLY_STAGE	is a dummy variable set equal to one if the fund focus was on early stage portfolio company development.

I find that my multivariate analysis produces results that are similar to my univariate tests. Portfolio success rates appear to be independent of industry diversification strategy, and positively related to the level of diversification across stages of portfolio company development. Table 16 contains the results of this multivariate analysis. The coefficient on my measure of stage focus is negative and statistically significant. This indicates that venture funds in my sample that have pursued a strategy of specializing in a particular stage of development were less successful than those who diversified across stages.

These results are not consistent with my predictions. It is possible that my measure of diversification is flawed and unable to capture the effect I expect, particularly when considering the strategy of diversifying across industries. By my measure, it is possible that a large percentage of the portfolio companies fall into one industry, implying that the venture fund is specialized, while the fund may only have invested a small percentage of investment dollars in those companies. A more precise definition of the degree of diversification would account for the dollar amount of each investment. Data limitations prevent us from exploring this possibility further.

Table 16. Multivariate analyses of specialization versus diversification

This table reports the results of two-limit tobit regressions with successful exits defined as IPOs (or registration for an IPO) or acquisition, or IPOs only. The dependent variable is the ratio of successful exits to total venture fund investments. Industry (Stage) Focus is the maximum concentration of fund investments in one industry (stage) category. Portfolio size is the number of portfolio firms per venture fund divided by the number of executives reported by the funds to SDC. Fund size is the total commitments in millions of 1997 dollars. Average portfolio company age is the average difference between the year the fund was created and the year each portfolio company was founded. Fund age is the difference between the year the fund was created and the venture capitalists' firm founding year. Fund number is the number of previous funds that the venture capital firm has raised previously plus one. High-tech is the percentage of the portfolio companies that are information technology firms. Hot market is the ratio of hot market IPOs to total IPOs (a year is classified as a hot market if

there were more than 600 IPOs in that year). A dummy variable is set equal to one if the fund is located in MA or CA and another dummy variable is set equal to one if the fund focused on early stage investments. P-values are in parentheses.

	IPO or Acquisition		**IPO only**	
Intercept	.346 * (0.000)	.425 * (0.000)	.131 * (0.000)	.178 * (0.000)
Industry Focus	.000440 (0.295)		.000190 (0.577)	
Stage Focus		-.00202 * (0.000)		-.00130 * (0.0061)
Portfolio Size	-.0000723 (0.923)	-.0000234 (0.976)	-.000493 (0.440)	-.000444 (0.482)
Fund Size	-.0000205 (0.842)	.0000353 (0.733)	.0000141 *** (0.088)	.000176 ** (0.035)
Average Portfolio Company Age	-.00353 *** (0.060)	-.00279 (0.137)	-.00158 (0.300)	-.00104 (0.495)
Fund Age	.000634 (0.504)	.0000658 (0.944)	.00284 * (0.000)	.00249 * (0.001)
High-tech	.0151 (0.542)	.00767 (0.754)	-.0385 *** (0.055)	-.0427 ** (0.031)
Hot Market	.272 * (0.000)	.261 * (0.000)	.185 * (0.000)	.179 * (0.000)
Fund in CA or MA	.0609 * (0.000)	.0612 * (0.000)	.0471 * (0.000)	.0472 * (0.000)
Early Stage Focus	-.0361 *** (0.0639)	-.0326 *** (0.093)	-.0439 * (0.006)	-.0417 * (0.009)

*,**,*** indicates significance at the 1%, 5%, and 10% levels, respectively.

The flaw in my proxy for degree of specialization could also explain the relationship between success and the degree of concentration in a particular portfolio company stage of

development. Some portion of the venture funds that I identify as diversified may be run by venture capitalists that specialize in early or middle stage investments. If the successful early stage investments continue to develop along the traditional path for portfolio companies, then they will become later stage investments before they go public or are acquired. It is likely that these early stage specialists would retain their ownership share in the private firm, but transition to a more passive investment role as later stage specialists took the lead role in the development of the portfolio company. If the early stage venture investor holds on to his shares but does not provide capital at the later rounds of financing, then his share of the firm would drop and he would have less incentive to actively monitor the firm.

It is also possible that the costs of becoming informed about the different stages of development and their associated advisory skills are not prohibitively high. This would also explain the greater success rates for more diversified (across stages) venture funds. Venture investors may rationally determine that the benefits of diversifying across stages of development exceed the costs.

Finally, the significance of the results that favor the diversification strategy may be capturing the effects of funds that appear to be diversified across stages, but in reality have fund managers that each offer their own specialization skills. Larger funds could have many partners and could potentially diversify across the fund while maintaining early stages, middle stages, and later stages divisions. This could potentially be captured with my fund size variable, but there may be a more effective way to capture this if there is little correlation between fund size and these types of large funds.

3. *Conclusion*

My analysis of the effects of diversification on venture investment portfolio success rates suggests that the decision to specialize in a particular industry rather diversify across industries rather has no impact on the portfolio success. Specializing in a particular stage of development has been shown to have a negative and significant impact on portfolio success rates. Several explanations for these results have been put forth in this essay. More research may be able to add to this discussion, though data limitations preclude a comprehensive analysis of this issue without additional data sources.

Chapter 6: Conclusion

This manuscript has served to shed some light on the often-murky world of venture capital finance. Despite the many problems with the dataset used throughout this analysis, there is sufficient evidence put forth that may serve as a building block for future research in the field. A more refined set of data would be valuable to help determine the true extent of the effects of venture capitalists' portfolio size, degree of diversification, location, and distance to portfolio firms on venture investment success.

Each of the ideas raised in this dissertation is fundamentally related to the real economic costs that venture capitalists face. Given time constraints, venture capitalists are only capable of effectively monitoring some particular number of firms, at some total distance from the venture firm, and in only so many unrelated industries. Unless a venture capitalist possesses an extraordinary skill set or benefits from innovation in the industry, there must be some decrease in benefits to the venture capitalists in the event that they choose to overextend themselves. It is likely that some of the reduced benefits arrive in the form of lower returns to the fund, but I have demonstrated that in some cases the portfolio success rates fall as well.

While it would be beneficial to examine this issue with actual investment returns data, it would also be useful to have information regarding the extent of the monitoring that the venture capitalists have actually pursued. It is expected that there are numerous venture capitalists in the industry that provide little more than financial capital to the entrepreneurs in their portfolio. For

these types of venture capitalists, you would likely find that any significant results would be spurious. Success for such "passive" venture investors would be expected to be a function of their ability to screen projects and/or entrepreneurial talent. Unfortunately, it seems more likely that venture capitalists will reveal actual returns data than to divulge the particulars concerning their management of portfolio investments.

This dissertation contributes to the literature in several ways. Given the lack of theoretical research regarding the determinants of successful venture capital investing, this manuscript suggests several ideas derived from the existing finance and economics literature. Further, building off of existing empirical work in the specific area of venture capital finance, I have identified a number of significant control variables that are primarily based upon fund and portfolio company characteristics.

The approach taken in this dissertation allowed for a focus on fund characteristics in chapters 3 and 5, while the analysis in chapter 4 centered on the characteristics of the investments themselves. The focus on fund characteristics logically follows from the fact that I was primarily interested in fund-level (or more specifically, venture capitalists' portfolio-level) decision-making in these two chapters. Should the venture capitalist choose to add more entrepreneurial firms to his/her portfolio? What type of strategy should the venture capitalist adopt: lower risk through diversification, or lower risk by specializing by industry or stage of development? These types of questions lend themselves naturally an analysis at the fund level. While the roles of distance and location could also be taken into account from the perspective of the venture capital funds, they may be just as important from the perspective of the entrepreneurs. There is no reason to presume that they are more relevant from the venture

capitalist's perspective, and here they provide an opportunity to examine the determinants of success from the point of view of the entrepreneurs.

So for control variables in chapters 3 and 5, I use averages of portfolio company characteristics and the more informative, actual fund-level data for fund characteristics. In chapter 4 I have the benefit of controlling for the actual portfolio company characteristics, at the expense of relying on averages for fund data. The overall benefit of using these two different methods is that I am able to verify the significance of the control variables used throughout this dissertation.

While many questions remain regarding the determinants of success in venture capital finance, this dissertation provides a valuable building block for future research of this topic. Any complementary analyses of this issue would appear to require more detailed data. Possible sources of this data include surveys, internal documents from venture capitalists themselves, or perhaps through filing statements for those portfolio firms that have completed the IPO process.

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Vita

James Richard Bartkus was born in Worcester, Massachusetts, on December 8, 1972. After he graduated from high school in 1990, he began his university studies at the United States Naval Academy in Annapolis, Maryland. He changed his course of study and subsequently received his B.S. in Interdisciplinary Social Sciences, with a concentration in history and economics, from Florida State University in 1995. Following a two-year stint in the U.S. Navy, he worked in the private sector in Cambridge, MA before beginning his graduate work in the Department of Economics at Florida State University. His interest in financial economics brought him to the University of New Orleans where he earned his Ph.D. in May 2004. He currently resides in Uptown, New Orleans with his beautiful wife, Alissa and equally beautiful son, Malachy Fenway.