Access to Venture Capital and the Performance of Venture-Backed Start-Ups in Silicon Valley

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This article examines start-ups' access to venture capital in Silicon Valley using a comprehensive database. The author finds that Silicon Valley consistently absorbs 20% to 26% of the total venture capital investment in the United States, and start-ups in this region benefit from the abundance of local venture capital. Venture-backed firms in Silicon Valley receive venture capital at a younger age and complete more rounds of financing. On one hand, this better access to capital makes start-ups in Silicon Valley more likely than start-ups elsewhere to complete initial public offerings and helps offset some of the negative effects of intense competition in the region. On the other hand, better access to venture capital is associated with a higher bankruptcy rate, possibly because competition for new ventures makes it more likely that poor business plans will get funding.

Keywords: *Silicon Valley; venture capital; performance of start-ups*

This study of venture-backed start-ups in Silicon Valley seeks to contribute to the empirical literature on industrial clusters and regional development. I hypothesize that start-up companies in Silicon Valley have better access to venture capital because of the strong venture capital industry in this region. Although simple stylized facts in the data are consistent with the hypothesis, I examine whether this better access still holds after controlling for various relevant factors. I also examine how better access to venture capital affects the performance of venture-backed start-ups in Silicon Valley.

By 2000, Silicon Valley housed more than 25,000 technology firms that provided 670,000 well-paying jobs in the technology sector.

Silicon Valley is arguably the world's most famous industrial cluster. Merely half a century ago, the piece of farmland curling around the southern tip of the San Francisco Bay was known only as the Santa Clara Valley, famous for its orange groves and plum trees. Beginning in the late 1950s, this region quickly developed into a center of semiconductor manufacturing, which inspired its current name by the early 1970s. It later became known as the capital of the personal computer revolution and the subsequent Internet revolution. By 2000, Silicon Valley housed more than 25,000 technology firms that provided 670,000 well-paying jobs in the technology sector (Zhang, 2003b). This remarkable economic success made policy makers throughout the world aspire to "clone Silicon Valley" in their own regions (Rosenberg, 2002).[1]

Partly because of the rise of Silicon Valley, research interest in industrial clusters has revived in the past two decades. Economists, as well as geographers and regional planners, have recently

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proposed a wide range of theories to explain the clustering phenomenon exhibited in Silicon Valley (e.g., see Arthur, 1990; Ellison & Glaeser, 1997; Fujita & Thisse, 2002; Harrison, 1992; Krugman, 1991; Martin & Sunley, 2003; Porter, 1998; Saxenian, 2000; Zhang, 2003a). Following the tradition of Marshall (1920), many of these scholars stress the notion that industrial activities tend to cluster because of "agglomeration economies." They argue that firms locating in an industrial cluster profit from various sources including proximity to customers or suppliers, access to high-quality labor and abundant capital, and knowledge spillovers from nearby firms. These locational advantages create a positive feedback loop: The more firms that are located in a cluster, the more advantageous it is for a new firm to start up there. This process of "increasing returns" continues until the expansion of the cluster reaches a point where costs of overcrowding, such as high real estate prices, traffic congestion, and excess competition, offset the benefits from agglomeration.

One source of agglomeration economy is the proximity to capital in an industrial cluster, which is particularly important for understanding the growth of Silicon Valley in the 1990s when this region had already become the leading center of venture capital investment. Access to venture capital is often made possible through social networks and personal contacts, which tend to be localized. Also, venture capitalists need to monitor the operation of the start-ups they invest in and provide management advice and guidance (Gompers & Lerner, 1999; Lerner, 1995; Sorenson & Stuart, 2001). Geographic proximity facilitates such activities. Lerner (1995) finds that more than half the firms in his sample have a venture capitalist on the board whose office is within 60 miles. He shows that venture capitalists headquartered within 5 miles are twice as likely to serve on the board of directors as those headquartered 500 miles away. Sorenson and Stuart (2001) find that firms 10 miles away from a venture capital firm are twice as likely to receive investment as those 100 miles away. In addition, as Porter (1998) points out, local financial institutions already familiar with the cluster may require a lower risk premium on capital.

Therefore, new entries in a cluster such as Silicon Valley are likely to benefit from the strong local venture capital industry. Indeed, every account of Silicon Valley's success in the 1990s stresses the important role of local venture capitalists (see, e.g., Kenney, 2000; Lee, Miller, Hancock, & Rowen, 2000). However, Silicon Valley's advantage of having a strong venture capital industry is yet to be fully understood. Although qualitative evidence distilled from interviews, anecdotes, and personal experience is plentiful, quantitative evidence based on systematic analysis of empirical data is scarce. In fact, no one has tried to examine exactly how firms in this region benefit from the proximity of venture capital and how big the benefits are. This article addresses these questions.

There is an emerging literature related to this study showing that the availability of venture capital affects the geographic distribution of new firms, especially in the high-technology industries. Relying on both interviews and regression analysis, Zook (2002) argues that venture capital investment determines the regional distribution of Internet start-ups. Stuart and Sorenson (2003) find a positive relationship between the number of local venture capitalists and the founding rate of biotech start-ups. Both of these studies use cross-sectional variation in economic variables at the regional level (in particular, the former at the Standard Metropolitan Statistical Area [SMSA] level and the latter at the zip code level) to infer the benefit of proximity to capital. This article approaches the issue in a different way: I use firm-level data to directly examine how a start-up benefits from locating in a particular cluster such as Silicon Valley. By looking into the effect of venture capital accessibility on the performance of firms, I provide some insights about a specific mechanism (i.e., access to venture capital) through which agglomeration economy operates.

Two points are worth noting here. First, the goal of this article is not to test competing theories about Silicon Valley's success. Rather, I present empirical evidence that could help identify and understand the unique features of the Silicon Valley economy that are likely to be related to its rapid growth in the 1990s. Second, by asking how Silicon Valley's strong venture capital industry helps local start-ups, I take this region's venture capital cluster as predetermined. That is, I will not focus on why and how the strong venture capital industry took hold in Silicon Valley in the first place.[2] Because the analysis is based on data mainly from the 1990s, when Silicon Valley had already been acknowledged as the largest cluster of venture capital firms in the United States for a considerable length of time, Silicon Valley's strength in venture capital is a given.

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This study relies on a comprehensive venture capital database provided by VentureOne, a company specializing in venture capital research. This unique database contains detailed firm-level information on venture capital deals completed between the first quarter of 1992 and the fourth quarter of 2001. Using these data, I investigate whether start-up firms in Silicon Valley have better access to venture capital, and if so, how the better accessibility affects the performance of venture-backed firms in this region.

I found that from 1992 to 2001, Silicon Valley consistently absorbed more than 20% of the total venture capital investment in the United States. Start-ups in this region benefited from the proximity to abundant venture capital on three dimensions: They received capital at a younger age (the average Silicon Valley start-up was 11.5 months old at the closing date of the first round of venture capital financing, compared with 19.9 months for the rest of the United States), they completed more rounds of venture capital financing, and they raised more money in each round.

Start-ups supported by venture capital are risky enterprises with a potential of rapid growth. To these firms, one year seems like a lifetime. Thus, early access to venture capital enables start-ups to grow quickly and benefit from the first-mover advantage. Indeed, I find that their better access to venture capital makes Silicon Valley start-ups more likely to complete initial public offerings (IPOs). In addition, this better access to venture capital has a positive effect on the employment size of start-ups and their likelihood of attaining profitability. However, I also find that the better access has a negative effect on the survival rate of start-ups, probably because it has allowed for many start-ups with poor business plans to obtain venture capital investment.

The rest of the article describes the research that led to these findings. The next section introduces the VentureOne database, followed by some descriptive statistics of venture capital investment in Silicon Valley during 1992 to 2001. The article then shows that start-ups in Silicon Valley have better access to venture capital and examines the effect of venture capital access on the performance of start-ups. The final section discusses implications of the findings.

DATA

VentureOne claims to have "the most comprehensive database on venture-backed companies." For each venture capital deal, VentureOne keeps a record of its size, stage of financing, closing date, venture capital firms involved, and detailed information about the firm that received the money, including, for example, its address, telephone area code, start year, and industry.

The data used in this article were provided by VentureOne, a leading venture capital research company based in San Francisco. VentureOne began tracking equity investment in 1992. It collects data by regularly surveying venture capital firms for recent funding activities and portfolio updates, gathering information through direct contacts at venture-backed companies, and scouring various secondary resources such as company press releases and IPO prospectuses (VentureOne Corporation, 2001). VentureOne intends to capture all the venture-backed companies in the United States and their early-stage financing events.[3]

VentureOne claims to have "the most comprehensive database on venture-backed companies."[4] For each venture capital deal, VentureOne keeps a record of its size, stage of financing, closing date, venture capital firms involved, and detailed information about the firm that received the money, including, for example, its address, telephone area code, start year, and industry. In addition, VentureOne tracks the venture-backed company and updates the information about its employment, business status, and ownership status until the venture capital support is brought to an end by certain events such as a bankruptcy of the venture-backed company, an IPO, or a merger and acquisition that allows venture capitalists to cash out. Although VentureOne's database is maintained for commercial purposes, its rich information has attracted many academic researchers. For example, recent empirical work by Cochrane (2005); Gompers and Lerner (2000); Gompers, Lerner, and Scharfstein (2005); and Zhang (2003b) has all used the VentureOne data.

This study's version of the data covers venture capital deals completed from the first quarter of 1992 through the fourth quarter of 2001. It includes 22,479 rounds of venture capital financing involving 11,029 venture-backed firms. Among these firms, 83.5% were founded in or after 1990. As expected, these venture-backed firms were disproportionally concentrated in a few high-tech centers. The San Francisco Bay area alone housed 29% of them (3,169 out of 11,029), most of which (2,162) were located in Silicon Valley.

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TABLE 1
Venture Capital (VC) Investment by Industry, 1992-2001

Industry	*Number of VC-Backed Companies*	*Number of VC Deals*	*VC Raised, ($ million)*[a]	*Percentage of U.S. Total*
Communication	1,381	2,984	49,502.21	23.31
Consumer/business services	2,060	4,051	41,240.49	19.42
Software	2,672	5,542	40,917.12	19.27
Information services	972	1,958	19,687.36	9.27
Biopharmaceutical	689	1,664	13,606.89	6.41
Retailing	390	784	9,242.43	4.35
Medical devices	626	1,470	8,903.98	4.19
Semiconductor	431	913	8,330.73	3.92
Electronics	619	988	6,608.62	3.11
Medical information services	336	723	5,669.59	2.67
Health care	341	643	4,607.45	2.17
Consumer/business products	251	399	2,111.29	0.99
Advance/special material and chemical	76	142	641.64	0.30
Energy	34	58	580.15	0.27
Agriculture	34	45	209.05	0.10
Other	117	115	463.30	0.22
Total	11,029	22,479	212,322.30	100

a. In 1996 dollars.

TABLE 2
Top 10 States by Venture Capital (VC) Investment, 1992-2001

State	*Number of VC-Backed Companies*	*Number of VC Deals*	*VC Raised ($ million)*[a]	*Percentage of U.S. Total*
California	4,302	9,856	93,655.50	44.11
Massachusetts	1,170	2,612	22,196.60	10.45
New York	610	1,179	11,129.79	5.24
Texas	598	1,145	12,008.25	5.66
Washington	347	787	6,881.90	3.24
Colorado	316	703	8,468.45	3.99
Virginia	323	673	5,632.51	2.65
Pennsylvania	359	657	5,466.01	2.57
Georgia	304	602	4,563.52	2.15
New Jersey	263	501	5,197.80	2.45

a. In 1996 dollars.

VentureOne categorizes venture-backed firms into 16 industry segments. Table 1 presents venture capital investment in each industry during 1992 to 2001. Topping the list are Internet-related industries including communication, software, consumer/business services, and information services. Together, these four industries account for 71.3% of the total venture capital investment over the decade. Venture capital investment also tends to concentrate geographically. As Table 2 shows, California received more than 44% of the U.S. total. Massachusetts, a distant second, received about 10% of the U.S. total. The Top 10 states cumulatively absorbed 82.5% of the venture capital investment in the United States.[5]

Although no variable in the VentureOne database directly indicates whether a firm is in Silicon Valley, the area code and zip code variables for each company can be used for geographic

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definitions. Because Silicon Valley has no official boundaries, I follow the Joint Venture: Silicon Valley Network and define Silicon Valley as Santa Clara County plus some adjacent cities in Alameda, San Mateo, and Santa Cruz counties.[6] I use the zip code variable to identify whether a firm is located in Silicon Valley (see appendix). For purposes of comparison, I use other important technology centers including Boston, New York, Seattle, and Washington, D.C. Given that the whole San Francisco Bay area, including both the San Francisco-Oakland and the San Jose metropolitan areas, has developed into an integrated regional economy that encompasses Silicon Valley and has a substantially larger technology sector than Silicon Valley, I also use "the rest of the San Francisco Bay area" for comparison. These comparison regions are defined using the area code variable (see appendix).

VENTURE CAPITAL INVESTMENT IN SILICON VALLEY

Although Silicon Valley's venture capital industry played an important role in its economic success of the 1990s (Kenney, 2000; Lee et al., 2000), the region did not start with a rich base of available venture capital. The inception of the U.S. venture capital industry is generally associated with the founding of American Research and Development in Boston in 1946, which is considered the first nonfamily venture capital organization (Bygrave & Timmons, 1992; Kenney & Florida, 2000). In the San Francisco Bay area, although there was a long tradition of wealthy individuals financing new technology firms, professional venture capital activities started later than in the Boston area. In 1957, when Robert Noyce and seven fellow engineers (the famous "Traitorous Eight") left Shockley Semiconductor Laboratories to start their own business, they had to look to the East Coast for investment.[7] The first West Coast venture capital firm, Draper, Gaither & Anderson, was not founded until 1958.

The situation soon changed. Starting in the 1960s, the development of the venture capital industry paralleled the rapid growth of high-tech industries in Silicon Valley. Venture capital helped fund every wave of innovation in Silicon Valley: the establishment of the semiconductor industry in the 1960s, the inception of the personal computer industry and the biotech industry in the 1970s, the boom of the workstation and networking industries in the 1980s, and the commercialization of the Internet in the 1990s (Banatao & Fong, 2000). Venture capitalists in Silicon Valley not only provide capital but also offer mentoring and guidance to entrepreneurs (Hellmann, 2000). Almost every highly successful company started in Silicon Valley during the past three decades received local venture capital support. The empirical analysis in this article covers the period from 1992 to 2001, long after venture capital had become an intrinsic part of the Silicon Valley ecosystem.

Silicon Valley is now the world's prime venture capital center. The VentureOne Corporation (2000) directory of venture capital firms shows that 159 venture capital firms have headquarters or offices in Silicon Valley and an additional 85 firms are located in nearby cities such as San Francisco and Oakland. In contrast, the entire state of Massachusetts, also famous for its abundance of venture capital, has only 94 venture capital firms listed in the same directory.

Figure 1 traces the nominal amount of venture capital invested in the United States and Silicon Valley over the 10 years from 1992 to 2001. Both trends show 8-year exponential growth ending in a severe crash. Between 1992 and 1995, venture capital investment in the United States nearly doubled, increasing from $3.5 billion to $6.8 billion. In the following 2 years, total venture capital investment grew by $3 billion a year. The manic growth of venture capital in the late 1990s was unprecedented: Starting from 1997, venture capital investment increased first by 34%, then by 166%, and finally by 92%, ending with a total of $88.9 billion in 2000. In nominal dollars, venture capital investment in 2000 was 25 times as much as it was in 1992. (Even in real dollars, this was a growth of 22 times.) This expansion mirrors the Internet bubble shown in the NASDAQ index. Similarly, the bursting of the bubble is also reflected in venture capital investment. In 2001, the total fell to $28 billion, a 69% decline. Yet, despite the big falloff, 2001 still represents the third most heavily invested year in venture capital history.[8]

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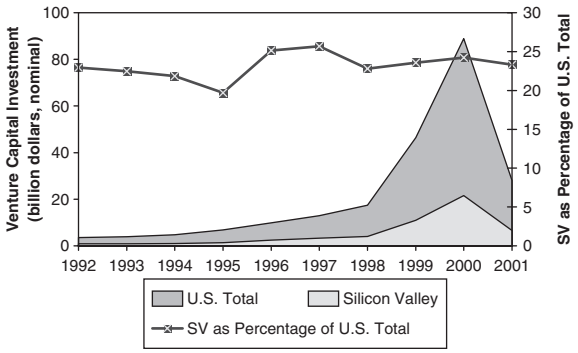

Figure 1: Total Venture Capital Investment in Silicon Valley and the United States, 1992-2001

NOTE: SV = Silicon Valley.

Venture capital invested in Silicon Valley followed a similar trend over these 10 years. At its peak in 2000, Silicon Valley attracted nearly $22 billion of venture capital, 27 times as much as the total in 1992. (This was a growth of 23 times in real dollars.) The sharp decline of investment in 2001 also occurred in Silicon Valley. As in the national trend, the $6.5 billion invested in that year is still the third largest amount the region has ever witnessed, second only to venture investments in 1999 and 2000. In proportion to the U.S. total, Silicon Valley's share fluctuated within a range of 19% and 26%. In 1992, 22.9% of the U.S. total investment occurred in Silicon Valley; the number dropped slowly to 19.7% in 1995. However, the investment in Silicon Valley regained its momentum in the next 2 years, peaking at 25.7% of the U.S. total in 1997. Silicon Valley's share declined slightly in the next 4 years but remained above 22% at all times.

VentureOne data show that Silicon Valley is undoubtedly the richest region in the nation in terms of available venture capital. And, thus, it is natural to expect that start-ups in this region gain access to venture capital more easily.

It is worth noting, however, that even in the high-tech sector, venture capital is not the primary source of financing and that only a small proportion of start-ups gain access to it. Most new firms rely on other sources of capital such as the entrepreneur's personal savings and bank loans. Although Silicon Valley was the greatest recipient of venture capital investment in the past two decades, venture capital was still unavailable for the majority of new firms in the region (Zhang, 2003b). Dun & Bradstreet data (Zhang, 2003b) show that about 29,000 high-tech firms were founded in Silicon Valley during 1990 to 2000 (Figure 2). Most of these firms stayed small or went out of business soon after inception. As a result, only a small proportion of these new businesses would ever have five or more employees. Venture-backed start-ups constitute an even smaller subset. In the early 1990s, fewer than 100 Silicon Valley start-ups obtained venture capital financing each year. In 1999, during the peak of the Internet boom, 375 start-ups secured venture capital—still a small group compared to the total number of firms founded in Silicon Valley.

Nonetheless, venture-backed start-ups arguably represent the most innovative firms and have the highest growth potential. Despite their relatively small numbers, they are the key drivers of the high-tech sector in Silicon Valley. For this reason, it is important to understand how Silicon Valley's venture capital industry works and how it affects the region.

ACCESS TO VENTURE CAPITAL IN SILICON VALLEY

This section examines whether start-ups in Silicon Valley have better access to venture capital. As mentioned in the previous section, 83.5% of the firms in the VentureOne database started

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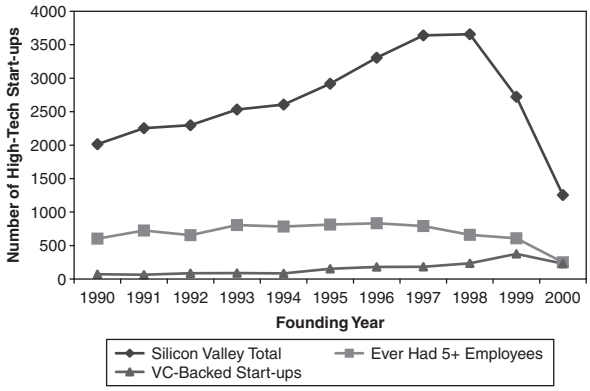

Figure 2: Number of High-Tech Start-Ups in Silicon Valley, 1990-2000

NOTE: VC = venture capital.

in or after 1990. Most of the firms founded before 1990 are not start-ups but long-existing companies that obtained venture capital support during 1992 to 2001 for only part of their operations or for a restart. From now on, I shall exclude firms founded before 1990 in this study and focus solely on venture-backed start-ups.

Access to Venture Capital in Silicon Valley and Other Regions: A Simple Comparison

Access to venture capital can be measured along many dimensions. The choice of measures here is dictated entirely by data availability. The measures are average age of start-up at the first-round venture capital, total rounds of venture capital financing per start-up, and money raised in each deal.[9]

Table 3 compares Silicon Valley with the rest of the San Francisco Bay area, Boston, New York, Seattle, and Washington, D.C., by these three measures. The last column, The Rest of the United States, includes all other areas not already covered by these regions.

Quick access to venture capital is important because it influences the likelihood that new firms in a region attain the first-mover advantage over competitors in other regions.

I first examined how quickly start-ups are able to obtain venture capital. Time-based competition and especially the reduction of "time to market" is an objective for many technology-driven firms that aim to gain a competitive edge (Cohen, Eliashberg, & Ho, 1996; Stalk, 1988). And venture capital plays a significant role in helping innovative start-ups reduce the time to bring a product to market (Hellmann & Puri, 2000). Thus, quick access to venture capital is important because it influences the likelihood that new firms in a region attain the first-mover advantage over competitors in other regions. I calculated the average time span between the founding date of a start-up and the closing date of its first round of venture capital financing. Table 3 shows that Silicon Valley firms are financed more quickly than firms in other regions. In Silicon Valley, start-ups, on average, raised their first rounds of venture capital at the age of 11.48 months. For the rest of the San Francisco Bay area, the average age is 12.80 months, only slightly higher. The average age is 16.53 months for Boston and 16.26 months for Seattle. In New York and Washington, D.C., it takes even longer (17.14 and 22.15 months, respectively) to secure the first-round venture capital. The rest of the nation has an average of 19.33 months.

I tested the hypothesis that the average start-up age at the first round of financing in Silicon Valley is equal to the average start-up age elsewhere. One-tailed t tests reject the null hypothesis at the 5% confidence level for the rest of the San Francisco Bay area and at the 1% confidence level for all other regions. That is, the differences between Silicon Valley and the rest of the San Francisco Bay area, Boston, New York, Seattle, Washington D.C., and the rest of the nation are all statistically significant.[10]

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TABLE 3
Access to Venture Capital, 1992-2001

	Silicon Valley	*Rest of San Francisco Bay*[a]	*Boston*	*New York*	*Seattle*	*Washington, D.C.*	*Rest of United States*[b]
Start-up age at first round of venture capital (months)							
M	11.48	12.80**	16.53***	17.14***	16.26***	22.15***	19.33***
SD	16.28	16.49	21.53	21.01	19.50	25.40	23.36
Number of observations	1,757	833	869	567	271	323	3,641
Rounds of venture capital per start-up							
M	2.61	2.48**	2.53*	2.08***	2.42**	2.08***	2.23***
SD	1.50	1.47	1.47	1.20	1.41	1.25	1.37
Number of observations	1,819	871	899	601	283	344	3,924
Venture capital raised per deal (millions, 1996 dollars)							
M	10.37	10.36	8.84***	10.98	9.33*	9.70	9.54***
SD	16.55	14.47	11.28	16.93	14.59	17.26	19.14
Number of observations	4,561	2,072	2,193	1,181	651	681	8,372

NOTE: M = mean; SD = standard deviation.
a. San Francisco Bay area excluding Silicon Valley.
b. All regions in the United States not already covered by Silicon Valley, the rest of San Francisco Bay area, Boston, New York, Seattle, or Washington, D.C.
*Statistically different from Silicon Valley at the 10% significance level by one-tailed *t* test.
**Statistically different from Silicon Valley at the 5% significance level by one-tailed *t* test.
***Statistically different from Silicon Valley at the 1% significance level by one-tailed *t* test.

The second measure of the accessibility of venture capital that I examined is a start-up's total number of venture capital rounds. Table 3 shows that on average, a Silicon Valley start-up completed 2.61 rounds of venture capital financing during 1992 to 2001. Start-ups in all other regions received significantly fewer rounds of capital, although the statistical significance varies. Boston and the rest of the San Francisco Bay area are not very far below. However, in New York and Washington, D.C., the number of venture capital rounds per start-up is only 2.08, not only lower than that of Silicon Valley but also lower than the national average.

The third measure of access to venture capital is the amount of money raised in each round of financing (in 1996 dollars). Table 3 shows that Silicon Valley start-ups on average received more money than those in many other regions in each round of financing. The average size of a venture capital deal is $10.37 million in Silicon Valley, although it is only $8.84 million in Boston. The rest of the San Francisco Bay area shows an average almost identical to that of Silicon Valley. New York has a slightly higher average than Silicon Valley, although not statistically significant. Interestingly, Boston and Seattle, also rich in venture capital investment, have average deal sizes not only significantly smaller than the Silicon Valley average but also smaller than the national average.

Overall, simple descriptive comparisons between Silicon Valley and other regions suggest better access to venture capital in Silicon Valley: On average, start-ups in Silicon Valley receive venture capital at a younger age, complete more rounds of financing, and collect more money in each deal. The difference between Silicon Valley and the rest of the San Francisco Bay area is generally smaller than the difference between Silicon Valley and any other region under examination. This is not surprising given that the boundary between Silicon Valley and the rest of the

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San Francisco Bay area is rather unclear, and one may even consider them as a single integrated regional economy.

Access to Venture Capital: Regression Analysis

It is important to control for other relevant factors and check whether Silicon Valley's advantages in venture capital access remain statistically significant. For example, industry composition may account for the differences observed in Table 3: If start-ups in the communication industry get access to venture capital easily and if Silicon Valley hosts a larger share of communication start-ups, then one would observe better access to capital in Silicon Valley.

It is also necessary to control for the founding date of a start-up. As Figure 1 shows, total venture capital investment increased rapidly from the early to the late 1990s, which is true both in the nation as a whole and in Silicon Valley in particular. Thus, it is possible that Silicon Valley start-ups receive more money at a younger age only because many of them were founded in the late 1990s, a period when venture capital was far more abundant in supply.

In the regression for total rounds of venture capital financing, it is appropriate to take into account the liquidity events that will trigger the ending of venture capital financing for some start-ups. As discussed in the data section, if a start-up is out of business, acquired by another company, or completes an IPO, it is no longer a venture-backed company, and VentureOne automatically stops tracking it. Because of this, liquidity events such as IPO, merger and acquisition, and bankruptcy are all likely to affect a firm's total rounds of venture capital financing observed. To control for such effects, I added ownership status dummies in the regression to indicate whether a start-up has completed an IPO, been acquired, or gone out of business. The remaining group, start-ups that are alive and privately owned, is used as the reference group.

In addition, to explain the deal size, one needs to control for the round class of venture capital investment and start-up age at the moment of the investment. The size of a venture capital deal is expected to vary with round class. A seed round occurs at a very early stage of a start-up when its need is limited and its growth potential is unclear. Such a deal will necessarily be small. Later rounds take place after a start-up has grown larger, and thus, such deals should naturally involve a larger amount of investment. For similar reasons, the age of the start-up at the closing date of the venture capital deal is also relevant in explaining the size of the deal.

I use the VentureOne data to construct these control variables and run simple OLS regressions to examine whether Silicon Valley start-ups still have better access to venture capital after controlling for the factors discussed above. The results are presented in Table 4. The coefficients of some control variables are omitted from this table.

Model 1 shows that Silicon Valley start-ups still have quicker access to venture capital even after controlling for industry and founding date. Because I use Silicon Valley as the reference group, any coefficient of a location dummy variable in Table 4 indicates the difference between that region and Silicon Valley. Model 1 shows that start-ups in Silicon Valley complete the first-round venture capital at a younger age than those in any other regions and that all the differences are statistically significant. For example, Silicon Valley firms have a 4.3-month advantage over those in the Boston area, a 7.9-month advantage over those in the New York area, and an 11.5-month advantage over those in Washington, D.C. This quicker access to venture capital in Silicon Valley gives a head start to venture-backed start-ups in this region. For those start-ups in an industry that exhibits substantial first-mover advantages, this head start could potentially make a big difference in terms of performance outcomes.

Model 2 shows that even after controlling for start year and industry, start-ups in Silicon Valley completed more rounds of venture capital financing. With the exception of the rest of the Bay area, the estimated coefficients for all the location dummies are negative and statistically significant, suggesting the total rounds of venture capital per firm outside of the Bay area are all significantly smaller than the average in Silicon Valley. In Washington, D.C., the number of rounds per firm is 0.49 smaller than that in Silicon Valley, the largest difference between any region and Silicon

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TABLE 4
Access to Venture Capital (VC): Ordinary Least Squares Regression Results

	Model 1 Dependent Variable: Age at First VC	*Model 2 Dependent Variable: Rounds of VC*	*Model 3 Dependent Variable: Size of VC Deal*[a]
Constant	19.17***	5.247***	4.759*
	(3.020)	(0.500)	(2.467)
Started after 1995			2.132***
			(0.484)
Start-up age at VC round			0.015**
			(0.008)
Start-up age in December 2001		–0.026***	
		(0.004)	
Location dummies			
Silicon Valley	Reference group	Reference group	Reference group
Rest of San Francisco Bay area	2.539***	–0.029	–0.068
	(0.738)	(0.055)	(0.437)
Boston	4.288***	–0.127**	–1.452***
	(0.720)	(0.053)	(0.425)
New York	7.871***	–0.379***	–0.331
	(0.847)	(0.063)	(0.542)
Seattle	5.592***	–0.136*	–1.292*
	(1.129)	(0.083)	(0.681)
Washington, D.C.	11.48***	–0.491***	–2.004***
	(1.047)	(0.077)	(0.678)
Rest of United States	7.716***	–0.344***	–0.708**
	(0.517)	(0.038)	(0.311)
Start-year dummies	[b]	[b]	
Closing-year dummies			[b]
Industry dummies	[b]	[b]	[b]
Ownership status dummies		[b]	
Venture capital round dummies			
Seed round			–7.019***
			(0.548)
First round			–2.847***
			(0.357)
Second round			1.850***
			(0.386)
Later rounds			4.889***
			(0.411)
R^2	.350	.210	.134
Number of observations	8,261	8,252	19,181

NOTE: Standard errors are in parentheses.
a. Millions, 1996 dollars.
b. Results are omitted from this table.
*Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Valley. Start-up age has a negative coefficient in Model 2, reflecting the fact that older firms were founded during the early years when venture capital was relatively scarce.[11]

A comparison between Models 1 and 2 suggests that regions where start-ups receive venture capital at a younger age are the same as the regions where start-ups complete more rounds of financing. This result is expected because, given that two start-ups are observed during exactly the same time period, the one receiving the first-round venture capital at a younger age will have more time to complete later rounds. In an alternative specification of Model 2, I added start-up age at the first-round venture capital as an independent variable to explain the total rounds per

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Start-ups in Silicon Valley do enjoy some locational advantage compared with those in many other regions in terms of total venture capital deals they can secure.

firm. Indeed, this age variable has a negative and statistically significant coefficient, confirming the fact that start-ups getting venture capital at a younger age tend to complete more rounds of financing. However, including this age variable does not affect the significance of some of the location dummies. In particular, locations in New York, Washington, D.C., and the rest of the nation (not in any of the high-tech centers examined) still have significantly fewer rounds of venture capital financing per firm than in Silicon Valley, although the size of the difference in each case becomes smaller. Thus, start-ups in Silicon Valley do enjoy some locational advantage compared with those in many other regions in terms of total venture capital deals they can secure.

To explain deal size, Model 3 included the same industry dummies but used a different set of year dummies. As shown in Figure 1, total venture capital investment grew very fast before the crash of 2001, which implies that capital was more easily available in the late 1990s. This trend suggests that deals completed in the late 1990s can be larger, which must be controlled for by using year dummies. However, different from Models 1 and 2, Model 3 uses the closing year of a venture capital deal because it is a more appropriate control than the start year of the firm. I also included round class dummies because one would expect a firm to raise more money in a later round of financing. Here I use the "other rounds" as the base for comparison, which includes, for example, restart, venture leasing, and corporate investment.

Model 3 suggests that start-ups founded after 1995 received significantly larger investments in each deal and, more generally, that older start-ups tend to complete bigger deals. Negative coefficients of location dummies again show that Silicon Valley start-ups are associated with larger deal size, although for the rest of the San Francisco Bay area and New York, the difference is not statistically significant. On average, a start-up in Silicon Valley raises $1.5 million more in each deal than do start-ups in Boston, $1.3 million more than those in Seattle, and $2.0 million more than those in Washington, D.C. Round class dummies are all statistically significant. Not surprisingly, later deals tend to be larger than earlier ones: A deal after the second round is on average $12 million larger than a deal in the seed round.

Although coefficients of year dummies are not presented in Table 4, some of the results are worth mentioning. Compared with start-ups founded in 1992, those founded later had access to venture capital at younger ages. The start-year dummies show a clear pattern that the later the founding year, the faster the start-up obtained venture capital. This reflects the fact that venture capital was increasingly available in the late 1990s.[12] Start-ups founded later completed fewer rounds of venture capital financing, which is expected because they are too young to complete several rounds. Compared with deals closed in 1992, those closed in 1993 to 1998 are not significantly different in terms of size, but those completed in the subsequent 3 years are significantly larger. In 1999 or 2001, an average venture capital deal raised $3 to $4 million more than a deal in 1992. In 2000, the peak year of venture capital investment, a deal was $8 million larger.

Because the last 3 years in our sample period (1999 to 2001) are around the peak of the Internet boom, one naturally wonders whether some of the results are driven by the enormous amount of venture capital investment in that period. Although year dummies were included in the regressions to control for the effect, it is important to take a closer look at this issue. I did a robustness check by dropping some of the observations in the later years. To examine the age of start-ups at the first round of venture capital and the total rounds of financing per firm, I excluded all start-ups founded during 1999 to 2001 from the regression (dropping 35% of the observations). Similarly, for the deal size equation, I excluded all deals completed during 1999 to 2001 from the regression (dropping 57% of the observations). The results are presented in Table 5.

I found that Silicon Valley start-ups still receive the first-round venture capital at a significantly younger age than do start-ups in other regions. In fact, a comparison between Model 1 in Tables 4 and 5 shows that the difference between Silicon Valley and other regions has become larger when the sample is truncated. This suggests that in terms of how quickly start-ups gain access to venture capital, the gap between Silicon Valley and other regions was actually closing during the Internet boom. Model 2 in Table 5 shows that start-ups in Silicon Valley still complete more rounds of venture capital financing than start-ups in other regions, with the exception of the rest of the San Francisco Bay area. Similar to the results in Model 1, the difference between

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TABLE 5
Access to Venture Capital (VC): Ordinary Least Squares Regressions Using a Truncated Sample

	Model 1 Dependent Variable: Age at First VC	*Model 2 Dependent Variable: Rounds of VC*	*Model 3 Dependent Variable: Size of VC Deal*[a]
Constant	14.65***	7.885***	2.417*
	(3.766)	(0.677)	(1.330)
Started after 1995			0.392
			(0.332)
Start-up age at VC round			0.007
			(0.007)
Start-up age in December 2001		–0.048***	
		(0.005)	
Location dummies			
Silicon Valley	Reference group	Reference group	Reference group
Rest of San Francisco Bay area	3.586***	0.050	–0.283
	(1.122)	(0.080)	(0.335)
Boston	6.399***	–0.138*	–0.982***
	(1.039)	(0.075)	(0.306)
New York	12.35***	–0.528***	1.097**
	(1.350)	(0.096)	(0.481)
Seattle	7.696***	–0.190	1.891***
	(1.698)	(0.121)	(0.544)
Washington, D.C.	16.69***	–0.689***	1.274**
	(1.586)	(0.113)	(0.596)
Rest of United States	11.04***	–0.441***	0.265
	(0.768)	(0.055)	(0.230)
Start-year dummies	[b]	[b]	
Closing-year dummies			[b]
Industry dummies	[b]	[b]	[b]
Ownership status dummies		[b]	
Venture capital round dummies			
Seed round			–2.974***
			(0.379)
First round			0.419
			(0.284)
Second round			2.181***
			(0.310)
Later rounds			3.715***
			(0.328)
R^2	0.269	0.117	0.105
Number of observations	5,357	5,349	8,174

NOTE: Standard errors are in parentheses. For Models 1 and 2, start-ups founded during 1999 to 2001 are dropped from the sample; for Model 3, VC deals completed during 1999-2001 are dropped from the sample.
a. Millions, 1996 dollars.
b. Results are omitted from this table.
*Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Silicon Valley and other regions is actually larger when start-ups founded in the last 3 years are excluded.

Interestingly, the result for deal size is different. After excluding the deals completed in the last 3 years, I found the results reversed for some regions. Using the full sample (Table 4), venture capital deals appear to be larger in Silicon Valley than in Seattle and Washington, D.C., but the opposite is true once the latest deals are dropped (Table 5), and both results are statistically significant. Boston is the only region that has significantly smaller venture capital deals in both

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samples. Thus, the result that start-ups in Silicon Valley raise more money in each round of financing is not robust with respect to sample period; it seems to be a phenomenon that is unique to the era of the Internet boom.

I have demonstrated that even after controlling for relevant variables, Silicon Valley start-ups tend to receive venture capital at a younger age and complete more rounds of financing. They also appear to raise more money in each round, but this is not necessarily the case before the Internet boom.

Better Access to Venture Capital in Silicon Valley: Some Discussion

There are many reasons to believe that the fact of earlier access and more rounds of venture capital financing in Silicon Valley simply reflect the standard "agglomeration economies" generated by an industrial cluster. That is, they stem from the concentration of venture capital firms in this region:

First, the proximity between entrepreneurs and venture capitalists facilitates the investment process in many ways (Zook, 2004). For example, entrepreneurs may take less time to identify potential investors because they are nearby. They may even be able to establish personal connections with venture capitalists through the local social network. The proximity also allows entrepreneurs and venture capitalists to meet in person frequently and to quickly develop a mutual trust. Venture capitalists often invest millions in a start-up whose performance hinges, to a great extent, on the ability of the entrepreneur. And because the venture capitalists usually do not have previous experience with the entrepreneur, there is an asymmetric information problem between the two parties that prevents quick investment. In this situation, mutual trust and personal connections are very important because they usually help overcome the asymmetric information problem and, thus, accelerate the investment process.

Second, the high concentration of venture capital firms in Silicon Valley may make it easier to develop a partnership for joint investment. It is common practice in the venture capital industry that several venture capital firms form a syndicate to invest in a start-up so that they will share the risks. Syndication also provides an important channel for venture capitalists to share information (Bygrave & Timmons, 1992; Sorenson & Stuart, 2001). It should be easier to form a syndicate in a venture capital cluster such as Silicon Valley, which allows for quick investment.

Third, the abundance of venture capital in Silicon Valley may have intensified competition among venture capital firms for potential investees, and the competition can lead to quick investment. The presence of a large number of venture capital firms naturally raises the awareness of competition among venture capitalists in Silicon Valley, thus forcing everyone to move quickly in order to ensure a share of a potentially high return from a promising start-up.

The results in Table 4, however, are open to alternative interpretations. For example, larger deal size (during the Internet boom) and more rounds of financing in Silicon Valley may simply reflect higher operating costs in this region. Silicon Valley has long been known for its high cost of living and doing business, which is particularly true during the go-go years of the Internet boom when the overheated high-tech sector in Silicon Valley pushed wages and rents a lot higher than elsewhere. This implies that start-ups in this region have to pay higher operating costs and, thus, need more cash to stay in business.

A concentration of well-developed innovation-supporting industries in Silicon Valley is also a possible reason for the better access to venture capital. These industries include, for example, legal services, human resource services, investment banking, management consulting, and accounting services, which together with venture capital firms form a whole "clustered community" that facilitates company creation (Lee et al., 2000).[13] To a large extent, venture capital investment is about creating new companies whose pace is affected by other supporting services. For example, a new round of venture capital financing sometimes is contingent on whether a professional manager can be found to help the founders to expand the business, and the experienced executive search firms in Silicon Valley can often make it happen more quickly.

Also, the quicker access to venture capital in Silicon Valley may imply that venture capitalists in this region are more willing to take risks. After interviewing individuals who had worked

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in both the Boston area and Silicon Valley, AnnaLee Saxenian (1994) observed, "East Coast venture capitalists were more formal and conservative in their investment strategies" (p. 65). The interviewees' experiences in these two regions help highlight the cultural difference. An entrepreneur in Silicon Valley told Saxenian:

> When I started Convergent [Technologies], I got commitments for $2.5 million in 20 minutes from three people over lunch who saw me write the business plan on the back of a napkin. They believed in me. In Boston, you can't do that. It's much more formal. (p. 65)

Another Silicon Valley entrepreneur made a similar observation:

> There is no real venture capital in Massachusetts. The venture capital community is a bunch of very conservative bankers. They are radically different from the venture capitalists in Silicon Valley, who have all been operational people in companies. Unless you've proven yourself a hundred times over, you'll never get any money. (p. 65)

Although it is tempting to attribute Silicon Valley's quick investment to its "unique risk-seeking culture," this explanation raises another question: What determines the "culture?" Anecdotal evidence suggests that many venture capitalists in Silicon Valley are previously successful entrepreneurs or experienced engineers. This prior experience gives them a good sense about the viability of a new idea. That expertise may allow them to depend more on instinct and less on paperwork to evaluate business plans. In contrast, other regions have many banker-turned-venture capitalists, who are more likely to have a business rather than a technical background. Such venture capitalists will necessarily follow more formal routines in evaluating business plans and will naturally be more conservative in making investments.

Yet another possible explanation of quicker access to venture capital is that those start-ups in Silicon Valley simply represent great business plans and have clearly better growth potential that do not require as much time for venture capitalists to screen. Although this notion may have some intuitive appeal, it is hard to believe that great business plans are so much concentrated in the San Francisco Bay area. As shown in the next section, start-ups receiving venture capital at a younger age are more likely to go out of business, suggesting that these firms are not more viable businesses than others.

PERFORMANCE OF VENTURE-BACKED START-UPS

I have shown that Silicon Valley start-ups have better access to venture capital. This section examines how this better access affects start-up performance. The performance of start-ups can be evaluated along various dimensions. Again, the dimensions chosen here are dictated by data availability. I examine the performance of venture-backed start-ups using the following criteria:

- Survival: whether a start-up has survived (i.e., not out of business).[14]
- Merger and acquisition: whether a start-up merged with or was acquired by another firm.
- Initial public offering: whether a start-up completed an IPO.
- Profitability: whether a start-up began to make a profit.
- Employment: number of employees at the start-up.

With the exception of merger and acquisition, all other variables clearly measure desirable outcomes. That is, a successful start-up is expected to survive, complete an IPO, make a profit, and create jobs. Merger and acquisition per se is not necessarily a good or bad outcome. Although a start-up may lose its identity through a merger or acquisition, its product, technology, and personnel are

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TABLE 6
Performance of Venture-Backed Start-Ups: A Comparison

	Silicon Valley	*Rest of San Francisco Bay*[a]	*Boston*	*New York*	*Seattle*	*Washington, D.C.*	*Rest of United States*[b]
Survival rate							
M	0.878	0.824***	0.903**	0.857*	0.848*	0.913**	0.869
SD	0.328	0.381	0.296	0.351	0.360	0.283	0.337
Number of observations	1,817	869	899	600	283	344	3,912
Rate of merger and acquisition							
M	0.200	0.148***	0.192	0.120***	0.187	0.145***	0.144***
SD	0.400	0.356	0.394	0.325	0.391	0.353	0.351
Number of observations	1,817	869	899	600	283	344	3,912
Rate of initial public offering							
M	0.125	0.079***	0.081***	0.070***	0.106	0.061***	0.073***
SD	0.331	0.271	0.273	0.255	0.308	0.240	261
Number of observations	1,817	869	899	600	283	344	3,912
Rate of profitability							
M	0.042	0.044	0.072***	0.072***	0.046	0.102***	0.091***
SD	0.200	0.204	0.259	0.258	0.210	0.303	0.288
Number of observations	1,819	871	899	601	283	344	3,924
Size of employment, 2001[c]							
M	67.74	90.07**	89.11***	83.46**	85.14**	96.26***	111.9***
SD	73.45	176.49	247.5	207.8	169.1	215.8	294.2
Number of observations	916	467	507	352	145	214	2,286

NOTE: M = mean; SD = standard deviation.
a. San Francisco Bay area excluding Silicon Valley.
b. All regions in the United States not already covered by Silicon Valley, the rest of San Francisco Bay area, Boston, New York, Seattle, or Washington, D.C.
c. Limited to the sample of surviving start-ups that are privately held.
*Statistically different from Silicon Valley at the 10% significance level by one-tailed *t* test. **Statistically different from Silicon Valley at the 5% significance level by one-tailed *t* test. ***Statistically different from Silicon Valley at the 1% significance level by one-tailed *t* test.

likely to be preserved. To the whole economy, this reorganization of ownership may result in a better allocation of productive resources. Even the founder of the start-up and the venture capitalists who invested in it may find a chance to cash out in a merger or acquisition, which may generate a handsome return for them.

Start-Up Performance in Silicon Valley and Other Regions: A Simple Comparison

Table 6 summarizes the statistics of start-up performance, comparing Silicon Valley with other regions. Among start-ups that were founded after 1990 and received venture capital during 1992 to 2001, 88% survived (by the end of 2001) in Silicon Valley. Survival rates in the rest of the San Francisco Bay area, New York, and Seattle are significantly lower. However, both Boston and Washington, D.C., have significantly higher survival rates than Silicon Valley, and start-ups in the rest of the United States have a similar chance of survival.

By the end of 2001, 20% of venture-backed start-ups in Silicon Valley were merged or acquired. Start-ups founded earlier are much more likely to end up in a merger and acquisition. In fact, in each cohort of Silicon Valley start-ups founded during 1992 to 1995, more than 30%

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went through a merger and acquisition with the 1994 cohort having the highest proportion, close to 36%. The rest of the Bay area, New York, Washington, D.C., and the rest of the United States all have significantly lower rates of merger and acquisition than Silicon Valley. Boston and Seattle, although also having lower rates of merger and acquisition, are not significantly different from Silicon Valley.

Table 6 shows that 12.5% of Silicon Valley start-ups had completed IPOs by the end of 2001. This percentage is significantly higher than the 7.3% average for the rest of the United States. Even the rest of the San Francisco Bay area had only 7.9% of the start-ups go public, a significantly lower proportion compared with that of Silicon Valley. All other regions under examination have lower IPO rates than Silicon Valley, and the differences are statistically significant except for Seattle. The impressive IPO performance in Silicon Valley partly explains why it became such a high-profile innovation center during the 1990s.

Yet the profitability measure does not favor Silicon Valley: Only 4.2% of the Silicon Valley start-ups attained profitability. This proportion is significantly lower than in Boston, New York, Washington, D.C., and the rest of the United States. The rest of the Bay area and Seattle also show slightly higher rates of profitability than Silicon Valley, although the difference is not statistically significant.

As mentioned in the data section, VentureOne stops tracking a venture-backed start-up once it is out of business, acquired or merged, or traded on the stock market. For this reason, the last performance measure, size of employment, was calculated using only the sample of start-ups that were still privately held by the end of 2001. A typical venture-backed start-up in Silicon Valley had 68 employees, compared with 112 in the rest of the United States.[15] Silicon Valley has a significantly smaller average employment size than all the other regions, including the rest of the San Francisco Bay area. This is in sharp contrast with the general impression of Silicon Valley that most people derived from the media. Although the public press is filled with stories about the explosive growth of Silicon Valley companies such as Yahoo!, eBay, and Google, the data show that even among venture-backed firms, such fast-growing start-ups are the exception rather than the rule in Silicon Valley.

Start-Up Performance: Regression Analysis

I have compared Silicon Valley with other regions using various measures of start-up performance. In this section, I examine to what extent the performance of start-ups in Silicon Valley can be explained by their better access to venture capital and whether locating in Silicon Valley still makes a difference after controlling for some obviously relevant factors such as industry and founding date.

The VentureOne data are used to construct start-year dummies and industry dummies to control for cohort and industry effects. In addition, I include start-up age as a control variable. Age here is measured in months, so it is not completely correlated with start-year dummies. For each start-up, I also know its age at the first round of venture capital and the amount of venture capital it raised at the first round. These variables directly measure the effect of venture capital accessibility on start-up performance. I cannot include a firm's total rounds of venture capital financing in the regression to explain its performance because of the concerns of endogeneity: Venture capital investment, especially later rounds, is usually conditioned on firm performance. I still include location dummies in the regression analysis to account for all the other regional factors that are not already picked up by the access-to-capital variables.

In the multivariate regression analysis, I use each of the five different measures of start-up performance as the dependent variable. The results are shown in Table 7. Again, the coefficients of some control dummies are omitted. I included start-year dummies and industry dummies in every regression. For the profitability regression, I also added the ownership status dummies, to indicate whether a start-up ended in bankruptcy, merger and acquisition, or IPO. Such events stopped VentureOne's tracking of a start-up and, thus, should have an effect on the observed profitability of the firm.

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TABLE 7
Performance of Venture-Backed Start-Ups: Regression Analysis

	Model 1 Logit DV = 1 if Survived	*Model 2 Logit DV = 1 if Acquired*	*Model 3 Logit DV = 1 if Completed IPO*	*Model 4 Logit DV = 1 if Made Profit*	*Model 5 OLS DV = Number of Employees*
Constant	5.082***	–5.507***	0.506	0.198	–20.73
	(1.225)	(1.176)	(1.447)	(0.588)	(66.20)
Start-up age	–0.038***	0.040***	–0.016	–0.001	3.007***
	(0.010)	(0.009)	(0.012)	(0.003)	(0.285)
Start-up age at	0.018***	–0.025***	–0.024***	–0.011***	–2.059***
first-round VC	(0.002)	(0.002)	(0.002)	(0.002)	(0.217)
Money raised at	–0.002	–0.003	0.011***	0.005**	3.168***
first-round VC[a]	(0.002)	(0.004)	(0.003)	(0.002)	(0.204)
Location dummies					
Silicon Valley	–0.031	0.165*	0.572***	–0.708***	–42.32***
	(0.097)	(0.087)	(0.111)	(0.148)	(9.177)
Rest of San Francisco	–0.330***	–0.067	0.196	–0.568***	–42.22***
Bay area	(0.111)	(0.120)	(0.157)	(0.189)	(12.12)
Boston	0.181	0.249**	–0.086	–0.159	–34.94***
	(0.131)	(0.106)	(0.151)	(0.155)	(11.34)
New York	–0.005	–0.108	0.416**	–0.100	–31.53**
	(0.140)	(0.151)	(0.192)	(0.190)	(14.00)
Seattle	–0.253	0.268	0.570**	–0.379	–26.30
	(0.185)	(.0181)	(0.229)	(0.304)	(19.34)
Washington, D.C.	0.241	0.067	0.215	0.255	–9.885
	(0.212)	(0.182)	(0.254)	(0.215)	(17.52)
Ownership status dummies				[b]	[b]
Start-year dummies	[b]	[b]	[b]	[b]	[b]
Industry dummies	[b]	[b]	[b]	[b]	[b]
(Pseudo) R^2	0.057	0.112	0.206	0.183	0.184
Number of observations	7,862	7,736	6,821	7,862	6,539

NOTE: Standard errors are in parentheses. DV = dependent variable; OLS = ordinary least squares; VC = venture capital; IPO = initial public offering.
a. Millions, 1996 dollars.
b. Results are omitted from this table.
* Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

To explain firm size, I excluded those firms that were out of business because I could not identify the date of bankruptcy and consequently did not know the associated date of the employment number. I did include firms that were acquired or completed IPOs but used the date of such events to compute the age of the firm. For example, if a start-up is privately held, its number of employees is its size at the end of 2001, the time when this version of the database was last updated by VentureOne. However, if a start-up was founded in May 1995 and went public in May 1998, its employment number reflects its size in May 1998 rather than its "current" size in 2001 because VentureOne would have stopped updating the information in May 1998. Therefore, although I still included the information of such a firm in the regression, I considered its age as 36 months (from May 1995 to May 1998). In the firm size regression, ownership status dummies were also included.

Model 1 in Table 7 is a logit regression of start-up survival.[16] The results show that an older start-up is more likely to be out of business than a younger one, which is both natural and consistent with previous literature on firm growth. Note that I also controlled for start year, which did not take away all the age effect. Firm age at the first round of venture capital is positive and statistically significant, implying that start-ups receiving venture capital at a younger age are more likely to go bankrupt. As results in Table 4 suggest, the average start-up age at the first-round venture capital in Silicon Valley is 4.3 months younger than in the Boston area. All else

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being equal, the coefficient of this variable in Model 1 implies that the odds of survival for a start-up in Silicon Valley are 7.4% lower than in Boston.[17] The size of the first round of venture capital has a negative sign but is not significant. The coefficients of these two variables (age at first round and size of first round) do not support the hypothesis that some start-ups have quicker access to capital simply because they have better plans. Rather, the results suggest that early venture capital support tends to fund more businesses that are not viable, probably because of inadequate screening by venture capitalists. The location dummies show that compared with the rest of the United States, Silicon Valley does not make a significant difference to the survival rate of start-ups. The same is true for Boston, New York, Seattle, and Washington, D.C. Yet in the rest of the San Francisco Bay area, start-ups have a significantly lower survival rate.

Model 2 is a logit analysis of the probability that a start-up goes through a merger or acquisition. The coefficient of start-up age is positive and significant, meaning that the probability is higher for older start-ups to be acquired. Start-up age at the first-round venture capital has a negative and statistically significant effect; that is, a start-up receiving venture capital at a younger age is more likely to be acquired by another firm. Again, consider the 4.3-month difference of start-up age at the first round between Silicon Valley and the Boston area. The coefficient in Model 2 suggests that start-ups in Silicon Valley are expected to have 11.3% higher odds of being acquired than those in Boston because of their quicker access to venture capital. The size of the first deal is insignificant. Locating in Silicon Valley and Boston significantly raises the chance of being merged or acquired, whereas other regions have insignificant coefficients.

The statistical significance of the Silicon Valley and Boston location dummies is not hard to understand given that they are the top two high-tech centers in the United States. Many of the most successful technology firms are headquartered in these two regions. Some of them, such as Silicon Valley's Cisco, consciously use acquisition as a strategy to gain access to new technologies and new markets, to acquire talents, or to eliminate competitors (Mayer & Kenney, 2004; Paulson, 2001). They even consider acquisition and development (A&D) as an alternative to the traditional approach of research and development (R&D). Start-ups close to those successful companies are undoubtedly more visible targets for acquisition.[18] What also distinguishes Silicon Valley and Boston from other regions is their well-developed supporting industries such as investment banking and legal services that specialize in deal making in the technology sector, which must have made it easier to find synergies among technology firms.

Models 3 and 4 in Table 7 analyze the probability that a start-up completes an IPO and makes a profit, respectively, and Model 5 explains a start-up's size of employment. All these are desirable performance outcomes. In all three regressions, both the two access-to-capital measures have significant coefficients. Start-up age at the first-round venture capital has negative effects: Start-ups receiving venture capital at a younger age have a higher chance to go public, a higher chance to make a profit, and are likely to have more employees. For example, given that an average start-up in Silicon Valley completed the first round of venture capital financing 4.3 months earlier than in Boston, the coefficients in Models 3, 4, and 5 imply that it tends to have 10.9% higher odds of completing an IPO, 4.8% higher odds of making a profit, and nine more employees than an average start-up in the Boston area. The size of the first-round venture capital has positive effects: Start-ups receiving more venture capital initially are more likely to complete an IPO, to make a profit, and to create more jobs. Combined with the results in Model 1 about firm survival, these coefficients suggest that although early venture capital investment supports many poor deals, it also buys a first-mover advantage to those start-ups that do have viable business plans. As a result, such start-ups tend to grow fast and become successful. Therefore, quick access to venture capital creates both a larger proportion of highly successful companies and a larger proportion of complete failures and, thus, fewer mediocre companies. Note that this may not be a bad outcome for venture capitalists because it is well known that the return from one great success is often more than enough to cover the loss of many failures.

It is expected that older firms are more likely to be on the stock market, more likely to make a profit, and have more employees. However, the age effect for IPO and profitability is insignificant, as shown in Models 3 and 4. This is actually captured by the start-year dummies whose

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coefficients are omitted from the table. Model 3 shows that start-ups in Silicon Valley have a significantly higher chance of completing an IPO. New York and Seattle also have positive coefficients that are statistically significant. The positive effect of Silicon Valley again could be a result of its strong supporting industries. That is, investment bankers, lawyers, and accountants in Silicon Valley might have helped push start-ups to the stock market. The same reason may also apply to New York. In addition, Silicon Valley, with a long tradition of producing highly successful technology firms, may have gained a good reputation among investors, and this lowered the barrier to the stock market for Silicon Valley firms.

Model 4 shows that start-ups in Silicon Valley, actually in the entire San Francisco Bay area, have a significantly lower chance to make a profit. This may have to do with the "Internet bubble" that had a particularly severe effect on the San Francisco Bay area economy. During the second half of the 1990s, venture capital supported a large number of dot-coms in this region. Many of them focused on gaining market share and paid little attention to generating profit in the short term. Their operation was made possible only by many rounds of venture capital. The location dummies may have picked up part of the effects of more venture capital rounds per firm in the San Francisco Bay area that are not reflected in the other two measures of capital abundance.

Fierce competition in the high-tech cluster provides a possible alternative explanation of the negative coefficients of location dummies in Model 4. Start-ups in an established high-tech center have to compete with many other firms for managers, engineers, customers, and suppliers, which naturally hurts their prospect of profitability (Stuart & Sorenson, 2003). In the late 1990s, the overcrowded San Francisco Bay area saw rapidly rising wage rates and housing prices, worsening road congestion, and a shortage of office space. All of these added up to higher costs of doing business in this region, which must have had a negative effect on the profitability rate of start-ups. Naturally, severe competition exists in all clusters, and this explains why all other location dummies, except Washington, D.C., also have negative coefficients. This negative effect is more evident in the employment regression in Model 5, where every location dummy has a negative coefficient. In other words, start-ups in all these technology clusters tend to have fewer employees. These negative coefficients are statistically significant for Silicon Valley, the rest of the San Francisco Bay area, Boston, and Washington, D.C. Again, the higher level of competition and the higher costs of doing business in clusters offer a plausible explanation of the result.[19]

Given the possibility that locating in Silicon Valley had negative effects on profitability and employment only because of the Internet bubble during the late 1990s, it is important to examine whether the results hold in the prebubble periods. Although I included start-year dummies as control variables, some further sensitivity analysis is still necessary. Thus, as a robustness check, I excluded all start-ups founded during 1997 to 2001 from the sample and reran the regression for Models 4 and 5. The results show that the Silicon Valley location dummy still has negative coefficients, and in both cases, they are statistically significant at the 1% significance level. Therefore, the Internet bubble is unlikely to be the reason behind the negative effects of locating in Silicon Valley.

The coefficients of some dummy variables were omitted from Table 7, but some of the results are interesting to note. Year dummies show that start-ups founded in the late 1990s are less likely to be alive in 2001 than those from earlier cohorts. This is unexpected because generally an older cohort would have a lower proportion of surviving firms. It is possible that the surge of venture capital investment during the Internet boom lowered the chance of survival for firms founded in the late 1990s. It was easier for start-ups to obtain venture capital in those years because too much money was chasing too few ideas. As a result, it is likely that many poor business plans were funded by venture capital in the late 1990s, and many of them soon went bankrupt. Year dummies also show that start-ups founded later were less likely to make a profit, go public, or have many employees.

Overall, I find that venture capital accessibility has a significant effect on the performance of start-ups. Receiving venture capital at a younger age increases a start-up's chance of completing an IPO, going through a merger and acquisition, making a profit, and hiring more employees. However, start-ups receiving venture capital at a younger age also have a lower survival rate.

Thus, the quick access to venture capital helps explain why start-ups in Silicon Valley have higher rates of IPO and merger and acquisition. However, the Silicon Valley location dummy still

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has significantly positive effects on IPO and merger and acquisition even after controlling for access to venture capital. It seems that Silicon Valley's other strong supporting industries such as investment banking, accounting, consulting, and legal services also helped.

Locating in Silicon Valley has considerable negative effects on a start-up's chance of making a profit and its employment size. This may result from the intense competition and congestion in this highly successful industrial cluster. Although better access to venture capital should mitigate such negative effects, they are unable to offset them completely. Thus, Silicon Valley start-ups generally have a lower chance of making a profit and tend to hire fewer employees.

DISCUSSION AND CONCLUSION

As the most salient example of high-technology centers, Silicon Valley has inspired a large amount of literature on the emergence and evolution of industrial clusters and their role in regional economic development. In this article, I tried to identify the agglomeration economies created by the Silicon Valley cluster. In particular, I examined whether start-ups in this region have better access to venture capital, and if so, how this better access affects the performance of start-ups.

I found that during the decade of 1992 to 2001, Silicon Valley start-ups consistently received 20% to 26% of the total venture capital investment in the United States. This relative abundance of venture capital apparently permits better access to capital in Silicon Valley. Start-ups in this region tend to receive venture capital support at a younger age, to complete more rounds of venture capital financing, and to raise more money in each deal. Although the last finding may be driven primarily by the large amount of venture capital flowing to Silicon Valley during the years of the Internet boom, the other two results are fairly robust across subsample periods.

This relative abundance of venture capital apparently permits better access to capital in Silicon Valley. Start-ups in this region tend to receive venture capital support at a younger age, to complete more rounds of venture capital financing, and to raise more money in each deal.

It is most likely that the better access to venture capital in Silicon Valley stems from the concentration of a large number of venture capital firms in this region. Entrepreneurs in Silicon Valley may take a shorter time to find potential investors because of their proximity to many venture capitalists. At the same time, venture capitalists in this region may have to expedite the process of identifying, evaluating, and investing in promising start-ups because a slow move will give an edge to many local competitors who are seeking the same opportunities. In addition, because it often takes several venture capitalists to jointly invest in a single start-up, the high density of venture capitalists in Silicon Valley would allow quick formation of a partnership.

However, this better access to venture capital in Silicon Valley is also open to alternative explanations. For example, start-ups in Silicon Valley may receive venture capital at a younger age simply because of its wide reputation as a risk-seeking culture. It is also possible that the strong supporting industries or the highly interconnected social network among venture capitalists and supporting industries in Silicon Valley has enabled quicker investment.

Regardless of its real cause, the better access to venture capital has a profound effect on the performance of start-ups. Controlling for cohort and industry dummies, I found that start-ups receiving venture capital at a younger age are more likely to go bankrupt, to be acquired, to complete an IPO, to make a profit, and to have more employees. The size of the first-round venture capital also has significant positive effects on the chance of completing an IPO, the probability of making a profit, and the size of employment.

Early access to venture capital clearly gives Silicon Valley start-ups substantial first-mover advantage, which enables pioneering firms in this region to quickly transform ideas into marketable products and become industry leaders. Netscape, Yahoo!, and eBay are among the examples of such leaders that emerged in Silicon Valley during the 1990s. In each case, the company's position as a first mover probably contributed as much to its early success as its technological advantage did. Silicon Valley's early access to venture capital is likely an important factor in explaining why it has recently led several waves of innovation in the technology sector.

On the other hand, Silicon Valley's early access to capital has a negative effect on the survival rate of venture-backed start-ups in this region. Presumably, early investment lends support to many

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poor business plans because of lack of prudent screening. This explains the higher start-up mortality rate in Silicon Valley compared with the rates in Boston and Washington, D.C. It also explains why the bursting of the Internet bubble hurt this region so severely.[20] However, it is important to note that although quick investment tends to produce more failures, it may not diminish venture capitalists' returns. It is well known that the property of increasing returns in high-technology industries tends to generate a large first-mover advantage and lead to a winner-take-all situation. Thus, quick investment has a better chance to produce highly successful start-ups that yield a return high enough to cover the loss from many more failures.

As a dense industrial cluster, Silicon Valley is necessarily subject to the diseconomies of agglomeration. Intense competition for local resources has substantially increased the costs of doing business in this region, which hinders the growth of start-ups. As a result, locating in Silicon Valley has a significantly negative effect on a start-up's chance of making a profit and on its employment size. The better access to venture capital in Silicon Valley helps mitigate these negative effects but not enough to offset them. In fact, one would not expect such negative effects to disappear in an equilibrium situation because the benefit of abundant capital will always attract the entry of new businesses in this region until negative effects arise to stop them.

Using a comprehensive venture capital database, this article has compared Silicon Valley with other technology centers along multiple dimensions. It has highlighted some unique features of the Silicon Valley economy; it also helps further the understanding of agglomeration economies and diseconomies related to venture capital. Many of the results are suggestive rather than conclusive, and some of the findings clearly call for further investigation. For example, the results show that earlier access to venture capital is a distinctive feature of Silicon Valley that has a significant effect on the performance of start-ups in this region. Understanding this feature should help identify the real cause of Silicon Valley's economic success in the 1990s. Thus, it is important to find out what, in addition to the local abundance, explains the quicker access to venture capital in Silicon Valley. I leave that for future research.

APPENDIX
Geographic Definition of Industrial Clusters

Following the tradition established by regional institutions such as the Joint Venture: Silicon Valley Network, I define Silicon Valley as the entire Santa Clara County and adjacent cities in Alameda, San Mateo, and Santa Cruz counties.

City	*Zip Code*
Santa Clara County	
All	All
Alameda County	
Fremont	94536-39, 94555
Newark	94560
Union City	94587
San Mateo County	
Atherton	94027
Belmont	94002
East Palo Alto	94303
Foster City	94404
Menlo Park	94025
Redwood City	94061-65
San Carlos	94070
San Mateo	94400-03
Santa Cruz County	
Scotts Valley	95066-67

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Other regions are more loosely defined using area codes.

Region	*Area Code*
San Francisco Bay area	Silicon Valley plus 408, 415, 510, 650, 925 if not already in Silicon Valley
Boston	508, 617, 781, 978
New York	201, 212, 347, 516, 646, 718, 732, 845, 908, 914, 917, 973
Seattle	206, 253, 360, 425
Washington, D.C.	202, 240, 301, 571, 703

NOTES

1. As Ethernet inventor and 3Com founder Bob Metcalfe (1998) famously observed, "Silicon Valley is the only place on Earth not trying to figure out how to become Silicon Valley."

2. These are undoubtedly important questions. Interested readers may refer to Kenney and Florida (2000) for a detailed account of the formation of the venture capital cluster in Silicon Valley.

3. A company is captured by the VentureOne database only if it receives some investment from venture capital firms. VentureOne defines a venture capital firm as "a professional, institutional venture capital limited partnership that generally manages over $20 million in assets and invests in privately held companies" (VentureOne Corporation, 2000, p. 4). Once a company receives investment from venture capital firms and enters the database, VentureOne tracks the company's financing from all sources, including bank loans and initial public offerings (IPOs). Although I do not count bank loans or money raised through an IPO as venture capital, I do include equity investment made by non–venture capital corporations or "angel investors" as venture capital in my calculations. It is worth noting that some start-ups might have received some equity investment from corporations or angels before they secured investment from professional venture capital firms. Such corporation or angel investments are not captured by the VentureOne database and, thus, are not included in my calculations.

4. See the company's Web site at http://www.ventureone.com/ (retrieved January 25, 2006).

5. In contrast, the Top 10 states accounted for only 55.5% of the U.S. gross domestic product in 2004.

6. Joint Venture: Silicon Valley Network is an organization that provides a forum for leaders from local business, government, universities, and nonprofit organizations to discuss challenges in Silicon Valley and possible solutions. It has published an annual Silicon Valley Index for more than a decade, which uses a geographic delineation of Silicon Valley that has become a tradition. The most recent editions of the Silicon Valley Index are available at http://www.jointventure.org/publications/index/indexofsiliconvalley.html (retrieved January 25, 2006).

7. It was the New York-based Fairchild Camera and Instrument Corporation that provided the capital to their start-up, thus named the Fairchild Semiconductor, which later spun off many semiconductor companies and became a legend in Silicon Valley's history (Saxenian, 1994; Von Burg & Kenney, 2000).

8. According to VentureOne, since 2001, total venture capital investment in the United States has further declined but stabilized around $20 billion. The total was $22.0 billion in 2002, $19.1 billion in 2003, $21.3 billion in 2004, and $10.1 billion in the first two quarters of 2005. See more detailed statistics for the most recent years at VentureOne's Web site http://www.ventureone.com/ii/2Q05FinancingRelease.xls (retrieved January 17, 2006).

9. In this article, venture capital "deal" and venture capital "round" are used interchangeably.

10. The Silicon Valley Economic Development Alliance, a local partnership of economic development professionals, promotes Silicon Valley as the region that has "the shortest distance from idea to market" (see http://www.siliconvalleyonline.org/index.html; retrieved January 23, 2006). There is apparently some truth in the statement given the quicker access to venture capital observed here.

11. On the other hand, one might expect start-ups to complete more venture capital deals if they have existed for a long time; that is, start-up age should have a positive effect. This effect is picked up by the start-year dummies, which show that start-ups founded later completed significantly fewer rounds of venture capital financing (not shown in Table 4).

12. Although there was a sharp decline in venture capital investment in 2001, it was not because of insufficient supply of capital. In fact, many of the venture capital firms had to refund some money to their investors because too much money was chasing too few ideas after the burst of the Internet bubble (see, e.g., Der Hovanesian, 2002).

13. See also Cohen and Fields (1999) for a discussion of all the related networks including the venture capital industry as the "social capital" in Silicon Valley.

14. In organization theory, a firm is considered dead if it lost its identity (Carroll & Hannan, 2000). In that case, a start-up acquired by another firm is not surviving. The definition of survival in this article is broader.

15. Venture-backed start-ups obviously grow much faster than average new firms in the economy. An overwhelming majority of new businesses in the U.S. economy will never hire more than 20 people.

16. For the analysis of survival and IPOs, hazard models are preferred over logit models. However, for most of the start-ups that were out of business, the VentureOne data indicate only that they no longer existed by the end of 2001 but do not specify an exact exit date. Thus, it is impossible to construct the time-to-event variable to estimate standard hazard models.

17. The term *odds of survival* is defined as the ratio of the probability of surviving to the probability of not surviving. Under a logit model, it is simply $e^{\alpha + x\beta}$. Thus, the ratio of these two odds (for Silicon Valley and Boston) is $e^{(x_i - x_j)\beta} = e^{-4.3 \times 0.018} = 0.926$.

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18. During 1993 to 2003, Cisco acquired a total of 97 technology firms, a vast majority of which are Silicon Valley firms. See Cisco's full acquisition record at http://www.cisco.com/en/US/about/ac49/ac0/about_cisco_acquisitions.html (retrieved May 6, 2005).

19. There is an alternative explanation of the negative effect on employment: The Silicon Valley region may be unsuitable for labor-intensive operations. Even within an industry, some firms are more labor intensive, and some others are more capital or knowledge intensive. If the Silicon Valley start-ups are more likely to be less labor-intensive firms because of the higher labor cost in the region, it is likely to observe Silicon Valley firms with fewer employees. Including industry dummies in the regression cannot control for this effect.

20. In Santa Clara County, the heart of Silicon Valley, the unemployment rate rose from 3.0% in January 2001 to 9.2% in January 2003. In merely 2 years, Santa Clara County lost 15.3% of its jobs: Total employment declined from 929,700 down to 787,200. (Source: California's Employment Development Department, data available at http://www.calmis.cahwnet.gov/htmlfile/subject/lftable.htm, retrieved on May 6, 2005).

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