

Venture Capital, Innovation, and Economic Development

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Venture capital is a unique form of finance capital with special implications for high-technology economic development. Conventional wisdom suggests that venture capital will stimulate high-technology development. This is reflected in state policies that seek to generate local high technology by overcoming regional venture capital gaps. Here the authors report findings from a two-year study, supported by the U.S. Economic Development Administration, that resulted in a new data base on venture capital supply and investment. The findings of the research indicate that venture capital is not sufficient to stimulate high-technology development. In fact, U.S. venture capital exhibits a strong flow toward established high-technology regions such as Silicon Valley and Route 128. This fact leads to the conclusion that venture capitalists are proficient in locating high-technology investment opportunities where they exist and that, as such, capital gaps are a reflection of underlying structural weaknesses in an area's technology base. Policymakers should turn their attention away from finance capital programs and return to the basics of building a strong technological infrastructure and integrated industrial base.

It is not venture capital that is the start of entrepreneurial activity. You can't simply put six venture capitalists in Butte, Montana, and expect that the availability of venture capital will engender a Route 128.¹

Venture capital clearly plays an important role in both technological innovation and economic development. Venture-capital-backed startups like Fairchild, Intel, DEC, Apple Computer, Cray Computer, Sun Microsystems, and Genentech have provided the epoch-making technological breakthroughs that define U.S. high-technology. California's Silicon Valley and Route 128 around Boston owe much of their vibrant growth to flourishing venture capital communities. Recent years have seen tremendous growth in the national pool of venture capital, from roughly \$3.5 billion in 1980 to more than \$33 billion in 1989.²

This article presents findings from a two-year research project on venture capital, technological innovation, and economic development. The research was informed by three basic questions. First, where are the major centers of venture capital supply? Second, where is venture capital invested? And, third, what is the relationship between venture capital and high-technology development? In

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order to answer these questions, the research compiled a new, microlevel data base on venture capital investment and coinvestment, accomplished interviews with venture capitalists in Boston, Silicon Valley, and other major venture capital centers, and developed new measures of the relationship between venture capital and high-technology development.

The research generated a series of important new insights on venture capital investment, its effect on high-technology development, and public policies designed to stimulate technology-based economic development by increasing state or local venture capital. The major findings of the research can be summarized in five major points.

1. Venture capital is extremely concentrated. The major centers of venture capital in the United States include California's Silicon Valley, New York City, and Route 128 around Boston. Less important, though still significant, concentrations of venture capital are found in Chicago, Texas, Connecticut, Minneapolis, and Colorado.
2. Venture capital exhibits extreme *bicoastalism* in the Northeast and Pacific regions. Together these two regions account for 65% of U.S. venture capital firms, 78% of venture capital resources, and 74% of venture capital investment.
3. Venture capital investments flow mainly to established high-technology centers—Silicon Valley and Route 128. Other venture capital centers, which are not high-technology centers, such as New York and Chicago, primarily export their funds to technology centers.
4. Venture capital's impact is context sensitive. In areas with an established high-technology base, venture capital fuels the growth of that sector. In areas without such a base, venture capital alone is not likely to stimulate innovation and high-technology development.
5. Public policies must recognize that venture capital is only one element of an area's technology base or *social structure of innovation*. Public efforts to stimulate high technology by enhancing the supply of venture capital without influencing the other elements of a region's technology infrastructure are not likely to achieve success.

The remainder of this article is organized as follows. The first section provides a review of the literature on venture capital and high-technology development. The second section outlines the research design of the study. The following sections summarize the major findings regarding the supply of venture capital, venture capital investment patterns, venture capital coinvestment, and the relationship between venture capital and high-technology development. The final section explores the implications of the research findings for economic development policy.

The majority of research on venture capital is devoted to the supply of venture capital, as measured by the number of firms or amount of resources concentrated in different areas. Such work highlights the fact that venture capital is highly concentrated in just a few areas, such as New York City, Chicago, Boston, and San Francisco, but for the most part does not provide answers as to why this is so.

VENTURE CAPITAL AND HIGH TECHNOLOGY: THE RESEARCH LITERATURE

The research literature on venture capital and high technology is limited by both unavailability of data and a lack of understanding of dynamics of the venture capital industry. While there is a fairly extensive literature on the business-management dimensions of venture capital,³ there are only a handful of studies that examine regional patterns of venture capital supply and investment,⁴ the relationship between venture capital and high-technology industry,⁵ and the role of venture capital in technological change.⁶ Most studies of regional patterns of venture capital supply and investment are limited, since they rely on highly aggregate data (available from Venture Economics) that give an inadequate picture of investment flows at the state or metropolitan level and from which it is hard to generate general findings. In addition, most research on venture capital supply and investment is hampered by a poor understanding of how the venture capital industry operates and is based upon anecdotes and second-hand stories.

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centers.⁷ The conventional wisdom assumes that venture capital is coincident with high-technology industry. This is partly true, at best. On the one hand, some high-technology centers, such as North Carolina's Research Triangle, have very little in the way of venture capital (being comprised mainly of high-technology branch-plant operations).⁸ On the other hand, a number of venture capital centers, such as New York and Chicago, have generated very little in the way of high-technology development. Research by Florida and Kenney, which provides the starting point for this study, indicates that venture capital supply is concentrated in three types of areas: those with high concentrations of financial institutions (e.g., New York and Chicago), those with high concentrations of high-technology businesses (e.g., Silicon Valley) and those with both (e.g., the Route 128 area).⁹

The literature on venture capital investment is less extensive, and it too tends to be mainly anecdotal or descriptive in nature. Good data on venture capital investment has been virtually unobtainable. Venture Economics, the main source of venture capital data, publishes only highly aggregated numbers for a few baseline states and some regions. It has been impossible to get any numbers on flows within or among states or at the substate level. Some researchers have relied on aggregate data, while others have tried to surmount this problem by using venture capitalists' investment preferences as a proxy for actual investment data.

Leinbach and Amrhein use aggregate data on venture capital investments for one year (based on the Venture Economics data base) to analyze regional variations in venture capital investment.¹⁰ From this they conclude that the Pacific Southwest, New England, and the Gulf Coast/Southwest regions attract the greatest volume of investment. Unfortunately, their analyses obscure many of the most interesting state and local differences in the venture capital industry.¹¹ While Leinbach and Amrhein allude to the regional mismatch of venture capital investments as evidence of regional "capital gaps" or "imperfections" in the market for venture capital, they offer limited evidence to support this claim.

McNaughton and Green use SBIC investment data as a proxy for venture capital investment.¹² The problem with this is that SBICs are a relatively unimportant type of venture capital institution whose investment patterns differ markedly from those of the broader universe of venture capital institutions. While their conclusion that venture capitalists invest locally may be appropriate for SBICs, there is little reason to expect that it will hold for other types of venture capital institutions, such as limited partnerships. It is contradicted by recent research by Florida and Kenney that shows an overall flow of venture capital toward major high-technology centers such as Silicon Valley and the Route 128 area.¹³ The findings of our research support the latter conclusion. While venture capitalists in established high-technology areas (e.g., Silicon Valley) tend to invest locally, venture capitalists in other venture capital financial centers (e.g., New York City and Chicago) export their funds mainly to established technology regions.

Green uses venture capitalists' investment preferences (as published in *Venture Economics, Guide to Venture Capital*) to derive a set of preference indicators from which he constructs a model of venture capital investment.¹⁴ This is problematic because the preferences reported by venture capitalists are not necessarily followed in practice—a fact the author acknowledges. His analysis of venture capital preferences leads him to conclude that venture capitalists have no geographic preference beyond the entire U.S. This analysis is directly contradicted by our findings, which show a distinct concentration of venture capital investment in Silicon Valley and Route 128.

Related literature explores the major factors at work in high-technology location and the formation of high-technology industrial complexes. But, unfortunately, this literature neglects venture capital's role in high-technology complexes. Empirical research on high-technology location by Markusen, Hall, and Glasmeier does not include a venture capital variable.¹⁵ While many researchers have suggested that a technological infrastructure comprised of high-technology businesses, universities, specialized labor pools, suppliers, vendors, and consultants is an important prerequisite for high-technology development, none of these researchers have tried to determine venture capital's role in such an infrastructure.¹⁶ Previous work by Florida and Kenney suggests that venture capital is a central component of the well-developed social structures of innovation that characterize high-technology regions.¹⁷

RESEARCH DESIGN

The research presented here was designed to shed new light on both venture capital investment and the relationship between venture capital and high-technology. The research involved three main tasks.

The first task was the design and development of a new data base on the venture capital industry. The venture capital data base was compiled from information reported in the *Venture Capital Journal* between January 1984 and December 1987, which represents roughly 40% to 45% of all venture investments made during the period 1983 to 1987.¹⁸ The data base contains microlevel information on venture capital firms, venture capital investments, coinvestment syndicates, and the companies that received those investments. This enabled us to construct detailed analyses of venture capital investment flows and coinvestment patterns at the local, regional, and national levels. The data base was used to compile detailed maps of venture capital supply, investment flows, and coinvestment patterns. The data was also employed to develop statistical measures of the relationship between venture capital and high-technology development.

The second task involved intensive field research (in Silicon Valley, the Route 128 area, and other areas) and was designed to shed light on the dynamics of the venture capital industry. Oral interviews were conducted with key figures in the venture capital industry, as well as with high-technology entrepreneurs who had received venture capital investment. The interviews provided unique insight into the history and evolution of the venture capital industry, the nature of venture capital investment, and the role venture capital has played in the development of high-technology regions. Interviews were also conducted with representatives of public venture capital programs to gain a contextual understanding of such efforts and to compare them to private venture capital operations.¹⁹

The third task involved detailed archival research on the origin and history of the venture capital industry and was conducted at the Harvard Business School, Stanford Business School, Silicon Valley Research Center, and other libraries. The archival research included a comprehensive review of relevant business documents, trade materials, unpublished reports, newspapers, and periodicals. It was designed to trace the history of venture capital in various areas and provide a broader historical and institutional context for empirical findings.

These various data items were then used to explore patterns of venture capital supply, venture capital investment, the relationship between venture capital and high-technology, and the potential effectiveness of public venture capital programs. This synthesis of quantitative and qualitative material enabled us to achieve a new perspective on venture capital and economic development, one that emphasizes venture capital's *embeddedness* in the broader social structure of innovation—the relationship between venture capital and the broader institutional context of high-technology development.

VENTURE CAPITAL SUPPLY

The research employed two measures of venture capital supply: the dollar amount of venture capital and the number of venture capital offices. The first provides a measure of resource concentration, and the second provides a measure of the number of potential venture investors.²⁰ The top two maps in Figure 1 show the supply of venture capital offices and resources by state, respectively.

The basic finding is that venture capital supply is highly concentrated at the regional, state, and metropolitan levels. The Northeast and Pacific regions together account for an incredible 78% of venture capital supply. Just three states—California in the Pacific region and New York and Massachusetts in the Northeast—are home to 70% of venture capital supply. Furthermore, just three metropolitan areas—San Francisco, New York City, and Boston—account for approximately 60% of the supply of venture capital.

At the regional level, venture capital supply exhibits an extreme bicoastal pattern, with major centers on both coasts, and lesser activity in the nation's interior. Within this general bicoastal

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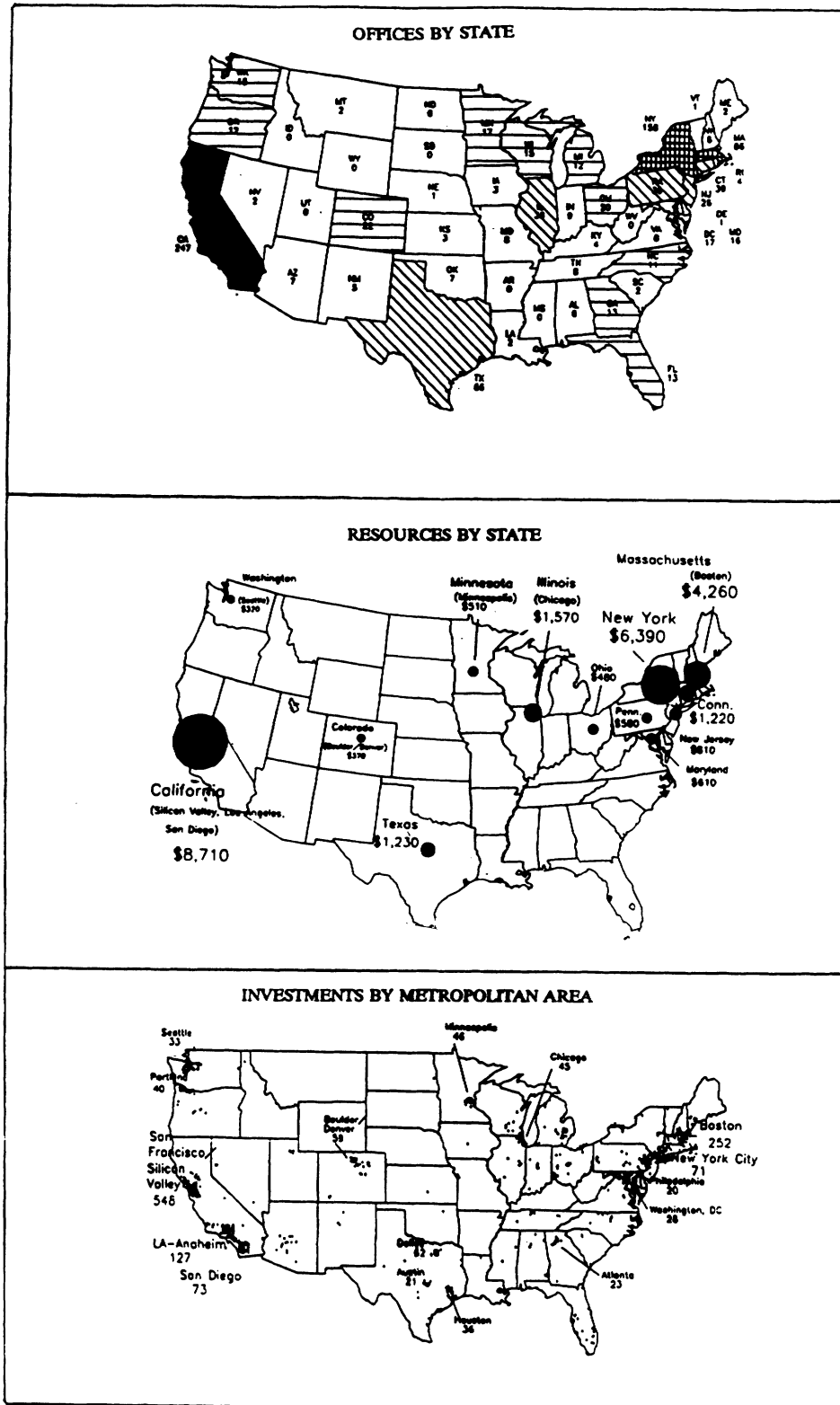


Figure 1: Venture Capital Offices, Resources, and Investments

SOURCE: Data on venture capital offices from Venture Economics, *Guide to Venture Capital* (1988). Data on resources from *Venture Capital Journal* (April 1988). Data on investments from authors' data base.

NOTE: *Resources by State*: All dollar figures are in the millions; States shown have 1% or more of the national venture capital pool of \$29,020. *Investments by Metropolitan Area*: Data represented reflect greater metropolitan-area totals (e.g., Silicon Valley includes the Oakland, San Francisco, San Jose, and Sacramento MSAs).

pattern there has been especially strong growth of venture capital supply in the Pacific region. Between 1977 and 1987 the Pacific region increased its share of the venture capital pool from 21% to 32%, and its share of venture capital offices over the slightly longer period of 1973 to 1987 from 18% to 28%. Much of this relative shift is attributable to the dramatic rise of venture activity in California, especially the Silicon Valley area. Growth in the Pacific region has come mainly at the expense of the Northeast region, which saw its share of venture capital supply decline from 55% to 46% between 1977 and 1987, and its share of venture capital offices fall from 49% to 37% between 1973 and 1987.

Venture capital is also highly concentrated at the state level. California is the leader among states with \$8.7 billion dollars, or 30% of the total dollar volume, of venture supply. It is followed by New York with \$6.39 billion dollars, or 22%, and Massachusetts with \$4.26 billion dollars, or 15% of venture capital supply. Together these three states control two-thirds of the U.S. venture capital pool, as well as over one-half of the venture capital offices. Illinois, Texas, and Connecticut are the only other states that have more than \$1 billion in resources. Together the top six states account for slightly more than 80% of the nation's venture capital resources in 1987.

The venture capital industry is concentrated at the substate or metropolitan level, as well. For example, two-thirds of California's venture capital offices are located in the San Francisco/Silicon Valley area, with the remaining one-third located in the Los Angeles/San Diego area. In fact, San Francisco/Silicon Valley is home to more offices than is any other state—over 16% of the U.S. total. More than 95% of New York State's venture capital offices are located in the New York City area, while Chicago is home to 90% of Illinois's offices. Boston and the Route 128 suburbs surrounding it account for the vast majority of Massachusetts's venture capital offices.

VENTURE CAPITAL INVESTMENT

The main contribution of the research is in terms of venture capital investment. Although a logical assumption might be that venture capital investments tend to concentrate in areas of venture capital supply, our results indicate that this is only partly true. Basically, the findings indicate that venture capital investments flow mainly to the nation's premier high-technology centers—California's Silicon Valley and Route 128 around Boston. In contrast, venture capital centers such as New York City and Chicago receive a much smaller share of venture capital investments.

At the regional level, venture capital investment is concentrated even more than venture capital supply, exhibiting pronounced bicoastalism. The Pacific (\$1.64 billion or 42%) and Northeast (\$1.1 billion or 28%) regions together attracted more than two-thirds (70%) of the \$3.9 billion funds invested by the venture capital industry in 1987. The Pacific region is led by California, which dominates the rest of the nation as a center of venture capital investment. The Northeast region places a distant second behind the Pacific. Within the Northeast region, Massachusetts attracts the majority of investments. Not surprisingly, the Midwest has seen a precipitous decline in venture capital investments. While the region attracted almost 20% of the total share of venture capital investments during the late 1960s, its share fell to just 8% by 1987.²¹

At the state level, just two states, California and Massachusetts, account for over one-half of all venture capital investment. California attracted the lion's share of venture capital dollars, roughly half, with \$1.5 billion, or 39%, of the national total in 1987. Massachusetts was second—with \$429 million, or 11% of total venture capital invested. Texas and New Jersey each attracted \$234 million (6%), while New York and Illinois each attracted \$117 million (3%). No other state drew more than \$100 million in venture capital investments. Although in recent years California and Massachusetts have commanded the majority of the venture capital investments, this pattern did not always hold. In the period before 1980 the combined share of investments for these two states was only 35%. A major reason for their growth lies in the relative decline of the New York and Chicago areas as centers for venture investment. The combined investment share for these two states declined from 18% from 1968 to 1975, to 6% by 1987.

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The map at the bottom of Figure 1 provides the first available picture of the national pattern of venture capital investments at the substate level. As this map shows, venture capital is extremely concentrated within states, mainly around centers of high technology. Silicon Valley was by far the leading recipient of venture capital investments with 548, more than two-thirds of all venture capital investments made in California. Within Silicon Valley, venture investments were tightly clustered in the cities of Sunnyvale, Santa Clara, and San Jose, which form the heart of the Silicon Valley high-technology complex. These three cities received 30% of the California total and 12% of total investments. Only Massachusetts received more venture capital investments than this three-city area. In addition to Silicon Valley, two other areas in California attracted relatively large numbers of venture capital investments: the greater Los Angeles area with 127 investments, and San Diego with 73.

The Route 128 area had the second largest concentration of venture capital investments at 252. Again, most of the investment was tightly concentrated, flowing to just three cities: Newton, Waltham, and Woburn, which form the heart of the Route 128 complex. These three cities received 62% of the Route 128 investments—almost 3% of the national total of venture capital investments.

Interestingly, the tendency of venture capital investments to cluster around high technology centers is also evident in states that control only minor amounts of venture capital. Atlanta, Georgia, the leading recipient of venture capital in the South region, is a leading center of high technology in the Sun Belt. A similar trend is evident in the Boulder-Denver area of Colorado where the distribution of venture capital investment is concentrated in the high-technology firms located along the Interstate 25 defense-high technology corridor.

However, New York and Chicago, two large centers of venture capital supply, attracted just 71 and 45 investments, respectively.

Investment Flows

The data base on venture capital investments also allowed us to perform the first detailed analysis of venture capital investment flows among major venture capital centers. Figure 2 shows the investment patterns for the three largest centers of venture capital: California, New York, and Massachusetts. The patterns here are quite striking.

Consider California first. California venture capitalists invest mainly in-state and export very little of their funds, and the state attracts a great deal of venture capital from other states. Greater than 70% (2,137) of the 3,012 investments made by California venture capitalists were located in-state. The next largest concentrations went to Massachusetts (194, or 6%), Texas (125, or 4%), and Colorado (98, or 3%). New York received just 46 (or 2%) of California investments.

Next consider New York, where the opposite pattern appears. New York venture capitalists exported most of their venture capital. Of the 1,443 total investments made by New York venture capitalists, just 106 (or 7%) of the investments of New York venture capitalists were made in-state. New York venture capitalists made 618 (or 43%) of their investments in California, 226 (or 16%) in Massachusetts, and 78 (or 5%) in Texas.

Last consider Massachusetts, whose venture capitalists split their investments between local investments and capital exports. Massachusetts venture capitalists made 443 (or 40%) of their investments within the state and 348 (or just slightly less than 30%) in California.

Coinvestment Patterns

Venture capitalists seldom invest alone. Instead, they invest in *coinvestment syndicates* comprised of two or more venture funds. Coinvestment is a process through which venture capitalists invest together, syndicating deals to diversify their portfolios and to pool risk among themselves.²² Coinvestment provides access to a much wider range of investment possibilities and enables venture capitalists to spread risk by investing in a larger number of deals.

In order to analyze the coinvestment of venture capitalists, a separate data base for venture capital coinvestments was compiled. The data base includes information on all of the coinvestors

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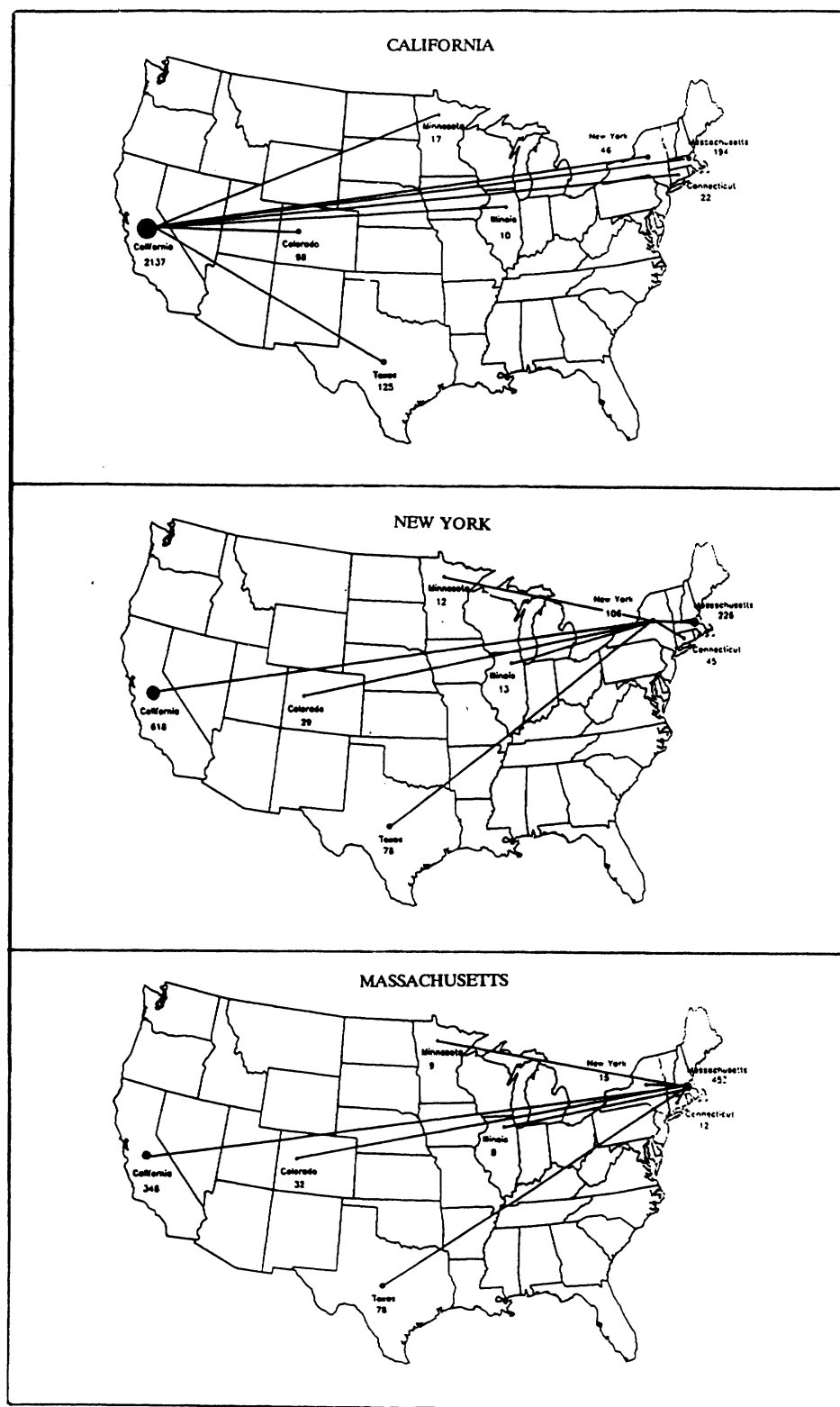


Figure 2: Venture Capital Investments by State of Origin
 SOURCE: Compiled by authors for the period of 1983 to 1987.

in venture capital investments. It measures investment decisions rather than the actual dollar amount invested; that is, each time a venture capitalist from a state participates in a deal, that is recorded as one investment decision. For example, a venture capital deal in which four venture capitalists participate is recorded as one investment decision for each of the venture capitalists.

Figure 3 shows the coinvestment patterns for the three leading centers of venture capital: California, New York, and Massachusetts. The patterns evidenced from these maps can be summarized as three basic findings.

First, venture capitalists in California invest mainly with one another. California venture capitalists place 40% of their coinvestments with other California venture capitalists. This high level of internal coinvesting reflects the abundance of good deals and the well-developed, internal information-sharing networks that are part of the Silicon Valley social structure of innovation.

Second, venture capitalists outside of California invest remarkably often with California venture capitalists. Venture capitalists in New York, for example, coinvest frequently with California venture capitalists, as do venture capitalists in Massachusetts. The ability of California to attract venture capital coinvestment is driven by the high number of investment opportunities afforded by its well-developed high-technology base.

Third, after California, Massachusetts is the second leading focus of venture capital coinvestment. Massachusetts venture capitalists invest frequently in their own state and also in California. New York venture capitalists are frequent coinvestors with their Massachusetts counterparts. Massachusetts attracts coinvestment for much the same reason as California. The well-developed social structure of innovation in the Route 128 area is a generator of investment opportunities that attract venture capital.

Taken together, these three major findings inform a basic conclusion. Coinvestment is the major vehicle for the mobility of venture capital and for overcoming so-called gaps in venture capital supply and investment. Coinvestment forms a link between *active* venture capital investors who are embedded inside the social structure of innovation of Silicon Valley and Route 128 and *passive* outside coinvestors located in financial venture capital centers like New York and Chicago. Active coinvestors play a lead role in locating and supervising investments, while passive investors supply external funds. Coinvestment allows passive venture capitalists to participate in deals originated by active venture capitalists in established high-technology regions. Coinvesting thus facilitates long distance flows of venture capital and reinforces the flow of venture capital toward locations with the most potential investment opportunities—those with a well-developed social structure of innovation.

VENTURE CAPITAL AND HIGH TECHNOLOGY

To understand the relationship between venture capital and high-technology economic growth, we looked in detail at the eight major centers of venture capital activity: California (San Francisco/Silicon Valley), Massachusetts (Boston), New York, Illinois (Chicago), Texas, Connecticut, Minnesota (Minneapolis), and Colorado. Drawing from previous studies, we explored the relationship of both supply and investment to two basic indicators: (1) a measure of the high-technology base (e.g., number of high-technology firms) and (2) a measure of the concentration of financial resources (e.g., the dollar volume of commercial bank assets).²³ The number of high-technology firms represents the strength of a region's technology base, and hence opportunities for technology-oriented investing. Commercial bank assets are a proxy for the relative size of the financial sector in a complex. We normalized these variables to take into account the significant variation in population size among the eight venture capital centers. Table 1 summarizes the results of Pearson product moment correlation coefficients.

To explore the determinants of venture capital supply, we ran correlations between the number of venture capital offices and the number of high-technology firms in the state, and between the

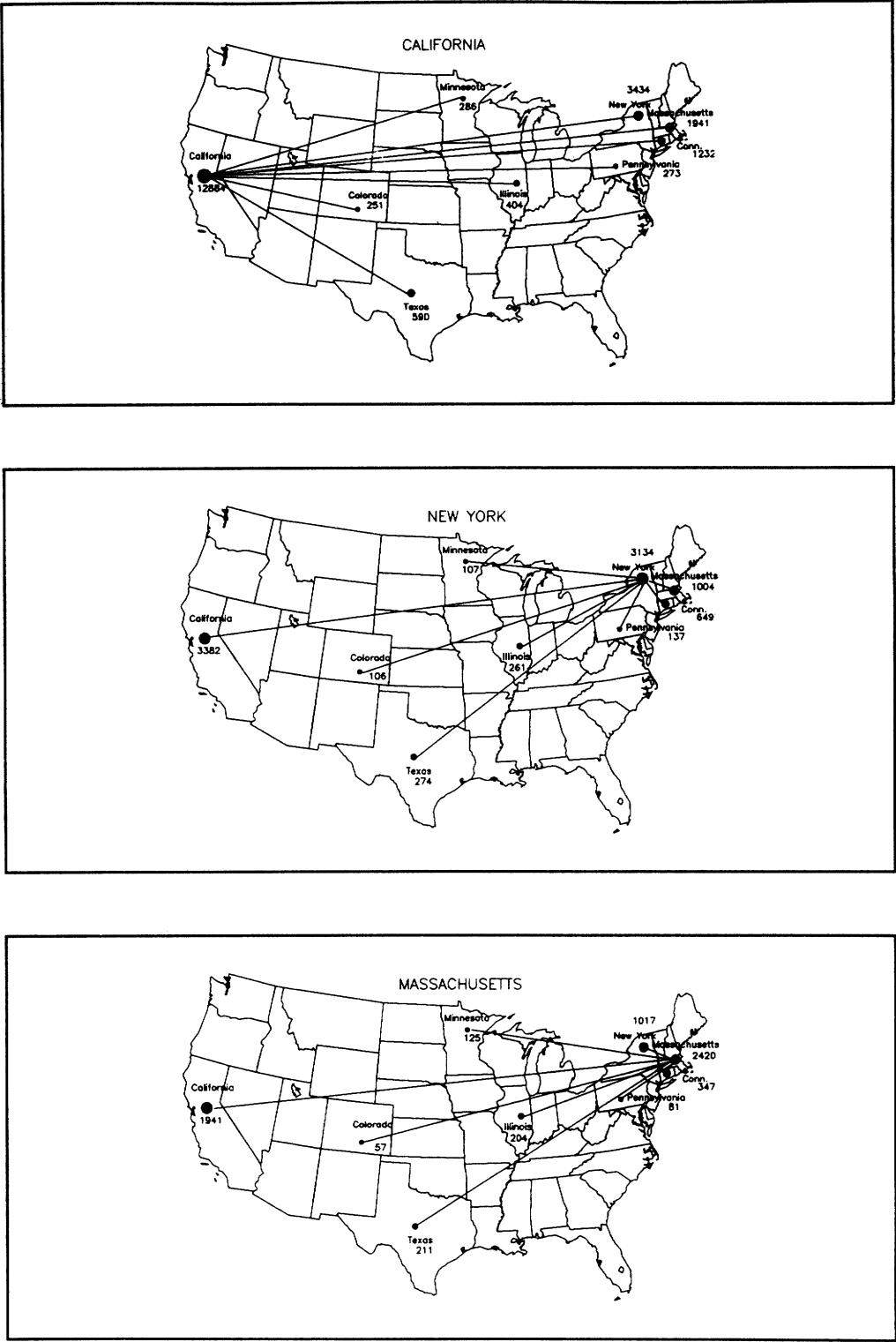


Figure 3: Venture Capital Coinvestments by State of Origin
 SOURCE: Compiled by authors for the period of 1983 to 1987.

TABLE 1
Correlations between Venture Capital, High-Technology Firms, and Bank Assets^a

<i>Measure of Venture Capital</i>	<i>High-Tech Firms</i>	<i>Bank Assets</i>
Venture capital supply		
Number of venture capital offices (50 states)	.954 (.873)	.830 (.090)*
Number of venture capital offices (8 leading complexes)	.943 (.874)	.720 (.054)*
Dollar volume of resources (8 leading complexes)	.903 (.870)	.708 (.222)*
Venture capital investment		
Dollars invested (8 leading complexes)	.982 (.955)	.348* (-.259)*

SOURCE: *Venture Capital Journal* (various years); Authors' data base; *Corporate Technology Information Services Directory* (Wellesley, MA, 1988); *State and Metropolitan Area Databook* (Washington, DC, 1988)

NOTES: a. Figures in parentheses have been normalized by population.

*Insignificant at the .05 level

number of offices and the dollar amount of bank assets for all 50 states, as well as the eight major complexes. For all 50 states, correlations were relatively strong across both dimensions. There was a correlation of .954 between the number of venture capital offices and the number of high-technology firms, and .830 between the number of venture capital offices and bank assets. These indicate that the supply of venture capital tends to concentrate in areas with a well-developed technology base and/or a high concentration of commercial bank assets.

We also ran the same correlations for the eight major venture capital centers. Here, the correlation between venture capital offices and high-technology firms was again strongly positive (.943). However, the correlation between the number of venture capital offices and bank assets was weaker (.720). When the variables were normalized for population, the correlation between venture capital offices and high-technology firms remained strong (.874), while the correlation between venture capital offices and bank assets was quite weak (.054) and insignificant.

We ran another set of correlations to gauge the relationship between the dollar amount of venture capital resources (another measure of supply) and the number of high-technology firms and the dollar amount of bank assets. Because data for all 50 states are unavailable, we did this for just the eight major venture capital centers. Here again, there were strong positive correlations with both high-technology firms (.903) and bank assets (.708). When the variables were adjusted for population, the correlation between venture capital resources and high-technology firms remained strong (.870), while that between venture capital resources and bank assets was weak (.222).

We next ran correlations to explore the relationship between venture capital investment and the same two variables. Here, the results were interesting. The correlation between high-technology firms and venture capital investment was strong (.982) and remained strong when the data are normalized by population (.955), an indication that a well-developed high-technology base draws venture investment into an area. But the correlation between venture capital investment and the volume of bank assets in a region was weak (.348) and insignificant. When we adjusted for population, the correlation was negative (-.259) and insignificant. This indicates that even though these areas possess a significant amount of venture capital resources, they do not attract a significant flow of venture capital investment. Based on these findings, we are led to conclude that while venture capital supply is related to both the high-technology base and financial resources, venture capital investment is related to the former only.

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VENTURE CAPITAL AND THE SOCIAL STRUCTURE OF INNOVATION

In addition to developing quantitative measures of venture capital supply and investment, the research also included a more qualitative component, designed to shed light on the institutional and organizational dynamics of various venture capital centers. The qualitative dimension of the research was based on detailed site visits and in-depth personal interviews with more than three dozen venture capitalists in Silicon Valley and Route 128.

The main findings of this qualitative dimension of the research highlight the importance of an area's technology base—or *social structure of innovation*—for stimulating venture-capital-backed high-technology development. Based on our research, we defined the components of the social structure of innovation as an adaptable institutional structure, well-developed networks of innovators, a highly skilled and adaptable labor force, a concentration of technology-intensive enterprises, dense venture capital networks, considerable public and private R&D expenditures, an efficient system of information and technology transfer, and business support services.²⁴ Silicon Valley and Route 128 are the best examples of places that possess well-developed social structures of innovation.

Since innovation is, by definition, a new type of activity, an adaptable social structure is needed to stimulate it. An existing base of technology-intensive companies, combined with well-developed networks of innovators and venture capitalists, creates an environment that allows the innovative personnel from many companies to interact easily and frequently, promoting the transfer of technology and information. The design and production aspects of high-technology industries require a skilled labor force, and the rapidly changing nature of these industries mandates that the labor force be adaptable as well. Venture capital provides a critical source of financial and managerial assistance for new projects. Public and private R&D expenditures help enhance the technology base and increase the concentration of scientists and engineers in the area. An abundance of business support services, particularly specialized legal and financial services, make it relatively easy to launch new innovative businesses and catalyze important breakthrough innovations. Networks for information transfer are important means to identify and access new technological opportunities and market openings.

Social structures of innovation can be thought of as a special case of an agglomeration economy. At the heart of such agglomerations lie a specialized set of economic, technological, social, and financial networks. These networks facilitate information transfer within the complex and are a vehicle through which services are obtained. Venture capitalists are critically dependent upon such networks to locate investments, put together investment syndicates, and build high-technology businesses.

Venture capitalists occupy a nodal position in social structures of innovation, helping to organize the various actors in the network while bringing important financial resources and business development skills to those networks.²⁵ Venture capitalists sit at the centers of these networks and can be thought of as catalysts, or *technological gatekeepers*, who accelerate the process of high-technology development by bringing the many components of those networks together. According to Regis McKenna, the high-tech marketer and part-time venture capitalist:

The network of supporting infrastructure of Silicon Valley is the most sophisticated outside Wall Street. The catalyst for that network is the venture capital community, which has evolved to become a strategic planner, management consultant, and corporate watchdog. The network is put to work for new companies and many members of the network have been well honed on dozens of startups. . . . In fact, one of the reasons . . . many companies do succeed is because the network goes to work to help companies survive: they help them find new customers, they help them do refinancing, they help them find new managers if necessary, they help them merge with other companies to be successful.²⁶

However, it should be noted that the social structures of innovation of the sort that exist in Silicon Valley and Route 128 are not a panacea for U.S. high-technology. While these innovative centers are especially well suited for radical new breakthrough innovations, they are not so well equipped to produce later-stage follow-through innovations in products or manufacturing processes.²⁷ In fact, these high-technology centers are immersed in an international spatial division of labor that is characterized by an extreme separation of innovation and production where an increasing share of manufacturing is done in the Third World.

GOVERNMENT PROGRAMS TO ENHANCE VENTURE CAPITAL: WHAT CAN BE EXPECTED?

Between the real contributions of venture capital to high-technology development and the folklore that has grown up around high-technology regions like Silicon Valley and Route 128, it is not surprising that government has become enamored with venture capital as a mechanism for generating technology-based economic development. Indeed, a growing number of state and local governments now view venture capital as an essential ingredient of economic development. The number of states with venture capital programs has increased from just two in 1980 to 23 by 1988.²⁸ According to a recent report by the Small Business Administration, the states currently spend more than \$400 million on public grant, equity, and early-stage financing efforts.²⁹

Recent states' efforts have taken a variety of forms. The two longest running programs are the Massachusetts Technology Development Corporation and the Connecticut New Product Development Corporation which invest directly in technology-oriented businesses.³⁰ A number of states use public money to underwrite privately managed venture capital partnerships. Public entities generally function as passive, limited partners in these arrangements, placing few strings on the type or location of investments. The New York Business Venture Partnership, for example, is a \$40 million limited partnership backed by two public pension funds and managed by Rothschild Ventures. The Primus fund in Cleveland, Ohio, is a \$30 million limited partnership backed in part by public capital that is constrained (though not limited) to investments in Ohio.³¹ Some states—including Ohio, Pennsylvania, Michigan, New York, Utah, Oregon, and Washington—allow public pension funds to commit a small percentage of assets to venture capital partnerships without regard for location. A number of others, most notably Ohio and Michigan, have experimented with direct investment in new enterprises.³² Still others use tax incentives to stimulate private venture capital pools.

The research findings suggest that there are serious reasons to question the efficacy of government involvement in venture capital. The reason for this is simple. Venture capital is just one of a host of necessary inputs to technology-intensive economic development. As the cases of New York and Chicago illustrate, the presence of abundant venture capital does not necessarily translate into high-technology development. These two centers export venture capital to established high-technology regions. The consensus view in the literature on high-technology regional development is that only a very limited set of areas possesses the attributes needed to generate and sustain a high level of high-technology-based economic growth.³³ Increasing the volume of venture capital in areas that lack such conditions is likely to have little effect on their technological capabilities and can have perverse effects if this capital simply flows to established centers of high-technology. It is possible that current models of public venture capital will confer disproportionate benefits to already advantaged regions, enabling them to consolidate their hold on high-technology development. Despite the important contribution venture capital has made to high-technology regions such as Silicon Valley and Route 128, public venture capital is not a solution to the serious technological and economic woes faced by many regions and localities.

Given the realities of the U.S. venture capital system, public venture capital programs are likely to face the following catch-22 situation. On the one hand, programs that try to encourage local

The research findings suggest that there are serious reasons to question the efficacy of government involvement in venture capital.

venture investing by placing tight restrictions on the investment activities of public venture capital pools will be problematic because they narrow potential investment opportunities and may cause public funds to invest in local companies that are not competitive. The absence of a supply of entrepreneurial human capital and a supportive institutional environment of law firms, accounting firms, and other business service firms are likely to increase the difficulties that these type of investments will encounter. On the other hand, if no strings are attached to public efforts, venture investments will flow toward areas that have the most attractive rates of return (e.g., Silicon Valley and Route 128). In such cases, publicly subsidized venture capital funds will mimic the export behavior of New York and Chicago venture capitalists. This may result in large outflows of venture capital and further depletion of local resources.

The research findings contradict the underlying rationale upon which public intervention in venture capital is premised: the concept of an imperfect venture capital market where large gaps in venture capital supply deny to high-technology firms the capital source they need to develop. Contrary to this assumption, the findings of the research presented here indicate that venture capitalists are quite proficient in locating existing high-technology investment opportunities and providing capital to them. Hence, it may be more appropriate to conceptualize capital gaps as a function of an area's underlying inability to generate high-technology firms, or more fundamentally, to establish the social structure of innovation from which high-technology development stems.

There are other reasons to be wary of state involvement in venture capital. It is important to note the extremely high failure rate associated with venture investing. Our cases' studies and interviews indicate that even the most experienced venture capital funds evidence a success rate of roughly 1 in 10 investments. Private venture capitalists are able to survive and prosper because they are equity investors who generate huge profits on a few big successes or "home-runs." Beyond this, the benefits of venture investments tend to be quite narrow. While they provide great wealth and profits for entrepreneurs and investors, they tend not to generate large numbers of jobs and other social benefits. In fact, a common pattern is that such jobs are exported to the Third World. Put another way, U.S. high-technology complexes produce technological breakthroughs but are less and less capable of follow-through in the development of high-quality, mass-manufactured products.³⁴

The basic policy implication of the research is that public venture capital is likely to be appropriate in only those limited areas that already possess or are beginning to solidify the social structures of innovation that underpin high-technology development. The success of the Massachusetts Technology Development Corporation, which makes many of its investments in the Route 128 area, tends to support this view.³⁵ Since venture capital is just one of many important inputs into the technology development process, public intervention in venture capital will be most successful in areas that already have a supply of the other inputs but do not have sufficient venture capital. In these few cases, and only in these cases, relief of the venture capital constraint is likely to have a significant impact.

In the end, venture capital is not a panacea for the serious economic development problems facing most states and communities. In light of our findings, economic development policy makers would do well to avoid quick-fix remedies such as venture capital programs, and get back to the business of building integrated strategies to bolster the underlying economic and technological capacities of cities, states, and regions.

NOTES

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6. Alden Bean, Dennis Schiffel, and Mary Moege, "The Venture Capital Market and Technological Innovation," *Research Policy* 4 (1975): 380-408; Matthew Bullock, *Academic Enterprise, Industrial Innovation, and the Development of High Technology Financing in the United States* (London: Brand Bros, 1983); Richard Florida and Martin Kenney, "Venture Capital and Technological Innovation in the U.S.," *Research Policy* 17 (1988): 119-137.
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9. Florida and Kenney, "Venture Capital, High Technology," pp. 33-48.
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11. For a critique, see Richard Florida and Martin Kenney, "Venture Capital's Geography: A Comment on Leinbach and Amrhein," *Professional Geographer* 40, No. 2 (1988): 214-17.
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14. Green, "Patterns of Preference for Venture Capital."
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16. Annalee Saxenian, "Silicon Valley and Route 128: Regional Prototypes or Historic Exceptions?" in *High Technology, Space, and Society*, ed. Manuel Castells, vol. 28 of *Urban Affairs Annual Reviews* (Beverly Hills, CA: Sage, 1985), pp. 81-105; Walter Stohr, "Regional Innovation Complexes," *Papers of the Regional Science Association* 59 (1986): 29-44; Allen Scott and Michael Storper, "High Technology Industry and Regional Development: A Theoretical Critique and Reconstruction," *International Social Science Journal* vol. 112 (1988): 215-212.
17. Florida and Kenney, "Venture Capital, High Technology."
18. The venture capital data base was compiled from information reported in Venture Economics' *Venture Capital Journal* between January 1984 and December 1987 and represents roughly 40% to 45% of all venture investments made during the period of 1983 to 1987.
19. Personal interviews conducted by Richard Florida and Martin Kenney during the period of 1986 to 1989.
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24. Florida and Kenney, "Venture Capital and Technological Innovation," pp. 119-37.
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32. Personal interview with Robert McLaughlin of the State of Ohio Retirement Fund, conducted by Richard Florida and Martin Kenney, 1986.

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