THE SPATIAL DISTRIBUTION OF ENTREPRENEURIAL SUPPORT NETWORKS: EVIDENCE FROM SEMICONDUCTOR INITIAL PUBLIC OFFERINGS FROM 1996 THROUGH 2000

August 28, 2003
BRIE Working Paper 153

DONALD PATTON
Research Associate
Department of Human and Community Development
University of California, Davis
Davis, CA 95616
dfpatton@ucdavis.edu

&

MARTIN KENNEY
Department of Human and Community Development
University of California, Davis
Davis, CA 95616
(530) 752–0328 (Office)
(530) 752–5660 (Fax)
mfkenney@ucdavis.edu
and
Berkeley Roundtable on the International Economy
UC, Berkeley

* The authors thank the University of California Office of the President's Industry-University Cooperative Research Program, the University of California, Davis Academic Senate, and the Alfred P. Sloan Foundation for providing funding for this research project.

INTRODUCTION

Theory and recent research demonstrates that entrepreneurship is a spatially and socially embedded activity.[1] In certain regions, dense support networks of institutions dedicated to assisting entrepreneurial start-ups have been established and a wide variety of authors have given credit to these networks for supporting regional entrepreneurship (Kenney and von Burg 1999; Saxenian 1994; Bahrami and Evans 2000). As Marshall (1890) recognized many, but not all, industries exhibit a strong clustering effect (see also, e.g., Storper and Walker 1988; Porter 1990; 1998). Research on these networks has been hampered by a lack of empirical data that contains spatial variables and identifies the relationship between various actors (i.e., venture capitalists, law firms and investment bankers) and the start-up firm. Thus research has been qualitative and anecdotal or when quantitative limited to certain industries usually biotechnology.

Because these institutions are dedicated to the formation of new firms their presence within a region serves to lower the entry costs of new firms into the region. The role of start-ups in the transmission of knowledge within a cluster has been widely noted as they are one of the key ways in which Marshall's "mysteries of the trade" are diffused within a cluster such as the Silicon Valley (Brown and Duguid 2000). Therefore the economic actors that comprise an entrepreneurial support network within a region serve, in their promotion of start-ups, as an important conduit of knowledge spill-overs.

This study is an examination of the spatial location of a firm's entrepreneurial support network, which we define as the network of actors that a start-up firm relies upon for financial, legal, and managerial support and expertise. In particular, this study is an examination of some of these actors with respect to start-up semiconductor firms that have reached a stage in their development where they have decided to go public with an initial public offering (IPO) of their stock. Although this is but one path a successful start-up may choose, the others being remaining as a private firm or being acquired or merging with another company, it is the one path that allows outside observers access to the inner workings of the new firm. This access is made available through the documents a firm going public must submit to the U.S. Securities and Exchange Commission, and it is these documents that provide the basis of this study.

[1] On social embeddedness, see Granovetter (1985). On the embeddedness of economic activity in a regional context, see Storper and Salais (1997).

ECONOMIC CLUSTERS, ENTRENEURIAL SUPPORT NETWORKS, AND THE FORMATION OF NEW FIRMS

The tendency of different types of economic activity to concentrate geographically is a widely observed phenomenon over time and across countries. These concentrations of activity are most frequently referred to as clusters or industrial districts, and the relationship between innovation, entrepreneurship, and geography of these clusters has attracted the attention of academics from a variety of disciplines in the last decade. The importance of industrial clustering for firm growth and innovation has been widely noted beginning with Alfred Marshall (1890), extending through Michael Piore and Charles Sabel (1984) to contemporary geographers (Malecki 1980; Scott 1993; Storper 1995).

Krugman (1991), in a restatement of Alfred Marshall's observations from 1890, concludes that there are three distinct reasons for localization. First, clusters allow for a large market of workers with highly specialized skills. For many firms such skilled labor can only be found within a cluster. Second, a cluster supports a wide range of specialized local suppliers of inputs and services. Again, some specialized inputs are only readily available in clusters. Technological spillovers, the tendency for knowledge to spill over from firms and individuals within a cluster, yet be geographically bounded by the cluster, is given as a final reason for industrial localization.

The literature investigating clusters has found that both traded and untraded interdependency benefits are responsible for the success of these regional economic agglomerations (Storper 1995; Porter 1990). Michael Porter (1998), in conclusions not very different from those of Paul Krugman above or economic geographers such as Walker (1985; 1988), identified three broad ways in which clusters affect competition. First, the externalities present in a cluster operate to increase the productivity of all member firms. Second, the cluster accelerates the innovative capacity of its firms. Third, the concentration of specialized skills and knowledge within the cluster reduces the barriers to entry and facilitates new firm formation. Baptista and Swann (1998) found evidence to suggest that all of these factors are at work and that innovation, firm entry and growth are all stronger in clusters. In qualitative work directed at particular industrial clusters, Kenney and von Burg (1999) have argued that these benefits are responsible for the success of innovative regions such as Silicon Valley and Route 128. Saxenian (1994) argues that the interactive nature of the Silicon Valley environment is the reason that Silicon Valley was more successful than Route 128.

Silicon Valley hosts a set of interdependent institutions that observers have termed an "ecosystem", a "social structure of innovation", or an "incubator region" (Bahrami and Evans 2000; Florida and Kenney 1990; Schoonhoven and Eisenhardt 1989). Silicon Valley can be considered as two intertwined but analytically separable economies. The first set of organizations consist of established firms, corporate research laboratories, and universities that are the constituents of the existing economy that are in one form or another not unusual for any industrial cluster. Silicon Valley, however, has another set of organizations that combine to create an "economy" predicated on facilitating entrepreneurs in the creation of new firms. Kenney and von Burg (2000) argue that this other economy is the *differentia specifica* of high-technology regions such as Silicon Valley, and is the trait that sets them apart from most other regions of industrial clustering.

The organizations of the first economy, either because of their charter to do research as in the case of universities and R&D laboratories, or as a by-product of their normal activities as in the case of firms, create inventions that may be capable of being capitalized in an independent firm. This ability to extrude an invention from an existing firm is facilitated by the rapid pace in high-tech industry, which often creates technological discontinuities and accompanying economic opportunities. In the electronics industry there have been recurring discontinuities, and very often the existing firms are unwilling or unable to exploit them, or simply miss them because they are preoccupied with their current businesses and customers (Christensen 1997).

The organizations of the second economy comprise the institutional infrastructure that has evolved to enable the creation and growth of new firms (Bahrami and Evans 1989; Florida and Kenney 1988; Schoonhoven and Eisenhardt 1989; Todtling 1994). Just as computers and microprocessors are the actual products of the firms found in the first economy, new firms can be seen as the products of the institutional infrastructure of the second economy dedicated to the creation of new firms. The components of this infrastructure are organizations whose primary or sole purpose is related to servicing start-ups. The capital gains derived from these start-ups fuel the entire process, whether these organizations receive fees for services rendered or receive equity in the enterprise. We refer to the particular constituents within this infrastructure that a start-up wishing to go public must turn to as the firm's entrepreneurial support network.

The history of the development of the semiconductor industry in Silicon Valley illustrates not only the remarkable technological importance of this industry to Silicon Valley and the

power of Moore's Law,[2] but also the role of members of a firm's support network, particularly venture capitalists. Silicon Valley's capture of the semiconductor industry was the result of a series of small events that would make an enormous difference, starting in 1955 when William Shockley, coinventor of the transistor at Bell Laboratories, decided to establish a firm to exploit his invention.

Shockley hired eight brilliant young scientists and engineers and brought them with him to Palo Alto. Shockley proved to be an ineffective manager, and the eight resigned in 1957 to form their own start-up. Not knowing how to find capital in the San Francisco Bay Area, they went through a U.S. East Coast investment bank to get funding from an East Coast firm, Fairchild Camera and Instrument Company, owned by Sherman Fairchild. The firm founded by these eight engineers was named Fairchild Semiconductor. Fairchild quickly became a technological leader in the transistor industry and spearheaded the transition to the integrated circuit.

With the Sputnik-related military buildup throughout the 1960s and the adoption of transistors and integrated circuits by the manufacturers of consumer electronics and computers, sales boomed and profits were exorbitant (Hanson, 1982). As a by-product of the exuberant growth of the semiconductor industry in the 1960s, many firm founders and early employees became very wealthy (Tilton, 1971). Their success, and willingness to invest in new ventures, put in motion a path-dependent logic, in terms of an example and an incentive for others to follow. Earlier successes justified future ventures. The dimensions of this spinoff process were immense; a genealogy of semiconductor start-ups through 1986 indicated that 124 start-ups could trace their roots to Fairchild.

Fairchild and its spinoffs were important in the history of Silicon Valley venture capital. In addition to Arthur Rock, who arranged the Fairchild investment in 1958, organized the funding for Intel, and provided funding to many other start-ups such as Apple, other important venture capitalists who began their career at Fairchild are Donald Valentine and Pierre Lamond of Sequoia Partners, and Eugene Kleiner of Kleiner Perkins. Most important, the success of Fairchild's spinoffs (such as Intel, Advanced Micro Devices, National Semiconductor, LSI Logic, and their spinoffs) created enormous capital gains for their founders, key employees, and investors in venture capital funds. Some gains were reinvested in venture capital funds and independent start-ups. The final important contribution of Fairchild and its early start-ups was the number of managers and engineers that had become

[2] Gordon Moore, one of the founders of Fairchild and later Intel, observed that the number of transistors on an integrated circuit doubled approximately every eighteen months even as the cost of the integrated circuit remained the same.

independently wealthy and were able to invest in or join start-ups without risking their financial future.

THE CONSTITUENT ACTORS OF AN ENTREPRENEURIAL SUPPORT NETWORK

One of the principal advantages of choosing to locate a new firm in a cluster is to access the knowledge spillovers that are to be found there. But as Powell et. al. (2002) argue, the existence of an infrastructure within a cluster that fosters knowledge transfer and the provision of capital is an important element in the firm's decision as well. This infrastructure, or support network, is comprised of universities, law firms, research institutes, venture capitalists and other professionals. This entrepreneurial support network maintains channels of communication among market participants that not only support the public good nature of technological knowledge, these channels also reduce the transaction costs of comprehending and utilizing such information (Antonelli, 2000).

In capitalist economies, quite naturally, access to capital is a requirement. In this study, two financial intermediaries, the venture capitalists and investment bankers, are included. The role of spatial and network proximity for financial intermediaries has attracted significant attention recently. Agnes (2002) in a study of the interest rate swaps industry found that "different financial services have differing informational contents, with implications for the local embeddedness of financial services firms." This is confirmed by the finding that formal institutional networks are actually embedded in informal relationships through which transactions and information flows (Clark and O'Connor 1997; Pryke and Lee 1995; Thrift and Leyshon 1994). In other words, as Uzzi (1999) illustrates formal relationships such as the lender-borrower relationship are embedded in a social context, and this social embeddedness, what Garud and Jain (1996) in their study of technological change refer to as "just-embedded," actually reduces the cost of loans and reduces risk. Abolafia (1997) finds that the necessity of social and physical proximity differs by the nature of the financial product. So, for highly standardized products such as listed equities and government bonds, traders need not be proximate, whereas for other more idiosyncratic financial instruments proximity is of greater importance.

There is an ample literature suggesting that venture capital investing is a locally embedded practice, because of the importance of their monitoring and informal assistance functions that go beyond simply providing capital (Florida and Kenney 1988; Sorenson and Stuart 2001; Gilson and Black, 1998). Indeed, Greenwald and Stiglitz (1992) have observed that the

venture capital industry shares many aspects with early financial market communities. Because venture capital firms operate in a tightly knit community and have detailed information of the projects they fund and the industries in which their entrepreneurs operate, there is a strong reliance upon trust and reputation in the relationship between venture capitalists and the firms they fund. The critical venture capitalists in a start-up are what are termed the "lead" venture capitalists who are the board members and those most responsible for monitoring and assisting the firm (Gompers and Lerner 1999), and it is these venture capitalists that one would expect to be local.

Investment banks are another part of a firm's entrepreneurial support network. Their expertise and connections with venture capitalists and entrepreneurs are core assets, from which other specialties have arisen. Here we would hypothesize that repeated transactions take place between individual venture capitalists and investment bankers, and that they will be located in close physical proximity to each other despite the fact that many of the investment banks such as Goldman Sachs and Morgan Stanley are located on the East Coast, though historically there were a number of smaller boutique investment banks on the West Coast including Hambrecht and Quist, Robertson Stephens (during the 1990s they were acquired by larger banks). However, very often the newly acquired investment banking arm was not relocated, so an attribution of the source of the investment banking service to the headquarters would be incorrect.

The legal profession is, quite naturally, local in practice even though most large legal firms have numerous branch offices. High-technology lawyers for small start-ups often have a multifaceted role that extends far beyond merely providing the legal services such as incorporation documents etc. They often advise entrepreneurs and provide introductions to venture capital firms and other business services (Suchman 2000). Of course, for firms in more remote locations such legal advice may not be available leading one to hypothesize that the start-up would either have a relatively unsophisticated local lawyer or be forced to retain counsel from a distant high-technology cluster.

PROXIMITY, TACIT INFORMATION, AND ENTREPRENEURIAL NETWORKS

David Audretsch (2000) has observed that an irony of globalization is that as technological advances in communication have drastically reduced the cost of transmitting information over distance, the perceived importance of geographically bound clusters of economic activity as engines of innovation and global competitiveness has grown. The ability to send

information almost costlessly anywhere in the world would tend to lead to the death of distance (Brown and Duguid, 2002), yet distance in the exchange of knowledge among economic actors is of great importance for a large number of such relationships. The importance of distance, then, derives from the attributes of the knowledge being transmitted. Knowledge, or information, that can be easily standardized and codified can be sent, and understood, over distance at very low cost. Knowledge that is difficult to articulate and is tacit in nature is more open to interpretation and uncertainty and therefore relies upon face-to-face interaction to be transmitted effectively (Feldman, 2000).

A large number of empirical studies demonstrate that knowledge spillovers are geographically mediated, which is to say that innovation is found in clusters. As early as Malecki (1980) it was observed that there was regional variation in R&D and from this he argued that there were significant differences between the ability of regions to innovate. Feldman (1994), using data collected by the Small Business Administration, found that innovations in particular industries were highly concentrated in states such as California and Massachusetts for electronics and New Jersey and New York for medical instruments. Audretsch and Feldman (1996) found that even after the geographical concentration of production is accounted for, innovations are found to cluster in industries where industry R&D, skilled labor, and university research are important inputs.

This phenomenon of clustering of innovation as measured by patents was first observed by Jaffe et. al. (1993) who found that patents will cite other patents originating in the same location more frequently than patents outside the location controlling for the existing geography of related research activity. Almeida and Kogut (1997) obtained similar results in studying patents in the semiconductor industry, indicating that patent citations are localized.[3]

In their studies of geographical proximity and the transmission of tacit scientific information, Zucker, Darby, and Brewer (1998), and Audretsch and Stephan (1996) examined the proximity of biotechnology firms to scientists conducting research in the field of biotechnology. Zucker et. al. found that the presence of star researchers in biotechnology in a region, as identified by a publishing record in genetic sequencing, was strongly and positively related to the number of biotechnology start-ups in a region. Audretsch and Stephan dealt with this same issue though a database linking start-ups with their specific scientific advisors. They found that scientists who were founders or were chair of a firm's Scientific Advisory Board were much more likely to be locally linked to the firm than other

[3] In an examination of labor mobility patterns among semiconductor engineers, Angel (1991) found that these engineers moved around the U.S. However, if they moved to Silicon Valley their mobility continued, but now their mobility was confined to the Silicon Valley.

affiliated scientists, indicating that those scientists intimately involved in the transfer of knowledge must do so through proximate, face-to-face contact.

While proximity of actors is critical to the transmission of tacit or sticky knowledge among them, proximity is also important in the interactions among members of entrepreneurial networks as well.

Gompers and Lerner (1999), in a study of venture capital oversight of firms, examined the geographical proximity of 271 biotechnology firms between 1978 and 1989 and the venture capitalists that funded them. It was found that the proximity of the venture capitalist to the firm was highly significant in explaining their service on the board of directors even after the venture capitalist firm's ownership and age were accounted for. Because effective oversight of a firm by a venture capitalist requires frequent visits and close involvement in the firm's affairs, the costs of oversight are highly dependent on the distance between the venture capitalist and the firm.

Powell et. al. (2002) found a strong pattern of spatial co-location of biotechnology firms and venture capital. Those venture capital firms that did invest outside their region tended to be older and larger. In their comprehensive study of venture capital investment across all industries from 1986 to 1998, Sorenson and Stuart (2001) observed that venture capitalists were more likely to invest in geographically distant firms when they had prior investing experience with other members of the investment syndicate. In general venture capital firms that have established numerous relationships with other VC firms tend to invest more across geographic distance than do those firms that have not established such relationships.

Our study extends these earlier efforts by focussing on the entire entrepreneurial network not just a single component such as venture capital. In this way, we provide a more comprehensive understanding of high-technology entrepreneurship than has earlier research.

DATA AND METHODOLOGY

Every firm wishing to go public must file a prospectus with the U.S. Securities and Exchange Commission (SEC) prior to its initial offering of stock. This initial public offering (IPO) is a defining event in the history of any firm. The IPO performs two important functions: First, it provides the firm with capital so that it can continue its expansion. Second, after the IPO, the stakes of both management and investors, (subject to certain lock-up delays) becomes liquid. In return, however, the firm must conform to the reporting and transparency requirements imposed by the SEC under the Securities Act of 1933. One of the primary objectives of the Securities Act of 1933 is to require companies making a public offering of their securities to

publicly disclose relevant business and financial information about their company so that potential investors can make an informed investment decision regarding the offering. To achieve this end the 1933 Act requires companies going public to file disclosure documents with the Securities and Exchange Commission, the most important of which are the general form S-1 registration statement and the 424B prospectus. These documents, in effect, provide us with a detailed snapshot of the firm at the time it goes public, and it is these documents which provide the basis of the data used in this study.

The Data

The semiconductor firms selected for this study were obtained from the Venture Economics database listing IPOs over the time period of June 1996 through the year 2000. These firms were identified by their Standard Industry Code (SIC) and were restricted to those filing an S-1 registration statement.[4] A population of 44 firms were selected by this criteria.

Although the IPO prospectus of a firm contains a great deal of information about the company going public regarding its finances, management, ownership, business strategy and the like, we have initially restricted our attention to the geographical location of the actors associated with the IPO.

On the lead page of every S-1 registration statement the names and addresses of the lawyers and their law firms involved in the IPO are given. In almost every instance the lawyers of two law firms are provided; one law firm representing the issuer, or firm going public, and one law firm representing the underwriters, or lead investment banker, of the IPO.[5] The addresses of these law firms allow us to map the precise location of two actors in the IPO process; firm lawyers and investment bank (IB) lawyers.

The location of the firm's lawyer has a straightforward meaning. The location of the investment bank's, or lead underwriter's, lawyer is less so. Originally we had hoped to obtain the name of the lead investment banker, but when this was found to be infeasible we considered identifying the lead banker's location by selecting the investment bank's branch office having the closest proximity to the firm going public. This approach, though, has two difficulties. First, it is unclear how accurately one can identify all of the branch offices of an IB at some point in history and second, even if such a listing were accurate selecting the most proximate office may be an arbitrary selection. Therefore we rely upon the location of the

[4] This eliminates firms considered by the SEC to be small businesses that file an SB-2 registration statement rather than an S-1. Although these small firms would be of interest, the most reliably complete list of IPOs at this time is comprised of larger, S-1 firms.

investment banks' law firm as a proxy for the lead IB location. The lead IB is identified in the prospectus as the underwriter having agreed to purchase from the firm, or issuer, the largest number of shares of stock for the IPO.

The SEC requires that each firm include a discussion of its management in its prospectus. This section on management includes a table that provides the name, age, and title of the executive officers and directors of the firm or other key employees. In addition, a one paragraph biography of each individual in the table is provided which indicates the individual's current and previous employment status and affiliation. On the basis of this information we constructed a list of independent directors in the sense that they were not employed by the firm at the time of the IPO.

This group of independent directors was in turn broken into two mutually exclusive sets; those board members that were affiliated with a venture capital (VC) firm, and the remaining board members that were not so affiliated. Determining whether a board member was affiliated with a venture capitalist firm was based on their biography. The address and location of all directors was found through extensive searching over the internet. The addresses of these directors allow us to map the precise location of two additional actors in the IPO process; non-VC directors and VC directors.

Geographical Distribution of Actors

The distribution of the actors geographically is shown below in Table 1. The most obvious feature of Table 1 is the dominance of California in firms that have gone public and the other actors in the startup process. Massachusetts, New York, and Texas are of secondary importance while Oregon is of some importance as well. The dominance of California comes of course from the Silicon Valley, but Southern California as a region is of importance on its own. Resticting attention to just national data by excluding foreign actord and those that could not be located, the relative importance of these states can be seen in Diagrams 1A and 1B.

[5] In the case of a spin-off both the new firm and the parent firm have legal representation.

Table 1. Distribution of IPO Actors

State	Firms	Firm Lawyers	IB Lawyers	Non-VC Directors	VC Directors	Total
Arizona				1		1
N. California	27	30	31	52	40	180
S. California	5	3	4	9	3	24
Colorado	1		2	1		4
Connecticut				1	2	3
Delaware	1			1		2
Florida				2		2
Illinois					1	1
Massachusetts	2	2	4	4	10	22
Maryland					1	1
Michigan		1		3		4
North Carolina				1		1
New Hampshire					1	1
New Jersey	2			2		4
Nevada				2		2
New York	1	4	3	5	5	18
Oklahoma				1		1
Oregon	2	2		4		8
Pennsylvania	1			3		4
Texas	2	2		2	9	15
Virginia				2		2
Washington					1	1
National Total	44	44	44	96	73	301
Foreign	0	0	0	12	9	21
Not located	0	0	0	5	1	6
Total	44	44	44	113	83	328

Diagram 1A shows the contribution of six regions; Silicon Valley (including the San Francisco Bay area), Southern California (LA and San Diego), Massachusetts, New York, Oregon, and Texas, to the ranks of the different actors. Diagram 1B illustrates this same data by showing the contribution of the different actors to each of six regions plus all other.

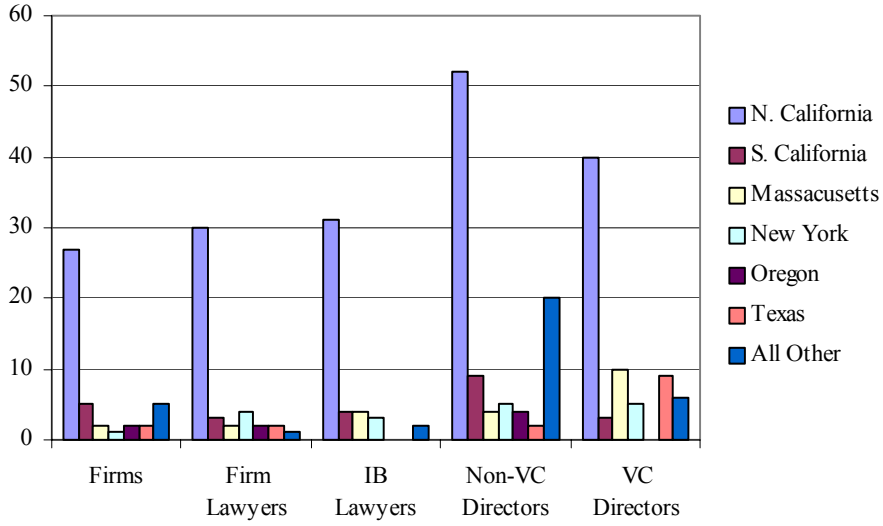


Diagram 1A

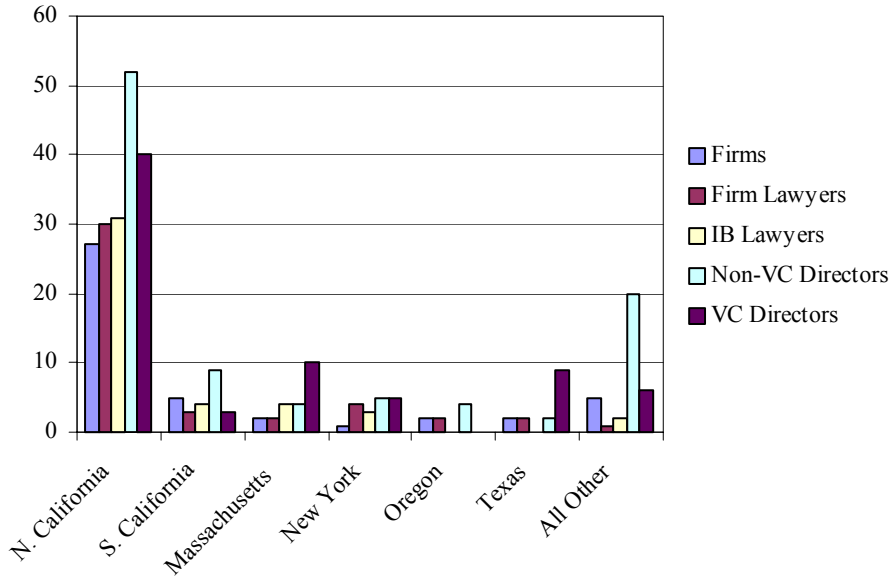


Diagram 1B

These diagrams show that while the Silicon Valley dominates in these IPOs, southern California, Massachusetts and New York have all the actors required for facilitating IPOs. The importance of Boston for venture capital firms and the importance of corporate banking in New York City stand out, as does the presence of venture capitalists in Dallas and Austin Texas.

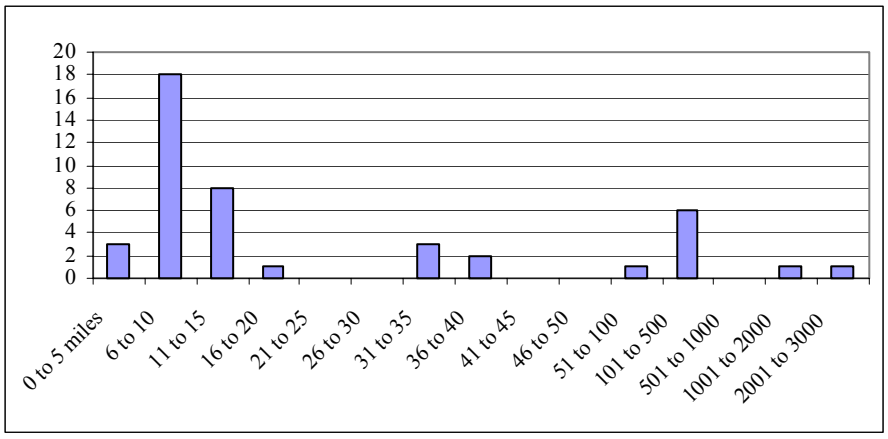


Diagram 2A. Firm Lawyers

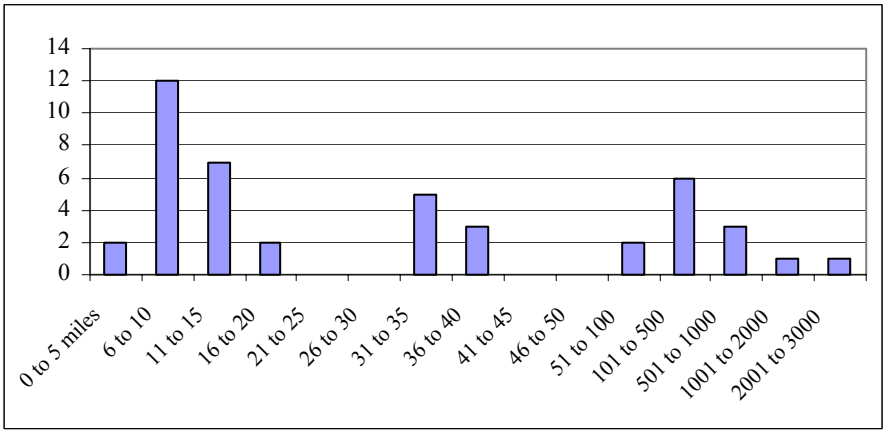


Diagram 2B. IB Lawyers

Proximity of Actors

The proximity of these actors to the firm going public in addition to their distribution over regions is of interest. The histograms in Diagrams 2A and 2B for law firms and Diagrams 2C and 2D for directors show their proximity to a firm in straight line miles for those actors we have precisely located.[6]

[6] All firm lawyers and IB lawyers could be precisely located. Therefore their straight line distance from the company going public could be determined. 88 out of 96 non-VC directors, and 72 out of 73 VC directors could be precisely located nationally. The remaining directors could be generally located within a state in Table 1.

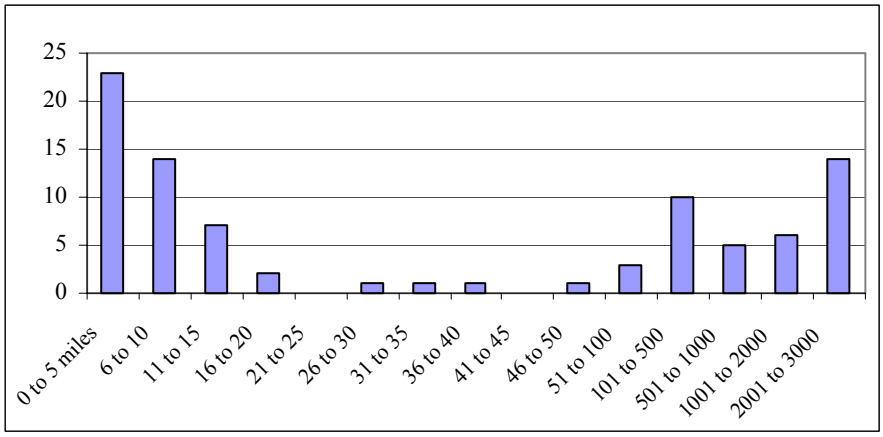


Diagram 2C. Non-VC Directors

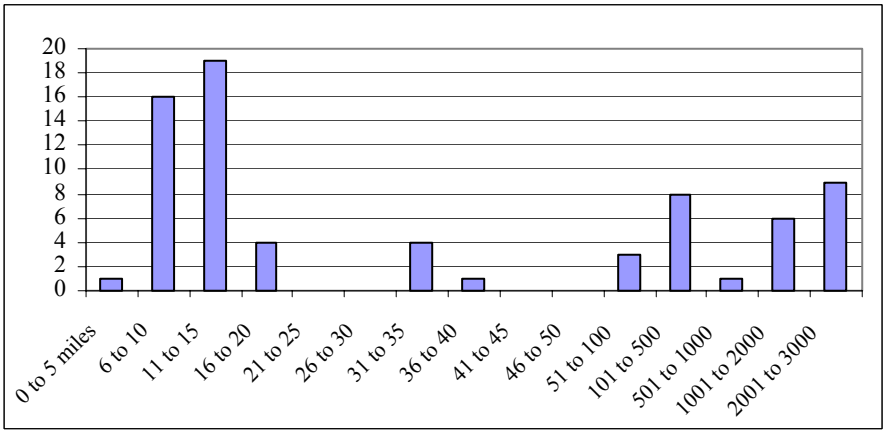


Diagram 2D. VC Directors

In comparing the proximity of law firms it is interesting to see how similar are the proximity distributions of firm and investment bank lawyers. In addition the number of law firms having an exact proximity of 25 miles or less is 30 out of 44 for firm lawyers, and 23 out of 44 for IB lawyers. It is striking how close most firm lawyers are to the firms they represent.

In comparing directors proximity differs somewhat with non-VC directors having a tendency to be either very close or on the other side of the country. This bicoastal pattern also emerges for VC directors. The exact proximity of these directors does not differ much though with 52.3% of all non-VC directors being within 25 miles of the firm compared to 55.6% for VC directors.

The significance of the proximity of these actors can be seen more clearly by including all of the actors that can be located by state or country. We define an actor as being inside a firm's region if it is within 50 miles of the firm, and outside the region otherwise.[7] Table 2 shows this breakdown by category of actor.

Table 2. Proximity of IPO Actors to Firms

	Firm Lawyers	IB Lawyers	Lawyer Total	Non-VC Directors	VC Directors	Director Total	Lawyers and Directors Together
Inside region	35	31	66	55	45	100	166
	79.55%	70.45%	75.00%	50.93%	54.88%	52.63%	59.71%
Outside region	9	13	22	53	37	90	112
	20.45%	29.55%	25.00%	49.07%	45.12%	47.37%	40.29%
Total	44	44	88	108	82	188	278
χ^2			0.97			0.29	12.51
Mean distance	128.43	201.00		572.27	494.04		
Median distance	11	19		16.5	15.5		

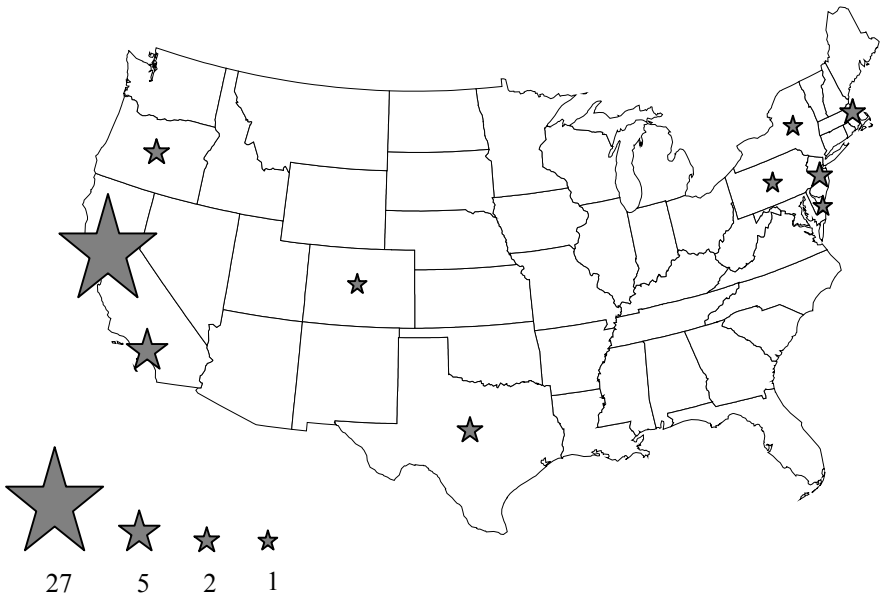
The results found in Table 2 are consistent with the above discussion of proximity. A Chi-square test indicates that a firm lawyer is not significantly more likely to be located inside a firm's region than is an IB lawyer, nor is there a statistically significant difference between the proximity of non-VC and VC directors. However, taken as a group it is true at the .005

[7] In Table 2 every actor that can be located is included, including foreign actors, who will obviously be outside the region of the firm.

level of significance that lawyers are more likely to be within the region of a company than are directors.

Because lawyers are so intimately involved in the negotiations surrounding the IPO and act as intermediaries among the actors it is not surprising that they should require close proximity to the firm during the IPO process. We would have hypothesized, though, that VC directors would in general have greater proximity than non-VC directors in agreement with the results of Gompers and Lerner (1999) on venture capital oversight. Since Silicon Valley dominates this industry segment this result could be driven to some degree by the geographical distribution of these two types of directors and the firms they serve in the Valley.

Networks and Regional Relations among Actors



Map 1. National Distribution of Semiconductor IPOs

The density of semiconductor IPOs across the U.S. indicates that semiconductor activity is concentrated in California and along the Northeast corridor with pockets of activity in Texas, Oregon and Colorado. We found that maps showing the distribution of all of the actors obscured much that can be known from this data. The density of activity in various centers such as Boston, New York City, and particularly the Silicon Valley, could not be clearly shown on a map of this sort. Moreover, the networks that exist within and among these regions are not shown. However, the networks that exist among these actors and the firms

they serve in the IPO process can be shown through regional diagrams illustrating the relationships between each firm and members of its support network.

The firms and actors in this study are found primarily in the Silicon Valley and five other regions. All of the dyad relationships between a firm and a member of its support network can be placed within this regional framework. The regional diagram shown below, Firm Lawyer→ Firm Dyads, should be interpreted as follows. The 27 firms in northern California all have law firms within northern California, two law firms in northern California represent firms in southern California, and one northern California law firm represents a firm in New Jersey. Three out of five southern California firms have lawyers within southern California. One New York law firm represents a New York firm, while the other three represent firms in Delaware, New Jersey, and Pennsylvania. Both Oregon firms are represented by lawyers within the state, as are both Texas firms. Finally, the semiconductor firm going public in Colorado is represented by a Michigan law firm. The arrow in these diagrams always points towards the firm.

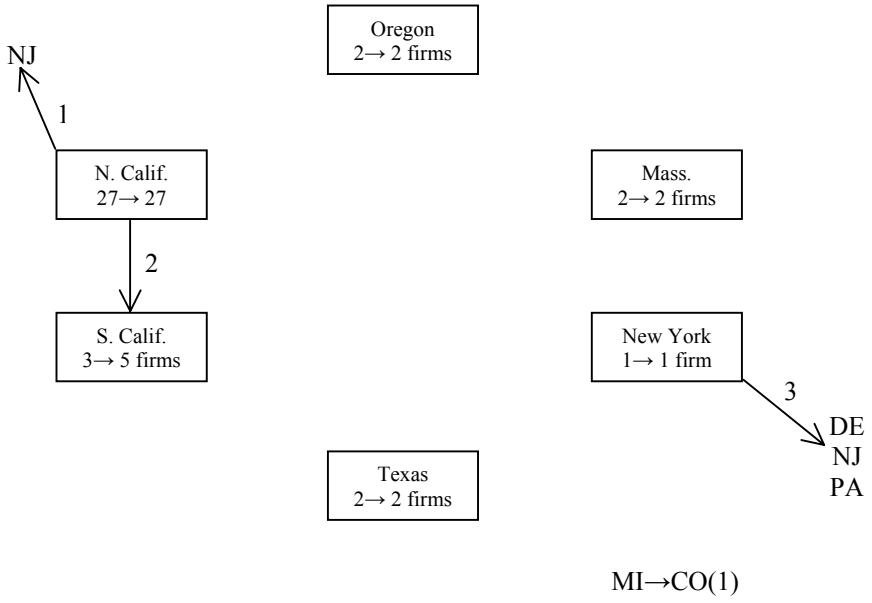
This diagram, together with the one illustrating regional relationships between firms and investment bank (IB) lawyers, shows just how localized the relationships between a firm and the legal counselors involved in its IPO can be. Every single firm within the major regions shown here chose a lawyer from its region with the exception of two southern California firms that relied on law firms from the Silicon Valley.

The reduced importance of proximity of newly public firms and the directors that serve on their board of directors is shown in the second set of regional dyad diagrams. A bicoastal distribution of directors, particularly of lead venture capitalists, is evident.

Taken as a whole these diagrams also tell us something about the regions themselves in the IPO process. West coast firms are quite dependent on the law firms of northern California for legal counsel. Similarly New York, although being home to only one semiconductor IPO, is the center of legal representation along the Northeast corridor. Massachusetts emerges as the center of venture capital for the eastern United States while the Silicon Valley provides venture capital to the entire country.

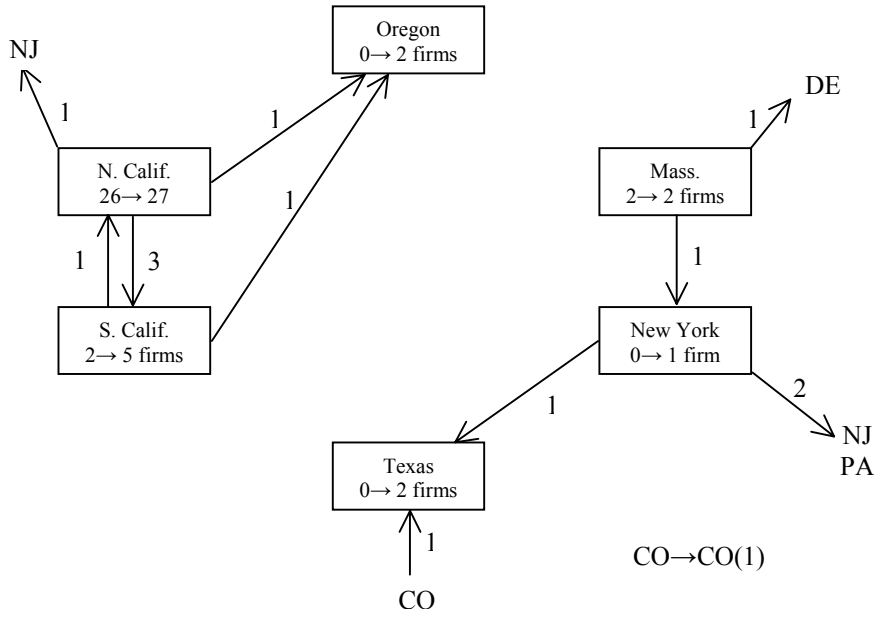
Silicon Valley, of course, dominates among all of these actors indicating that its preeminence in semiconductor manufacturing and new firm formation is matched by its being the core of entrepreneurial activity as well. None of this is surprising and is exactly what one would expect given the advantages of location within clusters for both new firms and members of the entrepreneurial networks examined here.

However, the degree of geographical clustering among some actors within the Silicon Valley was somewhat surprising. Map 2 provides visual confirmation of the density of the networks that exist in the Silicon Valley. All 27 of the semiconductor firms that went public in northern California can be found within a 7.5 mile radius off Highway 237. A more extraordinary clustering of actors can be found within a one half mile radius of Page Mill Road in Palo Alto where 19 out of 44 firm lawyers and 15 out of 44 investment bank lawyers can be found.[8] In addition, 24 out of 82 total venture capitalist directors can be found in a one mile radius off Sand Hill Road in Menlo Park.

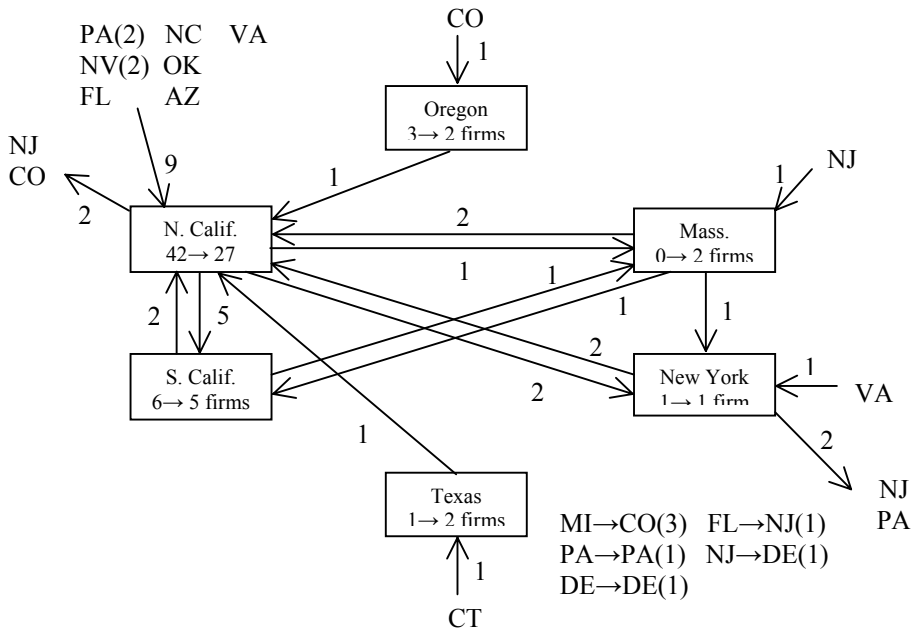


Firm Lawyer → Firm Dyads

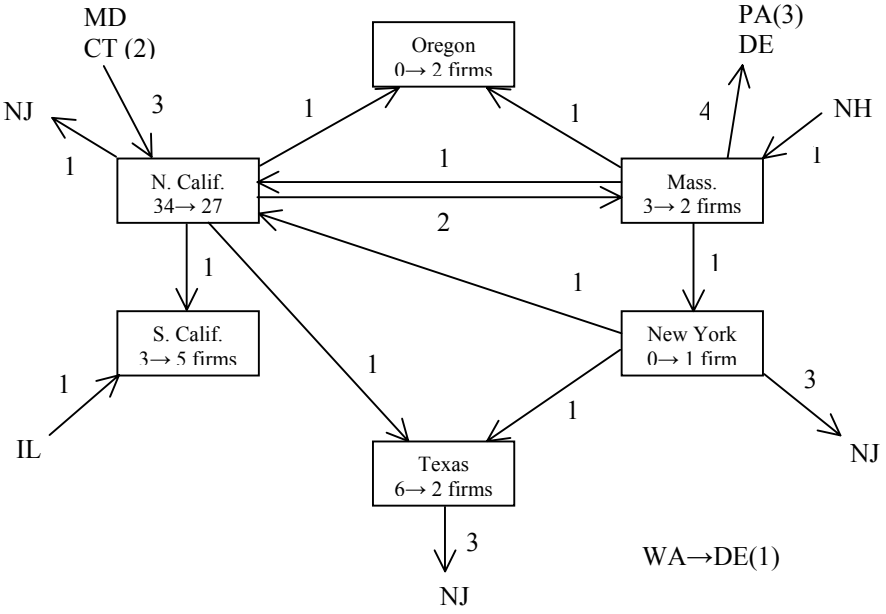
[8] It would be more correct to say firm lawyer or investment bank lawyer deals or events. Wilson Sonsini, a single law firm, was involved in 13 IPO deals as a legal representative of a firm in this population, and so this is recorded as 13 separate firm lawyers.



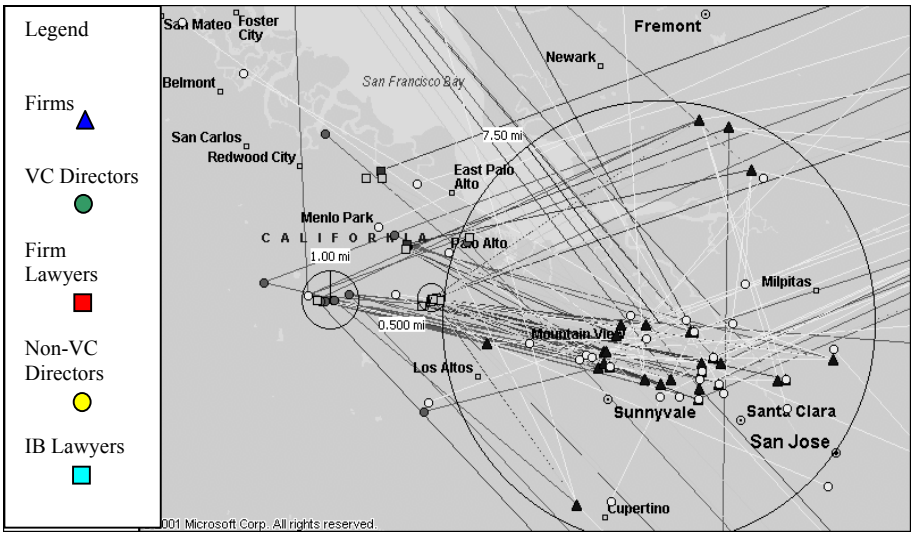
IB Lawyer → Firm Dyads



Non-VC Director → Firm Dyads



VC Director → Firm Dyads



Map 2. The Silicon Valley

While VC directors and non-VC directors have the same proximity to firms in this population, their distribution within the Silicon Valley is quite distinct. VC directors are concentrated around Sand Hill Road and are found almost exclusively in Palo Alto, Menlo Park and parts north. Non-VC directors, on the other hand, are distributed throughout the

region but are found in abundance in Sunnyvale, Santa Clara, and San Jose. The general pattern then is for many non-VC directors to reside throughout Santa Clara County where the firms are located, while VC directors are much more concentrated in the location of San Mateo County.

CONCLUSION

The investigations of the spatial location of the multiple constituents of the start-up environment has been limited. All of the studies have focused upon the venture capital-firm dyad, however even these studies have suffered from a lack of ability to identify the key venture capitalists. This study is the first step in an effort to overcome these shortcomings. This descriptive study confirms many of the results from the existing dyad-based literature, however it also advances the literature by providing a more comprehensive view of the institutions that support entrepreneurship in the semiconductor industry.

The attraction of the Silicon Valley to start-up semiconductor firms for all of the reasons cited in the literature on clustering was clearly in evidence as over 60% of all semiconductor firms going public from 1996 through 2000 nationwide choose to locate within a 7.5 mile radius in the Valley. The degree of clustering within the Silicon Valley also extended to the actors involved in the start-up process. Almost 40% of all legal counselors in the IPO process were found within a half mile radius in Palo Alto, and almost 70% of all law firms representing both firms and investment bankers were located in the Silicon Valley. Such proximity would be expected if as Suchman (2000) claims, lawyers perform a not only the function of providing advice on the formal aspects of legally creating a firm, but also act as intermediaries among the actors in the process as well.

Although venture capitalist directors in the Silicon Valley were heavily concentrated around Sand Hill Road, the dominance of Silicon Valley in providing venture capital to the semiconductor industry was not complete, as venture capitalists in Boston, Texas, and, to some extent, New York City also provided financial support. The importance of outside venture capital to Silicon Valley firms provides support to the observations made by Powell et. al. (2002) and Sorenson and Stuart (2001) regarding the role of local venture capitalists, but also the recognition that venture capitalists outside the region also invested. Even though this was a small sample, it extends upon Sorenson and Stuart's results by just focussing on the key venture capitalists in the firm (these are the venture capitalists most responsible for

the firm). In this small sample, we were surprised to find that, in some cases, one of the key ventures located outside the region.

There are limitations to a study of this type. In our case the population is limited to only those start-ups that have been sufficiently successful to undertake an initial public offering. In addition the population is quite small at 44 firms, and is a rather eclectic group as it includes semiconductor equipment and solar cell manufacturers. Nevertheless it provides a foundation for future work. Our future work will compare spatial location and network patterns among the constituents of entrepreneurial support networks over several industry groups. Since the importance of tacit information exchange among actors in the IPO process almost certainly varies across industries, it seems likely that the role of geographical location and proximity among these actors would vary across industries as well (Audretsch 2000).

Second, the collection of financial data after the IPO offering is quite simple, thus we will be able to examine whether various characteristics affect a firm's economic performance. This will provide an outcome measure for each firm as a function of its financial makeup and relationships with the market actors of the start-up process. With this we will be able to test one part of Schoonhoven and Eisenhardt's (1989) claim that the higher growth rates of semiconductor start-ups from 1978 to 1986 in the Silicon Valley were attributable to the Valley being an incubator consisting of institutions that nurtured and sped the growth of these start-ups. Expanding such an investigation to other industries would allow us to identify the extent to which such incubators exist in other locations and industries.

References

Abolafia, M. (1997). *Making markets: Opportunism and restraint on wall street.* Cambridge, Mass.: Harvard University Press.

Agnes, P. (2002). The 'end of geography' in financial services: Local embeddedness and territorialisation in the interest rate swaps industry. *Economic Geography*, 76, 347-366.

Almeida, P. & Kogut, B. (1997). The exploration of technological diversity and the geographical localization of innovation. *Small Business Economics*, 9, 21-31.

Angel, D. (1991). High-technology agglomeration and the labor market: The case of silicon valley. *Environment and Planning A,* 23, 1501-1516.

Antonelli, C. (2000). Collective knowledge communication and innovation: The evidence of technological districts. *Regional Studies*, 34 (6).

Audretsch, D. (2000). Corporate form and spatial form. In G. L. Clark, Feldman M.P., & Gertler, M.S.(Eds.), *The Oxford handbook of economic geograph.y*. New York: Oxford University Press.

Audretsch, D. B., & Feldman, M.P. (1996). R&D spillovers and the geography of innovation and production. *American Economic Review*, 86 (3), 630-640.

Audretsch, D. B., & Stephan, P.E. (1996). Company-scientist locational links: The case of biotechnology. *American Economic Review*, 86 (3), 641-652.

Bahrami, H., & Evans, S. (2000). Flexible recycling and high-technology entrepreneurship. In M. Kenney (Ed.), *Understanding silicon valley* (pp. 165-189). Stanford, CA: Stanford University Press.

Bahrami, H., & Evans, S. (1995). Flexible re-cycling and high-technology entrepreneurship. *California Management Review,* 37 (3), 62-89.

Baptista, R., & Swann, P. (1998). Do firms in clusters innovate more?" *Research Policy*, 27, 525-540.

Brown, J.S., & Duguid, P. (2002). *The social life of information*. Boston: Harvard Business School Press.

Brown, J.S. & Duguid, P. (2000). Mysteries of the region: Knowledge dynamics in silicon valley. In W.F.Miller, Lee, C., Hancock, M.G., & Rowen, H.S. (Eds.), *The silicon valley edge: A habitat for innovation and entrepreneurship*. (pp. 16-45).Stanford, CA*:* Stanford University Press.

Christensen, C. (1997). *The innovator's dilemma: When new technologies cause greatfFirms to fail.* Boston: Harvard Business School Press.

Clark, G. L. & O'Connor, K. (1997). The informational content of financial products and the spatial structure of the global finance industry. In K. R. Cox (Ed.), *Spaces of globalization reasserting the power of the local.* New York: Guilford press.

Feldman, M. P. (2000). Location and innovation: The new economic geography of innovation, spillovers,and agglomeration. In G. L. Clark, Feldman M.P., & Gertler, M.S.(Eds.), *The Oxford handbook ofeconomic geograph.y*. New York: Oxford University Press.

Feldman, M. (1994). *The geography of innovation*. Boston: Kluwer Academic Publishers.

Florida, R., & Kenney, M. (1990). *The breakthrough illusion: Corporate america's failure to move frominnovation to mass production*. New York: Basic Books.

Florida, R., & Kenney, M. (1988). Venture capital, high technology and regional development. *Regional Studies*, 22, 33-48.

Garud, R. & Jain, S. (1996). Technology embeddedness. In J. Baum & Dutton, J. (Eds.) *Advances in strategic management* (13, pp. 389-408).Connecticut: JAI Press.

Gilson, R. J. & Black, B.S. (1998). Venture capital and the structure of capital markets. *Journal of Financial Economics*, 47, 243-277.

Gompers, P. A. & Lerner, J. (1999). *The venture capital cycle.* Cambridge, Mass.: MIT Press.

Granovetter, M. (198. Economic action and social structure: The problem of embeddedness. *American Journal of Sociology*, 91, 481-510.

Greenwald, B., & Stiglitz, J.F. (1992). Information, finance and markets: The architecture of allocative mechanisms. *Industrial and Corporate Change*, 1, 37-63.

Hanson, D. (1982). *The new alchemists: Silicon valley and the microelectronics revolution.* Boston: Little, Brown and Company.

Jaffe, A.B., Trajtenberg, M., & Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations. *Quarterly Journal of Economics,* 108, 577-598.

Kenney, M., & von Burg, U. (2000). Institutions and economies: Creating silicon valley." In M. Kenney (Ed.), *Understanding silicon valley* (pp. 165-189). Stanford, CA: Stanford University Press .

Kenney, M., & von Burg, U. (1999). Technology and path dependence: The divergence between silicon valley and route 128. *Industrial and Corporate Change,* 8 (1), 67-103.

Krugman, P. (1991). *Geography and trade*. Cambridge, MA: The MIT Press.

Malecki, E. (1980). Dimensions of r&d location in the United States. *Research Policy*, 9, 2-22.

Marshall, A. (1890). *Principles of economics*. London: Macmillan & Company.

Piore, M. & Sabel, C. (1984). *The second industrial divide* New York: Basic Books.

Porter, M. (1998). Clusters and the new economics of competition. *Harvard Business Review* (November-December), 77-90.

Porter, M. (1990). *The competitive advantage of nations*. New York: Free Press.

Powell, W. W., Koput, K.W., Bowie, J.I. & Smith-Doerr, L. (2002). The spatial clustering of science and capital: Accounting for biotech firm-venture capital relationships. *Regional Studies*, 36 (3), 291-305.

Pryke, M. and Lee, R. (1995). Place your bets: Towards an understanding of globalization, socio-financial engineering and competition within a financial centre. *Urban Studies*, 32, 329-344.

Saxenian, A. (1994). *Regional advantage*. Cambridge, MA.: Harvard University Press

Schoonhoven, C.B., & Eisenhardt, K. (1989). The impact of incubator region on the creation and survival of new semiconductor ventures in the U.S. 1978-1986. *Report to the economic development administration, U.S. department of commerce (August).*

Scott, A. J. (1993). *Technopolis: High-technology industry and regional development in southern California.* Berkeley: University of California Press.

Sorenson, O., and Stuart, T.E. (2001). Syndication networks and the spatial distribution of venture capital investments. *American Sociological Review,* 106 (6), 1546-1588.

Storper, M. (1995). The resurgence of regional economies, ten years later: The region as a nexus of untraded interdependencies. *European Urban and Regional Studies*, 2 (3), 191-221.

Storper, M. & Salais, R. (1997). *Worlds of production: Frameworks of action in the economy*. Cambridge: Harvard University Press.

Storper, M., & Walker, R. (1989). *The capitalist imperative: Territory, technology, and industrial growth*. London: Basil Blackwell.

Suchman, M. C. (2000). Dealmakers and counselors: Law firms as intermediaries in the development of silicon valley. In M. Kenney (Ed.), *Understanding silicon valley* (pp. 71-97). Stanford, CA: Stanford University Press .

Thrift, N. & Leyshon, A. (1994). A phantom state? The detraditionalization of money, the international financial system and international financial centres. *Political Geography*, 13, 299-327.

Tilton, J. (1971). The international diffusion of technology: The case of semiconductors. Washington, D.C.: Brookings Institution.

Todtling, F. (1994). Regional networks of high-technology firms - The case of the greater Boston region. *Technovation*, 14 (5), 323-343.

Uzzi, B. (1999). Embeddedness in the making of financial capital: How social relations and networks benefit firms seeking financing. *American Sociological Review*, 64 (4), 481-505.

Walker, R. (1988). The geographical organization of production-systems. *Environment and Planning D: Society and Space,* 6, 377-408.

Walker, R. (1985). Technological determination and determinism: Industrial growth and location. In M. Castells (Ed.), *High technology, space and society* (pp. 226-264). Beverly Hills, CA: Sage Publications.

Zucker, L. G., Darby, M. R., & Brewer, M. B. (1998). Intellectual human capital and the birth of U.S. biotechnology enterprises. *American Economic Review*, 88 (1), 290-306.