VENTURE CAPITAL AND INDUSTRIAL COMPETITIVENESS

A Research Report to the U.S. Economic
Development Administration

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What is the role of venture capital in industrial competitiveness? On the one hand, venture capital has played a crucial role in the emergence of innovative entrepreneurial enterprises and high-technology regions such as Silicon Valley and Boston's Route 128 corridor. On the other hand, a number of commentators have suggested that venture capital contributes to a pattern of chronic entrepreneurship and the breakthrough illusion of U.S. high technology which have negative implications for U.S. technological and industrial competitiveness.

The research presented here explored the four major issues regarding venture capital's role in industrial competitiveness:

- the locational determinants of venture capital supply and investment and the relationship between venture capital and high-technology regional development;
- the positive and negative impacts of venture capital on industrial and technological competitiveness;
- the scope, nature, and implications of foreign participation in U.S. venture capital and its effects on U.S. industrial competitiveness; and
- the role of government in venture capital, particularly recent proposals for direct government intervention in the venture capital market.

This study used a combination of qualitative and quantitative research techniques to address these issues, including: (1) the development of new data on the venture capital industry; (2) econometric analyses of the determinants of venture capital supply and investment; (3) field research, personal interviews, and case studies with a representative sample of venture capital funds and companies funded by venture capital; (4) historical analyses of venture capital activity from its origins in the mid-to-late 19th century to the present; and (5) policy analyses of the efficacy of government intervention in the venture capital market.

This research yielded four major conclusions.

First, venture capital is highly concentrated in terms of both supply and investment. Th data analysis and statistical models confirm that the supply of venture capital is concentrate around major financial centers, such as New York and Chicago, and around leading high technology regions, such as Silicon Valley, California, and the Route 128 area around Bosto The principal factors that influence the supply of venture capital are concentrations of financi institutions, financial assets, and high-technology industry. The principal factors that produc venture capital investment are high-technology industry and financial networks. On balanc there is a flow of venture capital toward leading high-technology regions. Venture capital is central component of the technological infrastructure in these regions -- a special form of a agglomeration economy composed of specialized economic, technological, and financial networ that support high-technology development. Generally speaking, there has been a shift in th location of venture capital supply over time from traditional financial centers toward the ne high-technology industrial complexes and the development of a spatially-differentiated structu of the venture capital industry.

Second, venture capital has both positive and negative implications for U.S. industri and technological competitiveness. This finding stems from a comprehensive analysis of rece trends in the venture capital industry and detailed field research, interviews, and case studies both venture capital funds and the high-technology enterprises they finance. On the one hand venture capital is a source of competitive advantage for the U.S. economy. The U.S. possess by far the largest and most vigorous venture capital market in the world, dwarfing that of majo competitors, such as Japan and Germany. Furthermore, the U.S. venture capital market ha played a major role in the development of innovative high-technology enterprise commercialization of new technology, and the growth and development of leading hig technology regions. On the other hand, venture capital financing has contributed to th breakthrough illusion of the U.S. economy, creating strong incentives for technologic innovation and initial commercialization, but only weak incentives for the subseque development of strong domestic manufacturing capabilities. Venture capital also contributes a pattern of chronic entrepreneurship and the weakening and fragmentation of the overall U.S high-technology effort.

Third, foreign participation in the U.S. venture capital market has increased significant in recent years. The findings of the data analysis and detailed case studies of foreig participation in venture capital indicate that the effects of foreign participation are mixed, b on balance positive. Foreign participation has brought new capital to the venture capital marke during a period when U.S. financial commitments to venture capital have declined. Whi foreign participation has reinforced the movement of technology to offshore production locatio in some cases, foreign venture capital provides a useful source of longer-term patient capital f U.S. high-technology companies and reduced the cost of capital to entrepreneurial enterprise Since a significant share of foreign venture capital is provided by industrial corporations, it ha enabled high-technology enterprises to secure access to state-of-the-art manufacturing an marketing networks.

Fourth, government intervention in the venture capital market is problematic and is not warranted given past, current, and projected future conditions in the venture capital industry. Proponents of greater government intervention in venture capital claim that venture capitalists have significantly reduced their investments in recent years, particularly in so-called seed and startup investments. Because of this structural underinvestment by the private sector, they argue, government must step in to close the capital gap in this area. This position, however, overlooks or ignores important evidence on the actual operation and performance of the venture capital industry. Analyses of these data indicate that there is little evidence of a structural underinvestment in venture capital, and moreover that the U.S. venture capital market continues to operate efficiently, channelling funds to technologies and industries where rates of return are adequate. Furthermore, the track record of both federal and state initiatives in venture capital is problematic, and indicates that government is institutionally ill-equipped to play the role of venture capitalist. Simply put, the venture capital market does not need help; even if it did, government would be the wrong institution to provide it. Far more effective ways exist for government to help boost investment, technological and industrial competitiveness, and long-term economic growth.

CHAPTER 1

VENTURE CAPITAL AND INDUSTRIAL COMPETITIVENESS

Venture capital has clearly played a major role in the emergence of innovative h technology firms such as Intel, Apple Computer, Microsoft, Sun Microsystems, and Genen and high-technology regions such as California's Silicon Valley and the Route 128 arc Boston and Cambridge, Massachusetts. However, recent research has shown the nee understand both the positive and negative implications of venture capital-financed technology for U.S. industrial competitiveness. In previous research conducted for Economic Development Administration, Florida, Kenney, and Smith (1990) noted that alth venture capital has contributed to the growth of Silicon Valley and Route 128, it should nc seen as a panacea for other localities and regions which lack the requisite techno infrastructure or social structure of innovation to catalyze high-technology development. T concluded that local and state governments would be better served by economic develop programs that bolster underlying technological capacities and economic infrastructures, ra than focusing on the provision of venture capital finance, which is largely a function of technological infrastructure in the first place. Furthermore, the venture capital sector has pointed to by many analysts as a great source of competitive strength in the U.S. fina markets. In a recent report for the Council on Competitiveness, Michael Porter of the Har Business School notes:

> The United States performs well in high-risk startups that require five-to-seven year investments and in funding emerging industries . . . In these cases, investors recognize that current earnings are irrelevant and seek other value proxies, such as patents and new product announcements which are more supportive of investment. Indeed, long-term prospects may be over-valued in some emerging industries (Porter 1992).

Other research indicates that venture capital contributes to an accelerated pattern of new business formation or chronic entrepreneurship which may leave American high-technology firms and industries increasingly vulnerable to large foreign competitors (Ferguson 1988). There is some concern that venture capital contributes to the breakthrough bias of U.S. high-technology -- the growing inability of U.S. firms to turn cutting edge innovations into profitable product lines by turning them into mass produced products (Florida and Kenney 1990). And, there is increasing concern over the recent surge in foreign (especially Japanese) activity in U.S. venture capital which has led some to speculate about the deleterious consequences of allowing foreign competitors to gain privileged access to and ownership of cutting edge U.S. high technology.

The research presented here examined four key issues regarding venture capital's role in industrial competitiveness.

- First, the research examined the relationship between venture capital and high-technology economic development. To probe this issue, we used a comprehensive database of venture capital investments to develop regional econometric models of the relationship between venture capital and established high-technology regions, focusing on the underlying factors that affect the location and investment of venture capital. Data on high-technology firm formation and industrial characteristics were made available from the U.S. Small Business Administration. These models provided new empirical insight into the relationship between venture capital and high technology, and provide a benchmark from which to evaluate regional economic development policy designed to stimulate high-technology enterprise.

- Second, the research probed the effect of venture capital on innovation and technological competitiveness. This aspect of the research explored venture capital's effect on innovation and technological competitiveness along two dimensions. Do venture capital-financed enterprises favor radical new product breakthroughs over incremental improvements in products and manufacturing process innovation? And, does venture capital-financed innovation set high-technology industries on a technological trajectory that contributes to competitiveness problems? This aspect of the research was accomplished through case studies of venture capital-financed companies and personal interviews with venture capitalists, entrepreneurs, technologists, and managers of high-technology companies.

- Third, the research examined the role of foreign involvement in venture capital, and the implications of such for U.S. industrial competitiveness. This aspect of the research explored the growth of foreign, particularly Japanese, participation in the U.S. venture capital industry and its effects on U.S. high technology. It involved the redevelopment and analysis of new data on foreign investment in venture capital funds and in startup companies directly, obtained from Venture Economics and the European Association of Venture Capitalists. It also involved detailed case studies of and personal interviews with key executives in high-technology companies that have received foreign venture capital financing.

- Fourth, this research examined the role of government in venture capital financing and recent proposals for direct government intervention in the supply of venture capital.

RESEARCH DESIGN

To address these issues, the research was organized in five main tasks. The first research task involved the expansion of the micro-level venture capital data developed in the authors' earlier study for the Economic Development Administration (Florida, Kenney, and Smith 1990). The existing database was developed to provide information on the investments and coinvestments made by U.S. venture capital funds. This database is based upon published records contained in *Venture Capital Journal* and comprises roughly a 40 percent sample of all investments made by U.S. venture capitalists over the period 1983-1987. The database provides information on the venture capital investments and coinvestments and includes basic identifying information such as name and location for roughly 2,000 companies that have received venture capital financing. These data establish the broad parameters of venture capital's effect on the growth and development of high-technology firms and industries and help to guide the selection of case studies and other micro-data analysis.

The second task utilized these data to develop statistical models of the relationship between venture capital and regional high-technology development. These models explicitly address the chicken and egg relationship of venture capital and high technology, resulting in a better understanding venture capital's contribution to high-technology development. The models are based on venture capital database outlined above. The models explore the relationship between venture capital supply, venture capital investment, financial or bank assets, high-technology enterprises, and other indicators of the high-technology infrastructure of metropolitan areas. The models are cross sectional in nature, with two separate time periods considered and are designed to test the relationship among venture capital and high-technology firms at the metropolitan statistical area (MSA) level for 1984 and 1986. The first model explores the relationship between the supply of venture capital at the metropolitan area, the number of high-technology enterprises, financial assets, and the density of internal and external linkages at the metropolitan area. A second model explores the relationship between venture capital investment and similar variables, and was designed to isolate the factors that attract venture capital.

The third task developed new data on foreign sources of venture capital, focusing on investments by foreign corporations and institutions in U.S. venture funds, and on direct foreign investment in U.S. high-technology startups. The data are compiled by major OECD country and by region. Data on foreign venture capital were provided by the European Association of Venture Capitalists. Data on Japanese venture capital were obtained from publications in Japan. Data on foreign (especially Japanese) investment in U.S. were obtained from Venture Economics on a contract basis. The study team analyzed the data over time, constructed relevant indicators, and developed estimates of their likely effect on U.S. high-technology firms and industries.

The fourth task involved extensive case studies designed to get inside the black box of venture capital-financed high-technology firms. An invaluable feature of our previous research on the venture capital industry involved detailed interviews and case studies with venture capitalists which facilitated deep understanding of the nature and function of their activities. The current project conducted case studies and interviews with high-technology firms that have received venture capital, to gain a deep understanding of the role of venture capital in their development and progression to maturity, and explored the role of foreign financing in the development of high technology firms and, more broadly, in the industrial competitiveness of U.S. industry. The case studies involved intensive site visits to companies, detailed on-site observation, and structured oral interviews with founders and key principals of high-technology firms that have received venture capital. Case study firms were selected across a variety of criteria including geographic region, technology sector, and source of funding (foreign vs. domestic). Case studies were identified from the existing venture capital database as supplemented with discussions and interviews with experts in the high-technology industry and the venture capital community. Such discussions were facilitated through the principal investigator's existing network of contacts. Case studies of specific firms covered the range of technological and economic activities. Attention was given to the role of venture capital in the origin of the company, its business strategy, the kinds of innovations it chooses to develop, problems related to labor mobility, and its internal and external organization characteristics in general. Specifically, the case studies focused on the following issues:

- the role of venture capital in innovations and product development
- employee turnover and defection
- pressure to develop particular products
- changes in management orchestrated by venture capitalists
- spin-offs of company employees
- intellectual property
- foreign financing
- organization of manufacturing
- use and location of outside contract manufacturers
- location of outside suppliers.

The fifth task was to collect and analyze the empirical evidence as it relates to the role of government in the venture capital industry. Emphasis was given to the performance of the venture capital sector in recent years. In particular, the policy implications of recent federal legislation that would get government directly involved in the supply of venture capital were studied.

PREVIOUS RESEARCH

While the past few years have seen a number of important studies of the venture capital industry, there are still several areas that need further research. Although there is a fairly extensive literature on the business-management dimensions of venture capital (Kozmetsky et al. 1985; Wilson 1985), there are only a handful of studies that examine regional patterns of venture capital supply and investment (Green 1987; McNaughton and Green 1986; Leinbach and Amrhein 1987; Florida and Kenney 1987, Florida, Kenney, and Smith 1990; Florida and Smith 1990), the relationship between venture capital and high-technology industry (Florida and Kenney 1987, 1988a, 1990b), and the role of venture capital in technological change (Bean, Schiffel, and McGee 1975; Bullock 1983; Florida and Kenney 1988b). Most studies of the regional aspects of venture capital face severe data limitations, rely on highly aggregated data, and provide an inadequate picture of venture capital supply and investment. In addition, such research is frequently hampered by a poor understanding of how the venture capital industry operates, based upon anecdotes from the business press and second-hand stories. The following briefly outlines the major research contributions of preexistent research in four related areas: (1) determinants of venture capital supply, (2) determinants and flows of venture capital investment, (3) the relationship between venture capital and high-technology development, and (4) the role of venture capital in technological innovation and industrial competitiveness.

The majority of research on venture capital is devoted to the supply of venture capital, as measured by the number of firms or dollar amount of resources they control. This work highlights the fact that venture capital is highly concentrated in a few areas, such as New York, Chicago, Boston, and Silicon Valley, but for the most part does not provide answers as to why this is so. The literature shows what is mostly a cursory understanding of the differences among the venture capital centers (Leinbach and Amrhein 1987; Green 1987; McNaughton and Green 1986). Moreover, there is a general assumption that venture capital is coincident with high-technology industry. This is in turn reflected in state and local economic development policies which are premised on the rationale that the creation or enhancement of local venture capital will stimulate local high technology. However, a variety of evidence indicates that there are multiple determinants of venture capital supply and that venture capital supply is only loosely related to the development of local high-technology industry. For example, a number of high-technology regions such as North Carolina's Research Triangle have very little indigenous venture capital and are comprised mainly of high-technology branch plants (Luger 1984). Other regions which have relatively large concentrations of venture capital (e.g., New York and Chicago) but have given rise to only limited local high-technology development. Recent research (Florida and Kenney 1987, 1990a; Florida and Smith 1990) 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., Boston-Route 128 area).

The literature on venture capital investment is less extensive, and it too tends to be mainly anecdotal or descriptive in nature. Until the database developed by Florida, Kenney, and Smith (1990), good data on venture capital investment had been unobtainable or prohibitively expensive. Leinbach and Amrhein (1987) use aggregate regional data to analyze regional variations in venture capital investment, concluding that the Pacific Southwest, New England, and the Gulf Coast/Southwest regions attract the largest volume of venture capital investment. Unfortunately, this highly aggregate analysis obscures some interesting state and local differences in the venture capital industry (see Florida and Kenney 1988c for a critique). McNaughton and Green (1986) use Small Business Investment Corporation (SBIC) investment data as a proxy for venture capital investment. However, 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 the conclusion that venture capitalists invest locally may be appropriate for SBICs, there is little reason to expect it will hold for other types of venture capital institutions, such as limited partnerships. Green (1987) uses venture capitalists' investment preferences to derive a set of preference indicators for venture capital investment, concluding that venture capitalists have no geographic preference beyond the entire U.S. This is problematic because the preferences reported by venture capitalist are not necessarily followed in practice. Using a database sample of all venture capital investments in the U.S., Florida and Kenney (1990) indicate that venture capital investments flow mainly to established high-technology centers such as Silicon Valley and Route 128. This research further suggests that while venture capitalists in these high-technology centers invest locally, venture capitalists in financial centers such as New York and Chicago export capital to established high-technology regions.

A related literature explores the factors that determine high-technology location and the formation of high-technology industrial complexes. Unfortunately, this literature neglects venture capital's role in both high-technology location and complex formation. Empirical research by Markusen, Hall, and Glasmeier (1986) does not include a venture capital variable. 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 complex formation (Saxenian 1985; Stohr 1986; Scott and Storper 1988), this research has not looked in any systematic way at venture capital's role in such complexes. Florida and Kenney (1987, 1990) indicate that venture capital is a central component of the well-developed "social structures of innovation" which characterize high-technology regions (also see Florida and Smith 1990). Thus, venture capital's impact is context sensitive: in areas with an established high-technology base or social structure of innovation, venture capital fuels the growth of that sector, while in areas that lack such a base, venture capital alone is not sufficient to stimulate high-technology development. The policy implication that follows is that public efforts to stimulate high technology by enhancing the supply of venture capital without influencing the other elements of a region's underlying technology base are not likely to succeed, and indeed may cause scarce capital to be exported to existing high-technology centers.

Venture capital's effect on industrial competitiveness is a crucial but virtually unexplored area. On the one side, Gilder (1988, 1989) suggests that venture capital financing is a key component of innovative high-technology small firms which will continue to keep the U.S. ahead of its major competitors in both technological innovation and economic performance in key high-technology industries. On the other side, Reich (1987) and Ferguson (1988) question the efficacy of venture capital-financed high technology on the ground that it contributes to a process of accelerated business formation or chronic entrepreneurship which leaves U.S. high technology vulnerable to large Japanese competitors. Wilson (1985) calls attention to the debilitating role of so-called vulture capitalists who orchestrate raids of R&D scientists and other personnel from established companies. Sahlman and Stevenson (1985) suggest that the rapid increase in the venture capital pool has brought about a form of "capital market myopia" whereby individual venture capitalists fund duplicative copy-cat companies which increase competition for resources and markets and can cause devastating shake-outs, such that which occurred in the computer disk drive industry.

Florida and Kenney (1990) suggest that venture capital financing plays a role in the breakthrough bias of U.S. high technology, drawing resources and talent toward radical new product innovation and away from incremental improvement innovations in products and manufacturing processes. There are a number of aspects to this breakthrough bias. First, venture capitalists who need to generate sizeable returns over the seven to ten year life of their funds place considerable pressure on new enterprises to develop new breakthrough products which generate large revenue streams. Second, operating under this incentive structure, startup companies tend to focus attention on high-end innovation and disregard manufacturing. In fact, small high-technology companies increasingly depend upon outside contract manufacturers (often foreign) to produce their cutting edge products. According to some reports, foreign contract manufacturers like the Taiwan Semiconductor Manufacturing Company provide a growing share of manufacturing for venture capital backed startups (Hayashi 1988). Third, given the tremendous availability of venture capital, groups operating within existing companies have great incentive to develop new breakthrough technology as a new spin-off company. Florida and Kenney (1990) refer to this as externalization of innovation where new companies emerge to develop and commercialize new technologies. This is a dramatic reversal from the previous pattern of the internalization of innovation where large companies were able to internalize and thus benefit from innovations made by their R&D labs.

Other research notes the emergence of a new global division of labor in high-technology industry where small venture capital-financed high-technology firms innovate but depend upon foreign companies for sources of components supply as well as for an increasing share of production. While some continue to believe that the venture capital-financed startup companies of Silicon Valley and Route 128 are part of self-contained and tightly networked industrial districts, the accumulated evidence suggests that venture capital-backed firms are increasingly tied into global markets for component supply,

equipment supply, and actual production. According to a recent study, more than two-thirds of the components used in the development of new products by Silicon Valley firms come from companies outside the region (Gordon 1990). Foreign firms also comprise the fastest growing share of the market for U.S. high-technology firms; according to recent data, foreign sales by the top 200 U.S. high-technology electronics companies rose by 42 percent in 1989, while domestic sales increased by just 2.4 percent (Stallman and Rayner 1990). Very little systematic evidence is provided on the external relationships of venture capital-backed high-technology firms.

Lastly, there is growing concern among business leaders and policy makers over increasing foreign (especially Japanese) participation in U.S. venture capital and as direct investors in startup companies. During the 1980s, for example, Japanese corporations and financial institutions comprised one of the fastest growing segments of investors in U.S. venture funds and venture-capital backed companies. European financiers also increased their investments in U.S. venture capital and startup companies during this period. The European venture capital pool is currently in excess of $20 billion (roughly two thirds of the $35 billion U.S. pool) and its rate of growth exceeds that of the U.S. -- a significant share of this capital pool is being invested in U.S. companies. Some suggest that there is an emerging global division of labor in high technology where the U.S. concentrates on breakthrough innovations, while other nations like Japan emphasize downstream technological follow-through capturing the bulk of employment, profit, and wealth that come from them (Florida and Kenney, 1990).

CHAPTER OUTLINE

The following chapters use a combination of qualitative and quantitative research to probe these issues in considerable depth. Chapter 2 explores the organization and spatial structure of the venture capital industry. The evidence presented here shows that there has been a shift in the location of venture capital supply from traditional financial centers toward the new high-technology industrial complexes. Venture capital has become a central element of these regions and has taken an increasingly specialized and spatially differentiated form.

Chapter 3 presents the results of two models developed to test hypotheses regarding the spatial dimensions of venture capital location and investment. A venture capital location model tests the hypothesis that the location of venture capital is determined by both the concentration of high-technology business and the concentration of financial resources. A venture capital investment model tests the hypothesis that venture capital investment is drawn to major concentrations of high-technology business. The results confirm that venture capital is a central component of an area's technological infrastructure -- a special form of an agglomeration economy comprised of specialized economic, technological, and financial networks which support high-technology industrial and technological development.

Chapter 4 examines two central issues. The first issue is the role of venture capital in the international competitiveness of U.S. industry. Venture capital is considered by many analysts as a source of competitive advantage for the U.S. economy, since it has played a crucial role in the development of some of the most successful high-technology companies in the world. Others have pointed out that the contribution of venture capital to U.S. competitiveness is not totally positive, since it has helped to create a pattern of chronic entrepreneurship in the U.S., where the effort in high technology is focused on the creation of small companies geared to the production of technological breakthroughs. This neglects the actual manufacturing of high quality goods and the potential profits that come with it. The evidence on both sides of the argument is analyzed in this chapter. The second issue under examination in Chapter 4 is the role of foreign investors in the U.S. venture capital industry and the provision of capital for entrepreneurial high-technology companies. While some analysts have pointed out that foreign investors provide much needed capital for high-technology development, others argue that the United States is giving away a crucial edge in the international economic competition through this channel, since its major competitors in the world markets are gaining access to crucial technologies developed by American companies. The evidence presented here shows that foreign investment in U.S. high technology is not quite as extensive as has sometimes been portrayed by the media, and is indeed receding, given the current slowdown in global economic activity. Moreover, there is evidence that new patterns of cooperation and alliance between U.S. entrepreneurial high-technology companies and foreign corporate financiers are developing. These emerging patterns of cooperation offer unique advantages to all involved in these transactions.

Chapter 5 addresses the issue of the role of government in the supply of venture capital. It has been argued that venture capital is not fulfilling its original mission, because the percentage of venture capital funds no longer being used to finance seed and startup companies has been falling. Hence, the argument continues, government must assume an active stance in the venture capital market, operating as a direct supplier of funds to cover the gap left by private capital. The evidence presented in this chapter shows that this argument is fatally flawed. The available data show that while the venture capital market has gone through an adjustment phase, after the excesses of the 1980s, it is not accurate to say that private venture capital has abandoned seed and startup companies. Indeed, the venture capital market shows a remarkable ability to adjust to changing conditions. The participation of government as a supplier of venture capital is not needed. Moreover, empirical and theoretical evidence shows that government would not be capable of acting as an effective supplier of venture capital. Government is too big and too slow to act with the agility that is needed for success in this market. There is little credence to the notion that government managers, who are far removed from the market and how receive no personal compensation for success, can better direct the flow of risk capital. Moreover, government is too vulnerable to pressures from interest groups to assign resources effectively among high-technology prospects.

Finally, an appendix is included providing a detailed historical analysis of the role of early venture capitalists in the rise of technology-intensive enterprises in the late 19th and early 20th century in the United States. A series of historical precedents and parallels which carry forward to this day are highlighted.

CHAPTER 2

THE ORGANIZATION AND GEOGRAPHY OF VENTURE CAPITAL

The venture capital industry has seen significant growth over the past two or three decades. The pool of venture capital increased from roughly $2.5 billion in the late 1960s to more than $33 billion by 1990. However, the amount of new capital flowing into venture capital declined in the early 90's before rebounding sharply in 1992 and 1993. Venture capitalists invested almost $4 billion in 1,740 companies in 1987; of this total, 401 companies or roughly $1 billion were first time financings. By 1991, disbursements were $1.4 billion, distributed among 792 companies (Venture Economics 1992a).

High-technology industries are the target of the bulk of venture capital investment. In 1991, venture capitalists placed 37 percent of their investments in computer hardware and software, 12 percent in telecommunications, 11 percent in medical technology, 10 percent in electronics, and 8 percent in biotechnology. Predominantly, low-technology consumer products received only 10 percent (Figure 2.1).

Venture capitalists provide a significant share of the total pool of risk capital for new business formations. Gupta (1990) provides data which indicate that venture capitalists provided roughly 15 percent of all capital to emerging growth businesses in 1988; 35 percent came from individual investors, 25 percent from corporations, 15 percent from federal small business innovation research grants, and 10 percent from state and local economic development agencies. Venture capitalists are short-to-medium term investors holding their stake in the company for five to seven years at which point the company is brought to market, merged, or sold off to another company. Moreover, venture capital partnerships have a limited life-course of seven to 10 years at which point the capital gains and equity shares accrued by the fund are distributed to the investors.

There are a variety of different institutional types of venture capital. Private venture capital limited partnerships comprise by far the largest share of the industry, and have witnessed significant growth over the 1970s and 1980s. Venture capital limited partnerships are independent private funds which are comprised of professional venture capitalists who functions as general partners and outside investors who function as limited partners and whose liability is limited to their investment in the fund. In 1988, limited partnerships managed on average $30 million in capital; however, a number of large mega-funds manage more than $500 million. The next largest group of venture capital funds is the venture capital subsidiaries of large financial institutions. In 1988, there were 85 (12.9 percent) of these with holdings of roughly $2.9 billion (9.2 percent) in capital. The average size of these funds was $15 million in capital. Venture capital subsidiaries of industrial corporations were next with 84 funds (12.7 percent) and $2 billion (6.6 percent) in capital (Venture Economics 1989: 5-11). In 1988, their average

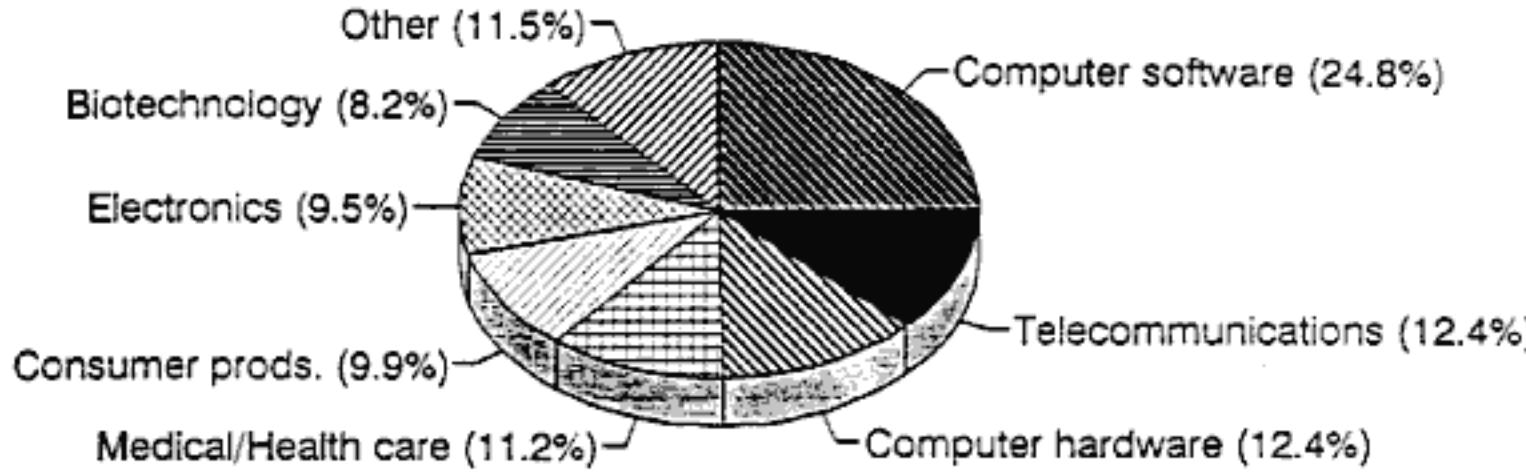


Figure 2.1: Share of Venture Capital Investment by Sector, 1991

Source: Venture Economics

size was $16.5 million in capital. There were 91 small business investment companies (SBICs) actively involved in venture capital. SBICs accounted for only a very small amount of venture capital, roughly $460 million, or 1.4 percent of the pool. In 1988, the average size of venture capital- oriented SBICs was $2.5 million in capital. Outside the formal, institutional venture capital industry are a large group of independent informal investors, mainly wealthy individuals, referred to as "angels." Gaston (1989) estimated that there were approximately 720,000 informal investors nationwide, who control more than $36 billion in capital and invest in approximately 87,000 entrepreneurial businesses per year. The investment behavior of informal investors is more localized and less technology-oriented than that of professional venture capital funds.

This chapter examines the geography of venture capital and the factors that influence that geography. We distinguish between two basic dimensions of venture capital: the location of venture capital funds (supply) and the geography of venture capital investment (demand). New data on the geographic distribution of venture capital supply and investment at the metropolitan statistical area (MSA) level, representing an advance over previous data and analyses of the venture capital industry which have been accomplished at the state or multistate level. The MSA level provides a relatively small and homogenous geographic unit that can yield meaningful results, as opposed to regions or states which are heterogenous and which tend to obscure important substate differences. Empirical models of the geographic distribution of venture capital supply and investment are developed and tested. The next section reviews the existing body of economic and geographic research and theory on venture capital's role in economic development. The succeeding sections examine state and metropolitan level data on the geographic distribution of venture capital funds and investments. In the following chapter, hypotheses about the geography of venture capital are formally tested through empirical models of venture capital supply and investment.

THE ECONOMICS AND GEOGRAPHY OF VENTURE CAPITAL

Venture capital is an important element in the processes of capital formation, technological innovation, and regional industrialization. Conventional economic theory assumes that capital markets, including the market for venture capital, are perfectly free and thus mobile (Stiglitz 1982). From this perspective, venture capital would be expected to flow freely across space. But studies of the venture capital industry (Wilson 1985; Kozmetsky et al. 1985) conclude that venture capital is a unique form of finance, combining elements of financial and industrial activity. Venture capitalists are significantly involved in the oversight and management of their investments. While the mobility of capital depends crucially upon perfect information, venture investing is characterized by high levels of uncertainty, high risk, and ambiguous information. Geographic proximity to investments provides a way for venture capitalists to cope with uncertainty and reduce risk. Indeed, surveys have found that venture capitalists prefer

to be close to their investments to screen, monitor, and assist in managing them (U.S. Congress, Joint Economic Committee 1984). Government intervention in the venture capital market has been premised primarily upon the notion of market imperfections, or "regional capital gaps," which allegedly hinder the ability of specific geographic areas to develop high-technology industries. Institutional economists and geographers have long argued that investment flows are subject to market imperfections and spatial rigidities. Myrdal (1957) suggested that investment is a cumulative process shaped by the existing distribution of productive activity, previous investments, and subject to incremental change. Clark, Gertler, and Whiteman (1986; also Gertler 1983, 1984, 1987) conceptualized the investment process as one of dynamic adjustment where previous investment patterns influence and shape new investments. Schumpeter (1934) argued that exceptional entrepreneurs funded by new groups of financiers are at times required to overcome the risks associated with technological innovation. Economic development is seen here as a process of discontinuous evolution driven by technological change. Major innovations -- or clusters of innovations -- set in motion strong "gales of creative destruction" which revolutionize industrial production and industrial organization. However, the risks associated with these major innovations are sufficient to deter average firms, so exceptional entrepreneurs are required to set such gales in motion. According to Schumpeter, a new group of financiers emerges to finance those endeavors which are too risky for traditional financial institutions. In formal language, Schumpeter's risk-taking entrepreneurs require a symmetric counterpart in the financial structure; contemporary venture capitalists provide that function for high-technology industry.

Geographers and regional scientists have long noted the tendency of financial institutions to agglomerate. Hoover and Vernon (1962) suggested that the clustering of financial institutions was a product of the specialized, information-intensive, and transaction-intensive nature of finance capital. Thompson (1968) suggested that established financial centers serve as incubators for new financial services.

There are compelling theoretical reasons to expect the demand for venture capital to be geographically concentrated. Ever since Marshall (1900), regional economists and geographers have noted the presence of agglomeration or localization economies, a form of external scale economy, in the location and organization of industrial activity. Krugman (1991a, 1991b) made a strong case for the regional specialization of industrial activity based on increasing returns and simple pecuniary externalities (also see David and Rosenbloom 1990). Arthur (1988, 1990) argued that locational clusters are likely outcomes, given increasing returns, historical "path-dependence," and locational "lock-in." Thus, both from the viewpoint of classical industrial geography and from the recent "increasing returns" perspective in economics, one would expect to see spatial concentration of the industries which comprise the main source of demand for venture capital.

There are a handful of empirical studies which examine the spatial distribution of venture capital (Green 1987; McNaughton and Green 1986; Leinbach and Amrhein 1987; Florida and Kenney 1988a,c). The consensus view in the literature is that venture capital is geographically concentrated and that venture capital investments are unevenly distributed (see Thompson 1989 for a review). However, as noted earlier, most studies of the geography of venture capital rely on highly aggregated data and thus provide only a partial picture of the spatial distribution of venture capital. Furthermore, we are aware of no academic research that has attempted to develop and test theoretically-informed econometric models of the geography of venture capital.

There is a growing body of literature on the venture capital industry from the perspective of both economic and geography theory. This literature highlights the connection between venture capital and high-technology industry (Wilson 1985; Kozmetsky et al. 1985; Florida and Kenney 1988a; Bygrave and Timmons 1992). Venture capital is defined as a unique form of capital which involves the exchange of capital for an equity stake in the firm (Wilson 1985; Kozmetsky et al. 1985). This equity stake allows the venture capitalist to generate extraordinary profits if the firm is successful (Timmons and Bygrave 1986). An unpublished study of the performance of 10 leading venture capital funds indicates that of 525 separate investments made during the period 1972-1983, just 56 investments (or 10.7 percent) generated more than half ($450 million) of the total value held in portfolio ($823 million), while roughly half (266) either broke even or lost money (Horsley, Keough and Associates, unpublished data).

Bean, Schiffel, and Mogee (1975) and Tyebjee and Bruno (1984) conceptualized venture capital investment as a staged process that includes screening, investment, monitoring, management assistance, and liquidation or exit. Investment pooling or coinvestment is a significant feature of venture capital investment. Coinvestment links venture capital firms together in local, regional, and national networks. A survey of venture capitalists found that approximately 90 percent of all venture capital investments involve coinvestment partners (U.S. Congress, Joint Economic Committee, 1984). Timmons and Bygrave (1986) suggested that coinvestment enables venture capitalists to pool expertise, diversify their portfolios, and share information and risk. They further distinguished between lead investors who identify and monitor investment opportunities and organize investment syndicates and follow-on investors who provide additional, external sources of capital.

The characteristic that distinguishes venture capital from other sources of risk capital is that it is highly organized and institutionalized (Bygrave and Timmons 1992; Wilson 1985; Kozmetsky et al. 1985). Janeway (1986) explored venture capital in relation to the theories of Marx, Schumpeter, Keynes, and Braudel, concluding that venture capital is a new, institutionalized form of finance capital which has grown up to bear the high risks associated with the new high-technology industries and to help organize the innovative process. He concluded that venture capitalists are "a hybrid species of capitalist and entrepreneur" (Janeway 1986: 440).

The geographic literature suggests that venture capital is highly concentrated (Rubel 1975; Charles River Associates 1976; Venture Economics 1983; U.S. Office of Technology Assessment 1984; Leinbach and Amrhein 1987; Green 1987; Green and McNaughton 1988). There is a general assumption in the literature that the concentration of venture capital funds or the supply of venture capital is coincident to the location of high-technology industry. (This is in turn reflected in state and local economic development policies which are premised on the rationale that the creation or enhancement of local venture capital supply will stimulate local high technology). However, recent evidence (Florida and Kenney 1988a, 1988c; Florida and Smith 1990) indicates that there are multiple determinants of venture capital location; venture capital is located in traditional financial centers (e.g., New York and Chicago) and in established high-technology industrial complexes (e.g., Silicon Valley and Route 128).

The literature further suggests that venture capital investment is geographically concentrated and uneven. Leinbach and Amrhein (1987) used regional data to analyze regional variations in investment, concluding that the Pacific Southwest, New England, and the Gulf Coast/Southwest regions attract the largest volumes of venture capital investment. While this geographically aggregated analysis provides a good first cut on the issue, interesting substate and local differences in the venture capital industry cannot be captured with these data. McNaughton and Green (1986) used Small Business Investment Corporation (SBIC) investment data as a proxy for venture capital investment, concluding that venture capitalists invest mainly in local industrial capital. However, SBICs are a less important type of venture capital institution whose investment patterns may differ from those of other venture capital institutions. Green and McNaughton (1988) used the geographic investment preferences reported by venture capitalists to derive a set of preference indicators for venture capital investment, concluding that venture capitalists have no geographic preference beyond the entire U.S. However, the preferences reported by venture capitalist are not necessarily followed in practice. Florida and Kenney (1988a) found that venture capital investments flow mainly to established high-technology centers such as Silicon Valley and Route 128. They further found that while venture capitalists in these high-technology centers invest locally, venture capitalists in financial centers such as New York and Chicago tend to export their capital to established high-technology regions.

To shed further light on these issues, the following pages provide data on the geographic distribution of venture capital supply and investment at both the state and metropolitan level.

LOCATION OF VENTURE CAPITAL

We begin with the location of venture capital supply. The first measure of venture capital supply is provided by the location of offices of venture capital firms. The location of venture capital fund offices in leading states over time is presented in Table

2.1. As shown in this table, from 1973 to 1987 there was a shift in the location of venture capital offices from established financial centers such as New York and Chicago to the new centers of high-technology industry such as Silicon Valley and Route 128. The number of venture capital offices in California increased from 98 to 247, while the number of offices in New York experienced a modest decline from 164 to 158.

Among the fastest growing locations for venture capital offices were California, Texas, Colorado, Maryland, Washington, and Oregon. As shown in Table 2.3, California's share of the national total of venture capital offices increased by 9 percent, while New York's share witnessed an 11 percent decline. Illinois witnessed a 2 percent decline in the national share of venture capital offices.

The location of venture capital fund offices at the MSA-level is presented in Figure 2.2. This is supplemented by Table 2.2, which presents a ranking of the leading MSAs on the basis of venture capital office location. The MSA-level geography of venture capital supply is clearly uneven, with the top five MSAs controlling roughly 46.5 percent of total offices. However, 27 MSAs in 17 states possess seven or more venture capital funds (1 percent of the national total). These include Rustbelt and Sunbelt locations, as well as established high-technology centers and traditional financial centers such as New York, Boston, San Francisco, Chicago, San Jose, Dallas, Houston, Los Angeles, and Washington, D.C.

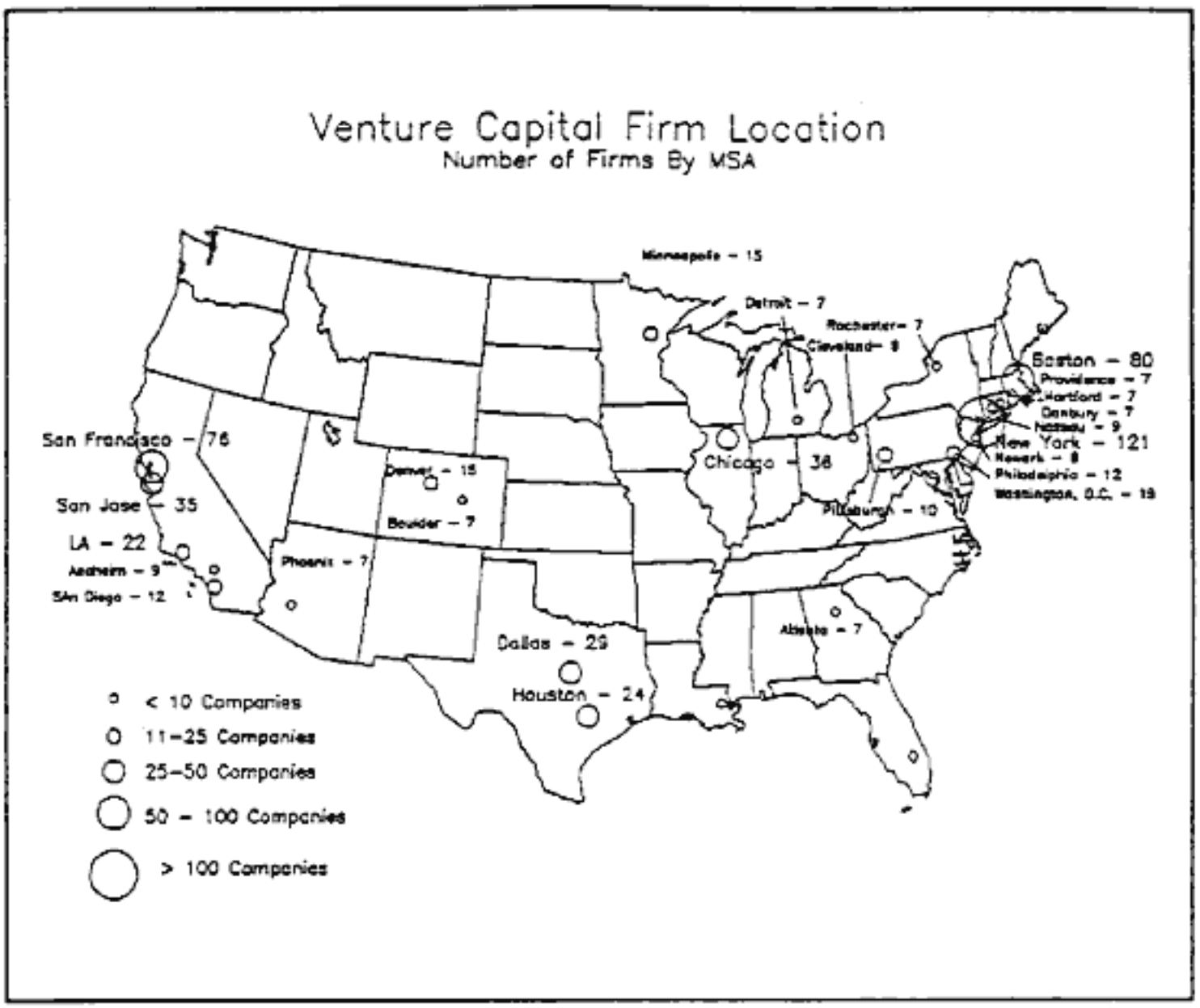


Figure 2.2: Geographic Distribution of Venture Capital Firms by MSA, 1987.

Table 2.1
Venture Capital Offices for the Top Twenty States, 1973-1987

1987 Rank	STATE	1973	Percent of total	1987	Percent of total	Total Change	Percent Change
1	California	98	15.9	247	25.4	149	152.0
2	New York	164	26.6	158	16.2	-6	-3.7
3	Massachusetts	57	9.2	86	8.8	29	50.9
4	Texas	28	4.5	66	6.8	38	135.7
5	Connecticut	29	4.7	39	4.0	10	34.5
5	Pennsylvania	24	3.9	39	4.0	15	62.5
7	Illinois	34	5.5	38	3.9	4	29.4
8	New Jersey	20	3.2	26	2.7	6	30.0
9	Colorado	7	1.1	22	2.3	15	214.3
10	Ohio	18	2.9	20	2.1	2	11.1
11	Minnesota	10	1.6	17	1.7	7	70.0
11	Washington, D.C.	11	1.8	17	1.7	6	54.5
13	Maryland	5	0.8	16	1.6	11	220.0
14	Washington	3	0.5	15	1.5	12	400.0
14	Wisconsin	13	2.1	15	1.5	2	15.3
16	Florida	13	2.1	13	1.3	0	0.0
16	Georgia	9	1.5	13	1.3	4	44.4
18	Michigan	3	0.5	12	1.2	9	300.0
18	Oregon	3	0.5	12	1.2	9	300.0
20	North Carolina	4	0.6	11	1.1	7	58.0
	NATIONAL TOTALS	617	100.0	974	100.0	357	

Source: Stanley Pratt, *Guide to Venture Capital* (for years indicated).

Table 2.2
Location of Venture Capital Fund Offices by MSA, 1986

MSA	Number of offices	Share of total	Venture Capital concentration index
New York, NY	125	15.9	47.98
Boston, MA	81	10.3	31.10
San Francisco, CA	81	10.3	31.10
Chicago, IL	38	4.8	14.59
San Jose, CA	37	4.7	14.21
Dallas, TX	29	3.7	11.13
Houston, TX	24	3.1	9.21
Los Angeles, CA	22	2.8	8.45
Washington, D.C.	22	2.8	8.45
Minneapolis, MN	15	1.9	5.76
Denver, CO	13	1.7	4.99
Philadelphia, PA	13	1.7	4.99
Seattle, WA	12	1.5	4.61
San Diego, CA	12	1.5	4.61
Pittsburgh, PA	12	1.5	4.61
Cleveland, OH	11	1.4	4.22
Anaheim, CA	10	1.3	3.84
Nassau, NY	9	1.1	3.46
Newark, NY	8	1.0	3.07
Danbury, CT	8	1.0	3.07
Atlanta, GA	7	0.9	2.69
Detroit, MI	7	0.9	2.69
Boulder, CO	7	0.9	2.69
Providence, RI	7	0.9	2.69
Rochester, NY	7	0.9	2.69
Hartford, CT	7	0.9	2.69
Phoenix, AR	7	0.9	2.69
NATIONAL TOTAL	784	100.0	1.00 (avg)

SOURCE: Venture Economics, *Guide to Venture Capital* (Wellesley Hills, MA, 1986)

NOTE: Venture Capital Concentration Index is calculated as follows:

$$\frac{\text{Number of Venture Capital Offices in MSA}}{\text{Average Number of Venture Capital Offices per MSA}}$$

Table 2.3
Change in Location of Venture Capital Offices, 1973-1987

State	Number of offices 1973	Share (%) of national total- 1973	Number of offices 1987	Share (%) of national total- 1987	Change in share (percentage points)
California	98	16	247	25	9
New York	164	27	158	16	(11)
Massachusetts	57	9	86	9	0
Texas	28	5	66	7	2
Connecticut	29	5	39	4	(1)
Pennsylvania	24	4	39	4	0
Illinois	34	6	38	4	(2)
New Jersey	20	3	26	3	0
Colorado	7	1	22	2	1
Ohio	18	6	20	4	(2)

SOURCE: Venture Economics, *Guide to Venture Capital.*
(Wellesley Hills, MA, 1973-1987)

A second measure of venture capital supply is the dollar volume of venture capital under management. The change in the dollar volume of venture capital supply between 1977 and 1989 is illustrated in Table 2.4. Note the tremendous rise in the amount and share of resources controlled by the leading high-technology areas, most notably California. In 1977, California controlled $524 million or 21 percent of the total venture capital pool; by 1989, the state controlled more than $10 billion in venture capital, 31 percent of the pool. Massachusetts registered a slight increase in share from 13 to 15 percent. New York, which was the leading center for venture capital in 1977 with $718 million or 28 percent of the pool, saw its share of the pool decrease to 22 percent. Illinois' share of the venture capital was cut in half, to 5 percent of the total pool.

Taken together, these data illustrate a shift in the location of venture capital supply from traditional financial centers toward the new high-technology industrial complexes. By the 1970s and 1980s, the new high-technology regions developed indigenous sources of venture capital. Whereas venture capital had originally come from outside these regions, it became a central element of them. Here, regional industrial development and regional capital formation grew up in tandem over time, creating a system of indigenous financial intermediaries articulated to the needs of local high-technology industry.

Table 2.4
Venture Capital Supply by Leading Centers 1977-1989*

	1977		1982		1987		1989		Change ($)
	$	%	$	%	$	%	$	%	
California	524	21	1,509	22	8,710	30	10,180	31	9,656
New York	718	29	1,835	27	6,390	22	7,480	23	6,762
Massachusetts	334	13	892	13	4,260	15	5,080	15	4,746
Illinois	255	10	808	12	1,570	5	1,690	5	1,435
Texas	83	3	259	4	1,230	4	1,160	4	1,077
Connecticut	89	4	276	4	1,220	4	1,650	5	1,561
Total	2,003		5,579		23,380		27,240		25,237

$ = Millions of dollars
% = Percent share of total

Source: Venture Economics, *Venture Capital Journal* (various issues)
Note: Venture Capital Centers with over $1 billion in 1989.

VENTURE CAPITAL INVESTMENT

We now turn attention to the geographic distribution of venture capital investment. Investment flows among the leading MSAs are identified in Table 2.5. San Francisco, New York, Boston, San Jose, Chicago, and Los Angeles represent the top six MSAs in terms of investments made -- no other MSA made more than 200 investments. Figure 2.3 is a map of venture capital investments at the MSA level. These data suggest a dual pattern of venture capital investment. On the one hand, venture capital is highly mobile. Venture capitalists in four leading MSAs, New York, San Francisco, Los Angeles, and Chicago, exported between 85 and 95 percent of their investments. As Table 2.5 shows, the flow of capital was overwhelmingly toward high-technology centers such as San Jose and Boston, which attracted 2,462 and 884 investments respectively. The newer high-technology centers of Dallas, San Diego, Boulder, and Los Angeles-Anaheim received significantly lower levels of venture capital investment. Together, the San Jose and Boston MSAs attracted almost two-thirds (62.7 percent) of the investments made by San Francisco venture capitalists and roughly one half (46.7 percent) of the investments made by New York venture capitalists. On the other hand, a small number of MSAs were characterized by a high level of local venture capital investment. San Jose venture capitalists, for example, made 44.6 percent of their investments locally. This suggests an overall pattern of relatively mobile capital flows, overlain on a geographic landscape that is defined by pockets of extreme spatial concentration.

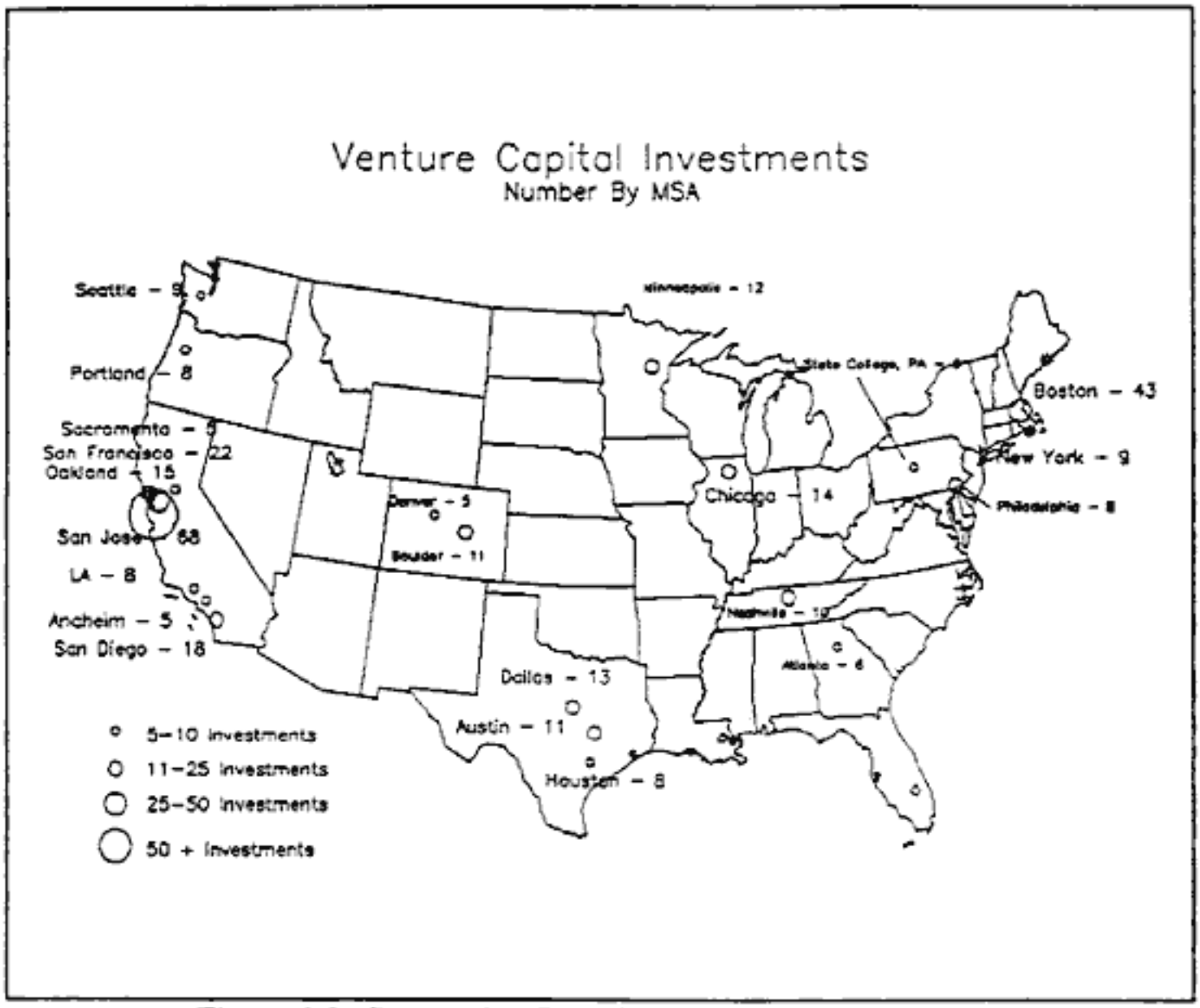


Figure 2.3: Geographic Distribution of Venture Capital Investments by MSAs 1982-1987

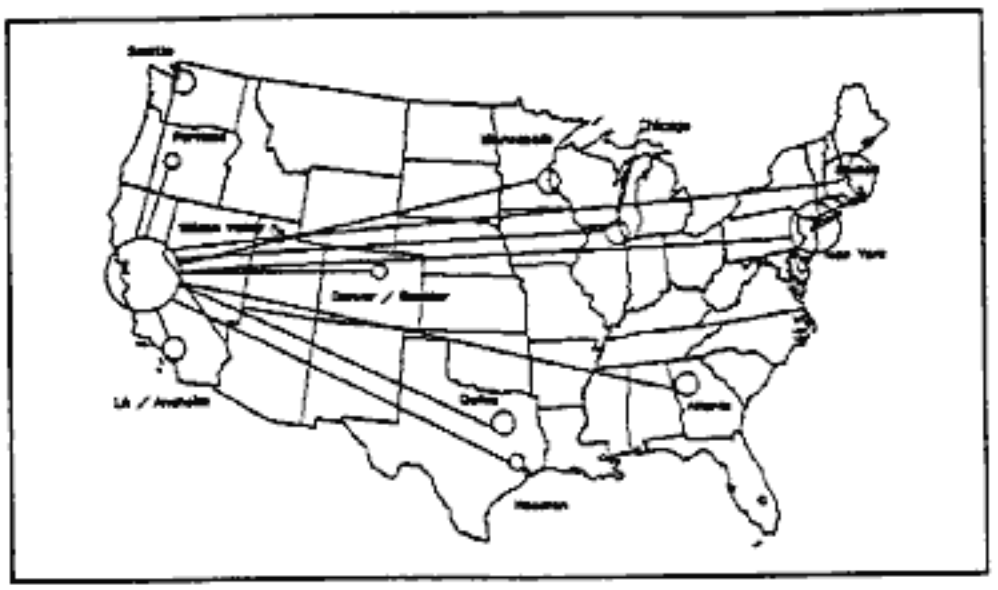
Table 2.5
Investment Patterns for Leading MSAs
Number of Investment Decisions, 1983-1987.

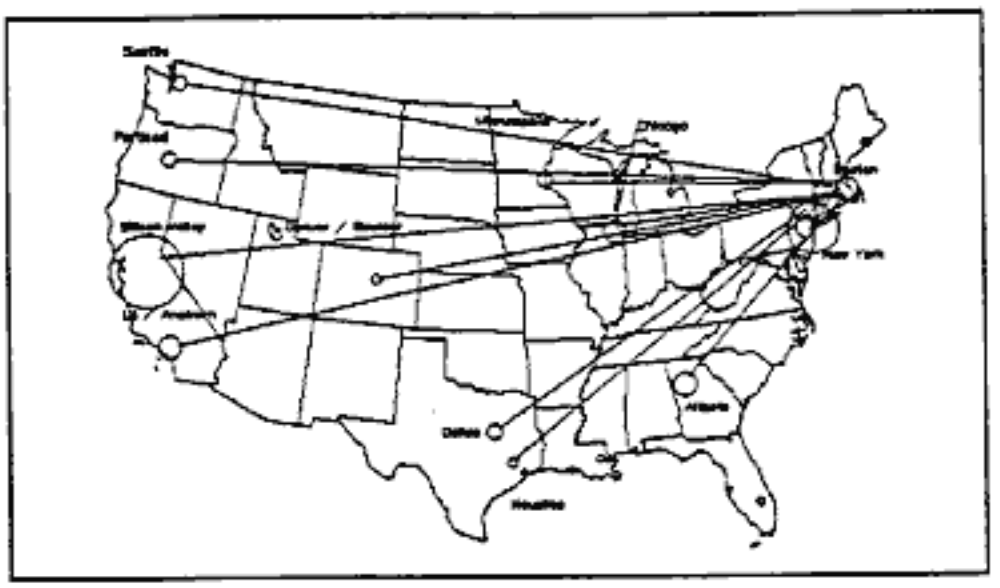
Destination of investment	San Francisco	New York	Boston	San Jose	Chicago	Los Angeles	Total
San Jose, CA	845	340	191	255	41	54	2462
Boston, MA	95	165	295	18	33	5	884
San Francisco, CA	144	66	37	43	11	6	441
Dallas, TX	45	43	29	13	6	7	313
Oakland, CA	107	24	15	36	2	9	304
San Diego, CA	64	38	26	24	5	15	335
Portland, OR	68	38	20	18	7	8	253
Anaheim, CA	48	30	24	12	5	31	265
Minneapolis, MN	1	12	9	3	6	9	210
Boulder, CO	57	16	15	11	19	2	244
Los Angeles, CA	26	31	14	6	9	29	196
Houston, TX	27	20	5	4	14	1	158
Seattle, WA	50	21	8	1	7	2	186
New York, NY	8	49	8	10	5	2	149
Chicago, IL	2	8	4	3	46	0	99
Other	312	373	346	115	104	63	
Total for MSA	1899	1274	1046	572	320	243	
Percent inside MSA	7.6	3.8	28.2	44.6	14.4	11.9	
Percent in San Jose or Boston	62.7	46.7	51.4	61.5	27.2	30.5	

NOTE: There were 9326 total investment decisions for the period
SOURCE: *Venture Capital Journal* (various years)

VENTURE CAPITAL COINVESTMENT

Coinvestment is an important aspect of the venture capital industry. It allows venture capitalists to diversify their investment portfolios, pool risk, and make investments outside new particular locations. Coinvestment patterns for the three most active states, California, New York, and Massachusetts, are outlined in Table 2.6. New York venture capitalists, for example, coinvest frequently with California (3,434) and Massachusetts (1,004) venture capitalists, using these outside coinvestments to participate in investments initiated and supervised by hands-on venture capitalists in Silicon Valley and Route 128. Massachusetts venture capitalists coinvest frequently with California (1,941) and New York (1,004) venture capitalists. While California venture capitalists also coinvest frequently with their counterparts in New York and Massachusetts, they engage in a much higher level of internal coinvestment placing more than





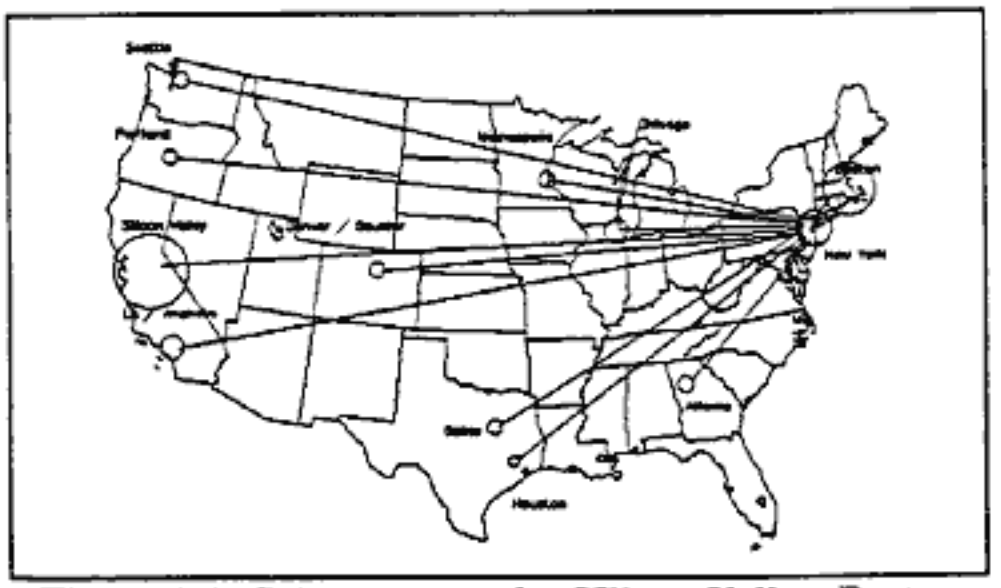


Figure 2.4: Coinvestments by SIlicon Valley, Boston and New York Venture Capitalists in Leading MSAs.

12,000 investments with other California venture capitalists. High levels of networking, investment pooling, and local investment among California venture capitalists further illustrate the embeddedness of venture capital in the Silicon Valley high-technology complex. Detailed maps of coinvestment flows at the MSA level for San Jose (Silicon Valley), New York, and Boston are provided in Figure 2.4. These maps indicate that the same general patterns hold at the MSA level.

Table 2.6
Venture Capital Coinvestments by Leading States

State	CA	NY	MA	CT	IL	TX	MN	CO
California	12884	3434	1941	1232	404	540	286	251
New York	3434	3134	1004	649	261	274	107	106
Massachusetts	1941	1004	2420	347	204	211	125	57

Source: *Venture Capital Journal* (1983-1987)

SUMMARY

Generally speaking, the geography of the venture capital industry can be understood in the following manner. Venture capital originally grew up around established concentrations of financial institutions where resources were plentiful. This is in line with traditional geographic theory which suggests that established concentrations of finance incubate new forms of financial services. However, over time, venture capital emerged within the new outposts of high-technology industry. It did so as the more general processes of regional technological and industrial development accelerated the process of regional capital accumulation, thereby generating significant indigenous pools of capital. The nature of the venture capital process enhanced this spatial shift. The uncertain, high-risk nature of venture investing required local financiers to identify, monitor, supervise, and assist with investments. Local venture capitalists reduce investment risk and compensate for ambiguous information by providing specialized knowledge, supervision, and hands-on assistance in their investment. These specialized knowledge, assistance, and investment functions are in turn enhanced by proximity and/or access to local high-technology networks. As new venture capital centers developed near regional high technology, the venture capital industry as a whole took on an increasingly specialized and spatially differentiated form. A network system developed connecting venture capitalists in regional high-technology complexes to their counterparts in leading financial centers. Ultimately, the geography of venture capital system developed over time as a network system with increasing geographic specialization of functions.

CHAPTER 3

VENTURE CAPITAL LOCATION AND INVESTMENT

This chapter examines the factors that affect venture capital location and investment. It presents the results of a series of empirical models which were developed to test hypotheses regarding the spatial dimensions of venture capital location and investment. The venture capital location model tests the hypothesis that the location of venture capital is determined by both the concentration of high-technology business and the concentration of financial resources. The venture capital investment model tests the hypothesis that venture capital investment is drawn to major concentrations of high-technology business. The main conclusion of this chapter confirms that venture capital is a central component of an area's technological infrastructure -- a special form of an agglomeration economy composed of specialized economic, technological, and financial networks which support high-technology industrial and technological development. The models are estimated at the MSA level to avoid the ambiguity or aggregation problems that might come from state or regional level data. The models are cross-sectional and drawn across two separate years.

VENTURE CAPITAL LOCATION MODEL

The location model examined the factors that affect the location of venture capital funds. The dependent variable (LOCATE) is operationalized as the number of venture capital offices in an MSA. While we would have preferred to run two models of venture capital location -- one using offices, the other using the dollar volume of venture capital resources they control -- it was impossible to obtain reliable data on venture capital resources at anything below the state level. There are four independent variables in the model: a measure of the size of the overall banking or financial sector (FINCAP), a measure of the presence of high-technology industry (HTEMP), a measure of venture capital coinvestment (NETWORK), and a measure of transportation access (TRANS).

The variables in the model are based on the following sources. HTEMP is based upon U.S. Small Business Administration (SBA) data which are a revised version of the Dun and Bradstreet data for 1984-86. Much has been written about the limitations of the Dun and Bradstreet data, particularly with respect to inaccurate representation of firm births and firm deaths. The SBA data have been updated and revised to minimize these biases. These data are the best available at present, and there is no evidence that the errors in the data are geographically biased. Therefore, the effect of these errors on the geographic, econometric analyses is likely to be small, and appear in the form of "white noise," rather than any systematic bias. FINCAP is based on data from the Federal Deposit Insurance Corporation for the period 1984-1986 and covers the total population of commercial banks in the United States. Data on financial assets held by other types of financial institutions are unavailable at the MSA level. The volume of commercial bank deposits covers roughly 70 percent of non-equity

financial assets held in the United States (U.S. *Statistical Abstract*, 1986). TRANS is based upon data provided by the Federal Aviation Administration (FAA) for the period 1984-86. Descriptive statistics for the variables are presented in Table 3.1.

A measure of the high-technology base (HTEMP) is included in the model to explore the relationship between venture capital and high-technology industry. This variable is measured as total high-technology employment in a metropolitan statistical area (MSA) for 1984 and 1986. We define high-technology employment using the U.S. Bureau of Labor Statistics "hybrid" definition, which combines two measures of high-technology intensity: the ratio of R&D expenditures to sales and the percent of the labor force who are scientists and engineers (see U.S. Office of Technology Assessment 1984; Markusen, Hall, and Glasmeier 1986 on definitional issues related to high technology). A measure of the concentration of financial institutions (FINCAP) is included to test the hypothesis that venture capital concentrates in areas with established concentrations of financial institutions. Generally speaking, we expect that a large base of financial institutions and assets provides the capital base required for venture capitalists to raise capital for a fund. In addition, proximity to financial institutions and to large concentrations of financial assets also facilitates connections to broader financial sources which allow venture capitalists to access later stage financing provided by banks and other institutional investors. The best measure of the financial base we were able to operationalize is the amount of commercial bank deposits within an MSA.

A measure of venture capital coinvestment is used to further explore the idea that coinvestment increases venture capital investment by allowing venture capitalists to diversify their investment portfolios and pool risk. Venture capitalists who are well-connected to local and national venture capital networks are expected to attract new venture capital offices either through new fund formation or spin-offs from established venture capital funds. The coinvestment network variable (NETWORK) is measured as a cumulative count of venture capital coinvestments engaged in by venture capitalists in a given MSA.

The coinvestment variable requires some additional clarification. For example, when venture capitalist x from MSA A participates in an investment with two other venture capitalists, venture capitalist y from MSA A and venture capitalist z from MSA B, this is counted as four coinvestments for MSA A (one between x and y, one between y and x, one between x and z, and one between y and z), and two for MSA B (one between z and x, and one between z and y). These data are measured from 1981 to the year in question to minimize contemporaneous correlation between coinvestment totals and the number of deals completed in a given year. It is important to note that this is a measure of the total number of coinvestment decisions rather than a measure of investment decisions (which in the example above would count the relationship between x and y as one investment for MSA A); and further that it is measure of venture capital coinvestment as opposed to the final destination of the investment itself. The coinvestment variable is from our venture capital data base outlined above.

Table 3.1
Descriptive Statistics for
Dependent and Independent Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
LOCATE 84	2.4	10.3	0	121
LOCATE 86	2.5	10.7	0	125
INVEST 84	1.6	7.8	0	114
INVEST 86	1.3	5.4	0	68
FIN CAP 84	3557	15700.0	0	212900
FIN CAP 86	4921.7	13770.0	0	201000
HTEMP 84	17602.0	38147.0	77	373100
HTEMP 86	19512.0	41352.0	72	407900
HTSTART 84	73.0	163.0	0	1312
HTSTART 84	81.0	172.0	0	1413
R&D 84	1460.5	4954.8	0	63830
R&D 86	2223.7	6824.6	0	78300
NETWORK 84	80.7	517.7	0	6804
NETWORK 86	155.1	961.6	0	12830
TRANS 84	11286.0	20427.0	0	205700
TRANS 86	12324.0	21413.0	0	212900

N = 301

NOTE 1: All Figures based on 301 Observations

NOTE 2: No significant collinearity (> .6) is present between the independent variables, except between the TRANS and HTEMP variables, which have an .83 correlation coefficient.

A transportation access variable (TRANS) examines the importance of access to investments in determining the spatial distribution of venture capital supply. Surveys indicate that access to investments is an important consideration in the location of venture capital funds (U.S. Congress, Joint Economic Committee 1984). Given the hands-on character and proximity requirements of venture capital investing, it is important to explore to what degree venture capitalists choose locations based upon transportation accessibility to outside investments. In other words, if a venture capitalist is based in a given MSA and invests elsewhere, that venture capitalist has to be able to visit those outside investments. Thus, the home base for all operations is likely to depend upon good air transportation to many potential investment sites. Reflecting this, the transportation variable is a measure of air accessibility represented by the number of commercial airport operations (takeoffs and landings) within an MSA. This measure represents an improvement over the "hub airport" variable employed by Markusen and her collaborators (1986) in that it is continuous and that it includes non-hub airports.

The dependent variable is characterized by a large number of zero observations, as many MSAs do not have any venture capital firms. In this case, zero is the censoring point in the distribution of venture capital firms, since an MSA cannot have fewer than zero firms. However, not all MSAs with zero venture capital firms can be assumed to be equally (un)attractive locations for a venture capital firm to locate. Attempting to estimate a model with data from a censored distribution using ordinary least squares regression would result in biased estimates for the parameters. However, the TOBIT method of estimation is designed to yield consistent estimates in the case of a censored regression. It does so by estimating a two-part likelihood function, taking into account the likelihood of being above zero and estimating the parameters in those cases. To better understand the nature of our limited dependent variable, envision a normal distribution. Then, place a lower limit of zero on the distribution, which slices all observations below that point and reports them as a zero observation. Hence, we have data on y, the observed data, and wish to make inference about y*, the unrevealed true distribution. We observe $y = y^*$ for $y^* > 0$, and $y = 0$ for $y^* <= 0$. TOBIT estimates both the effect of a variable on the probability of being above the zero censoring point and the effect on the positive observations of y (in this case either the number of venture capital offices or investments). The likelihood function is as follows:

$$L = \prod_{0} [1 - \phi(x'\beta/\sigma)] \prod_{>0} \sigma^{-1}\phi[y_i - x'\beta/\sigma]$$

We used Limdep version 5.1 to perform the estimation. Limdep uses the iterative, Newton method of maximum likelihood estimation of the parameters. The model of venture capital location that was estimated is specified as follows:

1.1 $LOCATE = B_0 + B_1*FINCAP + B_2*HTEMP + B_3*NETWORK + B_4*TRANS + E_i$

where B's are coefficients to be estimated and E is the disturbance (or error) term.

VENTURE CAPITAL INVESTMENT MODEL

A second model explored the factors that affect the geographic distribution of venture capital investment. It examined venture capital investment in light of the underlying high-technology base, the local supply of venture capital, and the presence of venture capital networks. This model also operates at the MSA level for the years 1984 and 1986. The model was set up as a recursive, simultaneous system with the location equation, in order to separate out the direct effects of the independent variables on investment from the indirect effects that work through the location variable.

The dependent variable in the model is the number of venture capital investments (INVEST). The investment data were compiled from information on venture capital investment published in *Venture Capital Journal*, the monthly trade journal of the venture capital industry. The venture capital data cover the period 1982-1987; however, limitations in the data used for the independent variables made it necessary to limit the analysis to the years 1984 and 1986. The venture capital data comprise a representative (40-45 percent) sample of all venture capital investments made by institutional venture capital intermediaries over the study period according to Venture Economics, the organization that collects the raw data.

Although we would have liked to run two models, the first on the number of investments, and a second on the dollar volume of investments, the data are unavailable. There are a significant number of missing observations on the dollar volume of venture capital investments. Furthermore, using the number of investments avoids the bias imparted by a measure of the dollar volume of investments or dollar volume per transaction which may be skewed toward a small percentage of large-scale financing, e.g., leveraged buy-outs of existing companies, which are not representative of the startup investments associated with venture capital. Ultimately, what we want to measure is the level of venture capital activity, not the size of the deals being financed. Thus, the number of investments is the most appropriate measure.

The investment model includes the following independent variables. Three separate measures are included to capture the high-technology base: high-technology employment (HTEMP), high-technology startups (HTSTART), and industry-funded R&D at universities (R&D). Together, these variables examine the flow of venture capital toward established concentrations of high-technology industry. High-technology employment provides an overall measure of the size of the high-technology sector. High-technology startups are a more specific measure of potential investment opportunities; we expect that the number of actual investments will be a function of potential investment opportunities. These two variables are adapted from the SBA data, and as such suffer from some limitations. The limitations of the startup data are more severe, given the underreporting of new firms which are not captured in Dun and Bradstreet's credit ratings and the overcounting of change of ownerships as new starts. However, both phenomena are unlikely to be geographically correlated, and as such are not likely to impart systematic bias to the results. The limitations of the data can reasonably be assumed to amount to adding white noise to the model.

The R&D variable is defined as industry-funded R&D at universities, in order to capture potential university-based spill-overs to commercial technology development (see Jaffe 1989). In addition, such R&D expenditures contribute to the development of the underlying technological base and supply of scientific and technical labor power, and thus are part of the broader infrastructure for innovation and new technology development. The R&D variable is based on data reported by the National Science Foundation on university R&D, and is the best available measure of R&D at the MSA level. The number of venture capital offices (LOCATE) is included to test the hypothesis that venture capitalists invest locally. This is the same as the dependent variable in the location model. Venture capital coinvestments (NETWORK) are used to explore the relationship between venture capital networks and investment. We expect that venture capital centers that have a high level of coinvestment will be more active investors.

A transportation access variable (TRANS) tests the hypothesis that accessibility influences venture capital investment. Survey research suggests that venture capitalists frequently visit their investments (U.S. Congress, Joint Economic Committee 1984). Furthermore, the need for access is heightened due to the information-intensive and interactive nature of venture capital investing, where financiers provide managerial assistance as well as capital. It is also expected that investments are less likely to be discovered in areas that have relatively poor transportation access and when discovered are likely to pose significant opportunity and transaction costs for investors thereby reducing their attractiveness.

The investment model is specified as follows: venture capital investment (INVEST) is a function of (1) the size of the high-technology employment base (HTEMP), (2) the number of high-technology startups (HTSTART), (3) the amount of industry-funded R&D at universities (R&D), (4) the number of venture capital offices (LOCATE), (5) venture capital coinvestments (NETWORK), and (6) transportation access (TRANS).

The model is specified as a of recursive system of equations to account for the separate effects on location and investment. The model is estimated in its reduced form and solved for the structural coefficients in order to separate the direct effect of variables on investment from the indirect effect on investment that occurs through the variables that affect the location of venture capital supply. Thus, the model is specified in terms of the following recursive system of equations; where the B's and C's are parameters to be estimated, and the E's are disturbances:

$$1.1 \quad LOCATE = B_0 + B_1*FINCAP + B_2*HTEMP + B_3*NETWORK + B_4*TRANS + E_1. \text{ AND}$$

$$2.1 \quad INVEST = C_0 + C_1*LOCATE + C_2*HTEMP + C_3*NETWORK + C_4*TRANS + C_5*R\&D + C_6*HTSTART + E2.$$

In this system, each of the dependent variables is best treated as a (censored) limited dependent variable, due to a large mass of observations that are zeroes. As such, both equations are treated as censored regressions and utilize the type-1 TOBIT procedure to estimate the

parameters via maximum likelihood estimation. Since there is some reason to suspect that the error terms are correlated, and it is likely that some of the unobserved effects picked up by the disturbance terms are indeed coincident, the TOBIT procedure is performed on the reduced forms of each equation, listed below. Since the equations are recursive in structure, standard methods for tobit estimation of each equation in isolation are appropriate only when the disturbance terms can be assumed to be uncorrelated. If they are not, then the variable, LOCATE, in the investment equation would be correlated with the disturbance term (E2) in that equation violating the conditions for consistency.

1.2 $LOCATE = B_0 + B_1*FINCAP + B_2*HTEMP + B_3*NETWORK + B_4*TRANS + E_1.$

2.2 $INVEST = C_0 + C_1*[B_0 + B_1*FINCAP + B_2*HTEMP + B_3*NETWORK + B_4*TRANS + E_1]$
$+ C_2*HTEMP + C_3*NETWORK + C_4*TRANS + C_5*R\&D + C_6*HTSTART + E_2.$

This reduces to:

2.3 $INVEST = (C_0+(C_1B_0)) + (C_1B_1)*FINCAP + (C_1B_2+B_2)*HTEMP + (C_1B_3+C_3)*NETWORK$
$+(C_1B_4+C_4)*TRANS + C_5*R\&D + C_6*HTSTART + (C_1E_1 + E_2).$

Using Gs for the reduced form parameters and V for the reduced form disturbance yields:

2.4 $INVEST = G_0 + G_1*FINCAP + G_2*HTEMP + G_3*NETWORK + G_4*TRANS + G_5*R\&D +$
$G_6*HTSTART + V.$

Statistical theory tells us that consistent estimators of parameters that are continuous functions of other, consistently estimated parameters are obtainable from continuous functions of the estimators of those parameters. We obtain estimates for the G coefficients. However, it is the C coefficients that are the parameters of interest. Noting that $G_1 = C_1*B_1$ is a continuous function, and that we have consistent estimates of the parameters G_1 and B_1 from TOBIT estimation applied to the first equation and the reduced form of the second equation, we obtain a consistent, asymptotically efficient estimator for C1 by dividing the estimator of G1 by the estimator of B1. Similarly, we solve uniquely for each of the other parameters of interest, namely the structural parameters of the investment equation (the C's). Estimated standard errors for the structural coefficients in the investment equation are obtained using the Delta Theorem for continuous functions of consistent estimators.

RESULTS OF THE LOCATION MODEL

The main findings for the venture capital location model are presented in Table 3.2. The model performed well, and the findings are robust. The results suggest that the geography of venture capital supply is driven by the following factors: first, the spatial distribution of venture capital supply is related to the size of the existing financial base, specifically by the volume of bank assets. This confirms the hypothesis that venture capital is concentrated near established financial centers. Here, we conclude that a relatively large concentration of financial assets and institutions provide the capital base required to raise a venture capital fund. In addition, a significant number of venture capital funds in large financial centers like New York and Chicago are divisions of large financial institutions or spin-offs from those institutions. Proximity to financial institutions and to large concentrations of financial assets also allows venture capitalists to access the sources of later stage financing provided by banks and other institutional investors.

Second, and not surprisingly, the location of venture capital funds is positively related to high-technology employment. The model thus confirms the hypothesis that venture capital is located near high-technology industry. We attribute this to the specialized, information-intensive and transaction-intensive nature of venture capital activity, particularly the hands-on nature of venture capital investment in high-technology industry. This further suggests that venture capital and high-technology industry are mutually reinforcing.

Table 3.2

Results of Venture Capital Location Model

Variable	Year	Coefficient	Standard error	t-ratio
FIN CAP	1984	0.00035	0.00003	11.225
	1986	0.00031	0.00003	11.998
HTEMP	1984	0.000055	0.000013	4.290
	1986	0.000035	0.000012	3.013
NETWORK	1984	0.011480	0.000681	16.854
	1986	0.006483	0.000350	18.537
TRANS	1984	-0.000001	0.000026	-0.049
	1986	0.000032	0.000024	1.356
INTERCEPT	1984	-5.833	0.57789	-9.315
	1986	-4.344	0.55051	-7.891
SIGMA	1984	4.753	0.35878	13.248
	1986	4.574	0.34349	13.317

Third, the spatial distribution of venture capital supply is strongly related to linkages to and networks with outside venture capitalists. Ties to outside venture capitalists matter in location decisions, as venture capital funds locate in proximity to others that are well-integrated in national networks or near other funds with which they have coinvested before.

Fourth, the transportation variable is not related to the spatial distribution of venture capital supply. This coefficient is insignificant and negative in the 1984 sample, and it is insignificant and positive in the 1986 sample. This implies that transportation access is not an important factor in venture capitalists' location decisions. However, we are cautious in interpreting this result. The analysis indicates some degree of correlation between the variables TRANS and HTEMP. This type of collinearity can affect the statistical significance of the estimates. However, it does not affect the consistency of the estimates, and the coefficients have opposite signs in the two equations. Thus, collinearity alone cannot explain the seemingly anomalous result. This result may reflect the limitations of our departures and arrivals data and we are willing to entertain the notion that a more robust variable -- perhaps flight time weighted by MSA -- might yield a different result. However, given our understanding of the venture capital industry and the previous analysis of venture capital coinvestment patterns, we conclude that transportation access is mitigated by the coinvestment process. Simply put, the need for access is minimized because the venture capitalists who are located close to the investments act as lead investors, allowing the remainder to participate as long distance investors.

RESULTS OF THE INVESTMENT MODEL

The results of the venture capital investment model are portrayed in Table 3.3. This model also performed well, and the findings are again robust. First, venture capital investment is positively related to the high-technology industrial base. All three measures, high-technology employment, high-technology startups, and industry-funded R&D at universities, are positive and significant for both 1984 and 1986. This confirms the hypothesis that venture capital flows to specialized centers of high-technology industry.

Second, venture capital investment is positively related to the level of venture capital coinvestments in an area. Venture capital investment is stimulated by a highly networked venture capital community which provides access to outside capital. Such networks help venture capitalists identify investments and obtain access to outside capital.

Third, transportation access is not significantly related with venture capital investment. It is negative and the estimated coefficient has a very small t-ratio. This indicates that access does not effect venture capitalists' investment decisions and that transportation access does not appear to affect the flow of venture capital across space. This apparently contradicts the findings of survey research which indicate that venture capitalists' have a preference for proximity. The lack of significance of this variable might also be explained, in part, by the significant degree of collinearity between TRANS and the high-technology variables HTEMP and HTSTART. However, we conclude that this lack of significance can be explained as the outcome of the

coinvestment process, where lead investors identify, monitor and provide hands-on assistance to new ventures, loosening the overall spatial constraint, while confirming the need for proximity. These lead investors are embedded within the local technological infrastructure, and as such can access tacit information and provide the face-to-face contact required to reduce investment risk for themselves and for other, external investors. Given the variables' lack of significance in any of the models, the models were re-run excluding the TRANS variable. While the magnitudes of the coefficients changed slightly, their signs and significance were unchanged in all cases.

Table 3.3
Results of Venture Capital Investment Model

Variable	Year	Coefficient	Standard error	t-ratio
HTEMP	1984	0.000161	0.000087	1.851
	1986	0.000101	0.000046	1.198
HTSTART	1984	0.044369	0.013037	3.403
	1986	0.020756	0.009280	2.237
R&D	1984	0.000292	0.000131	2.235
	1986	0.000199	0.000071	2.798
VCLOC	1984	-0.83523	0.209000	-3.996
	1986	-0.52427	0.134600	-3.895
NETWORK	1984	0.016415	0.003330	4.929
	1986	0.006617	0.000750	8.780
TRANS	1984	-0.000160	0.092700	-0.0021
	1986	-0.000053	0.000049	-1.1300

Fourth and perhaps most significantly, venture capital investment is not related to the distribution of venture capital supply. The coefficients for the location of venture capital offices are negative and significant in both samples. Thus, venture capital investment is not determined by the location of venture capital funds, contradicting both the conventional wisdom and academic theory and the underlying rationale for public policy intervention -- that local venture capital supply generates local venture capital investment, leading ultimately to high-technology economic development. This reflects the operation of the venture capital network as coinvestment loosens the spatial constraint on venture capital investing. While we would expect this result to be statistically insignificant, the negative result is a bit surprising. A number of factors drive this result. Part of the explanation lies in the high level of venture capital exported from New York and Chicago. Furthermore, while Boston area and Silicon Valley venture capitalists do invest a higher percentage of their capital locally, venture capitalists in both areas,

especially the Boston-Route 128 area, do export some of their capital. This result also reflects the fact that Silicon Valley is comprised of a series of separate MSAs. Here, the model may be picking up the local export of capital from San Francisco based venture capitalists to investments in the San Jose, Santa Clara, and Santa Cruz MSAs.

SUMMARY

Research on venture capital has suggested that venture capital is unevenly distributed, that it is clustered in so-called high-technology innovation complexes, and that it has a catalytic effect on the development of such complexes. The research presented here confirms some aspects of the conventional wisdom, contradicts others, and sheds new light on the geography of venture capital supply and investment.

This chapter's findings indicate that venture capital supply clusters around concentrations of financial institutions and assets, concentrations of high-technology industry, and the presence of venture capital coinvestment networks. Venture capital investment is significantly related to concentrations of high-technology businesses and employment and venture capital coinvestment. It is not, however, related to the existence of venture capital supply. This contradicts a major notion in the literature which suggests that a local supply of venture capital leads to high-technology development. It also contradicts the underlying premise upon which much public policy in this area rests, that gaps in the venture capital supply are a major reason for the lack of high-technology development in certain places.

The findings of this chapter inform the interesting conclusion that venture capital is both highly mobile and highly local. On the one hand, venture capital investment flows to the areas of greatest opportunity and return on investment; this is exactly as economic theory would predict. On the other hand, we note the development of specialized sources of venture capital supply around both established financial centers and centers of high-technology industry, which is in line with theories of agglomeration and regional specialization (Krugman 1991a, b). The demand for venture capital is regionally specialized and geographically concentrated, as venture capital flows mainly toward high-technology industry in established high-technology regions. Geographic proximity is required to reduce uncertainty, compensate for imperfect and ambiguous information, and minimize investment risk. Venture capital coinvestment facilitates long-distance capital flows and in doing so loosens the spatial constraint on venture capital investment. Capital mobility occurs, not through the operation of a free market, but through the network structure of the venture capital industry which is strongly rooted in specific places. In contrast to the economist's view that capital is abstract and perfectly mobile, venture capital is characterized by strong geographic effects.

It is important to point out that the geographic structure of the venture capital industry developed gradually over time. Capital was initially mobilized and provided by actors located in or around existing financial centers (e.g., New York and Chicago). The growth of new regional centers of high technology created both the demand and the indigenous capital base to

support local venture capital institutions. Venture capital emerged within the context of the general developmental trajectory of U.S. high technology, moving from a source of outside finance capital to become a central element of the technology infrastructures of emerging high-technology complexes. A set of linkages and networks then developed connecting the various nodes and peripheries in an integrated venture capital system of information sharing and investment flows. A complex network system of institutions thus evolved with increasing specialization of functions over time.

This chapter also sheds light on the broader processes of capital formation, investment, and regional development. It suggests that the processes of regional industrialization and capital formation are cumulative and self-reinforcing. New mechanisms for providing capital emerge alongside new technologies and new industries as part of the more general development process. Successful waves of innovation and regional industrial development feed the development of larger pools of local capital, which are in turn reinvested in new rounds of innovation and industrial development. Here, the fundamental insights of Schumpeter (1934) regarding the relationships between technological change, finance, and economic development are important. We place them in an explicitly spatial context. Major technological changes and/or shifts in the organization of production set in motion a regional economic take-off, creating the expanding economic base, vibrant investment climate, and opportunities for regional capital accumulation. The initial opportunities are filled by financiers and investors in established financial centers especially given the well-developed financial structure of contemporary capitalism. Yet over time, the developmental trajectory of the new regional growth complex creates a momentum of its own generating an indigenous pool of regional capital for finance and investment. The evolving regional complex is now able to finance itself and embarks on a period of self-reinforcing growth, while at the same time retaining connections to outside sources of capital and investment. Thus, the processes of regional industrialization and regional capital formation work together and in tandem over time.

CHAPTER 4

VENTURE CAPITAL, INDUSTRIAL COMPETITIVENESS, AND FOREIGN INVESTMENT

Venture capital plays an important role in U.S. industrial competitiveness. Most commentators have assured that venture capital is a key positive element in U.S. technology development and economic growth. They cite the cutting edge high-technology enterprises funded by venture capitalists and the organizing role played by venture capitalists in high-technology innovation complexes such as Silicon Valley and Route 128. However, in recent years a number of commentators and analysts have noted several negative aspects of venture capital-financed high technology. They argue that venture capital may weaken U.S. technological capabilities by contributing to the overfunding of companies and to a more general pattern of chronic entrepreneurship, as well as by reinforcing the breakthrough illusion of U.S. high technology -- an emphasis in new breakthrough innovation at the expense of follow through and actual manufacturing of high quality commercial products. In addition, the decade of the 1980s saw a significant increase of foreign participation in U.S. venture capital. Many politicians and analysts are alarmed at this development, viewing it as selling-off U.S. technological assets. Others, however, see foreign investment in U.S. venture capital and high technology as a useful and important source of capital for investment in U.S. capabilities.

This chapter examines venture capital's role in the industrial competitiveness of U.S. industry. It focuses on venture capital's role in the innovation process and the implications of foreign participation in venture capital for U.S. competitiveness. The information presented in this chapter is drawn from quantitative data on foreign participation in venture capital, and from case studies and interviews with venture capitalists, foreign investors, and venture capital-financed high-technology firms.

VENTURE CAPITAL'S ROLE IN THE INNOVATION PROCESS

Venture capital plays an important role in the process of technological innovation in the United States. Indeed, venture capital arose as a response to the rigidities of the mass production model of industrial organization and its heavily bureaucratized model of corporate R&D. Venture capital created a way to overcome financial and organizational barriers that held back innovation in large, mass production corporations. Venture capitalists invest in new, unproven enterprises which traditional financial institutions ignore, becoming active investors who, as a rule, get deeply involved in the management of startup firms. They sit at the center of elaborate networks linking financial institutions, large corporations, universities, and entrepreneurs and catalyze the complimentarities which exist between large and small institutions. These new agents of change formalize the role historically played by independent financiers or capitalists and help structure the innovation process -- the Schumpeterian "gales of creative destruction" that are the lifeblood of capitalism. Through this process, venture capital

has transformed the way in which innovation takes place in the U.S., helping to bring to life some of the most successful enterprises in history.

Moreover, venture capital has helped to give rise to a new model for innovation which integrates components of both elements of the entrepreneurial driven versus corporate-led dichotomy posed by Schumpeterian theory (Freeman, Clark, and Soete 1982, Florida and Kenney 1988b). Under the model of entrepreneurial innovation, individual entrepreneurs or entrepreneurial groups drive the innovation process. These actors either utilize ideas drawn from science or employ technical know-how to launch new products and forge new product markets. The technological and organizational changes brought about by these innovations generate strong bandwagon effects and stimulate an accelerated round of economy-wide activity. This leads to the creation of some industries, the revitalization of some older ones and the disappearance of still others, setting the context for economic expansion.

Under the more traditional corporate model of innovation, large corporations organize the R&D process and hence control much innovative activity. These corporations use internal R&D to remain at the forefront of new technology and to generate successive waves of innovation. According to Freeman et al., this creates "a strong positive feedback loop from successful innovation to increased R&D activity, setting up a virtuous self-reinforcing circle" (Freeman, Clark, and Soete 1982: 41). The internalization of R&D and innovative activity within large corporations makes the technological change a less sporadic, more continuous process.

Venture capital has helped to spur a symbiosis or a complimentarity between large and small corporations. While large corporations and universities establish the scientific base and technological context necessary for major innovations and to some extent function as "incubator organizations" for technological change (Freeman, Clark, and Soete 1982; Rothwell 1983, 1984; Friar and Horwich 1986), these technological opportunities are not exploited by them but by the more agile and risk-taking small entrepreneurial companies. These two kinds of firms interplay through direct channels such as circulation of personnel and attendant transfers of technological and managerial capabilities (Roberts and Hauptman 1985), as well as through indirect channels such as informal exchanges of information, research literature, and professional relations among manufacturers, suppliers, and vendors.

Venture capitalists are crucial for this new type of innovation process because they are situated at the center of the overlapping networks and are able to reach into large corporations, universities, financial institutions, and a variety of other organizations. This enables them to help to overcome a variety of financial, technological, and organizational barriers which stymie technological progress. They bypass the risk aversion of established financial intermediaries and the organizational inertia and extreme specialization of large corporations, and help entrepreneurs solve the multifaceted technological, organizational, and financial requirements of new business development. Because of the central position they occupy in the innovation process and the intensive flows of information at their disposal, venture capitalists are able to identify critical barriers or discontinuities, to reduce uncertainties over the adoption of critical

new technologies, and to fashion the requisite set of organizational adaptations to bring such innovations to fruition. While only a small subset of all venture investments ultimately pay off, the most important choices or technology bets made by venture capitalists in fields such as semiconductors, microcomputers, and biotechnology have disrupted existing socio-technical trajectories and opened up whole new frontiers for technological progress, setting the stage for clusters of imitative activity and swarms of incremental innovations.

LIMITS OF VENTURE CAPITAL

Despite all the contributions of venture capital to U.S. high technology, it must be recognized that the U.S. model of venture capital-financed innovation is also beset by a series of limits and weaknesses. First, the U.S. model of venture capital-financed innovation is characterized by a process of chronic or hyper-entrepreneurship, evidenced in the continuing proliferation of small high-technology firms which lack the resources and the scale to be globally competitive. According to the U.S. Small Business Administration, more than 100,000 high-technology startups were launched between 1976 and 1986 (roughly 10,000 per year). Data from Venture Economics indicates that more than 1,300 venture capital-backed companies were launched in 1988 alone. This chronic entrepreneurship is in turn caused by extraordinarily high rates of employee turnover and defection or hyper-mobility. Labor mobility is exacerbated by the actions of so called "vulture capitalists" -- venture capitalists who actively raid existing companies (Wilson 1985). It has further been suggested that the recent increase in the venture capital pool has caused venture capitalists to fund a relatively large number of duplicative copy-cat companies which duplicate each other's efforts, create increased market pressures, and dilute the overall supply of human resources (Sahlman and Stevenson 1985). The combination of hyper-mobile external labor markets and a hyper-entrepreneurial pattern of new business formation has shaped a process we refer to as the externalization of innovation, whereby new companies become the vehicles for the development and implementation of new technologies. This developmental pattern is the reverse of the previous pattern of growing scale and internalization of innovation associated with both Schumpeter and product cycle theories of industrial development.

Second, the model of venture capital-financed high technology is characterized by a high degree of industrial fragmentation which makes it difficult for firms to generate hybrid innovations via the combination of two or more discrete technologies, or larger systems innovations such as high-definition television, which requires the development of a combination of unrelated technologies (e.g., semiconductors, optical devices, cameras, receivers, antennae, satellites, and transmission systems) (U.S. Semiconductor Industry 1989).

Indeed, the extreme organizational fragmentation and hyper-competition found in Silicon Valley and Route 128 contrast sharply with the idealized model of flexible specialization (Piore and Sabel 1984). Luigi Mercurio, president of David Systems Inc. from Silicon Valley, characterized the Valley as a dynamically innovative market economy driven by the potential to realize huge profits, drawing a sharp contrast to traditional European industrial districts -- such

as those that can be found in Italy and Germany -- which he saw as an old world economy, where a legacy of family and community provided stability and an environment of long term cooperation. U.S. high-technology industrial organization is, if anything, characterized by too much flexibility and too much specialization, lacking a broader context of stable social institutions as found in the European industrial districts. Also, the overspecialization of the U.S. model is a source of fragmentation and hyper-competition: a sign of structural weakness rather than strength.

Third, the U.S. model of venture capital financed high technology suffers from a systemic neglect of manufacturing and an extreme separation of the sites of innovation and production. This is evident in: (1) growing attempts to automate production to eliminate high-technology production workers, (2) the extreme low wages ($4.75 to $8.00 per hour) and insecure employment conditions, (3) pre-Fordist sweatshop conditions found in many U.S. high-technology manufacturing plants, (4) the absence of unions in high-technology plants and the extreme anti-union position of most high-technology firms, and (5) the increasing use of third world branch plants and subcontractors to manufacture and assemble high-technology products (Early and Wilson 1986; Sayer and Morgan 1987). In 1985, for example, U.S. semiconductor firms employed 150,000 foreign factory workers and just 115,000 domestic production workers; recent estimates place the Asian share of subcontract manufacturing in excess of 60 percent of all subcontract manufacturing undertaken by U.S. semiconductor firms (Alic and Harris 1986; Hayashi 1988). The neglect of manufacturing recreates the separation of innovation from production found in traditional mass-production industry, making it extremely difficult to turn new breakthrough innovations into a continuous stream of high-technology products. The end result is that although the U.S. model of venture capital-financed high technology continues to generate important new breakthroughs, it is particularly inept at technological follow-through.

FOREIGN INVESTMENT IN VENTURE CAPITAL

Foreign investment in high-technology enterprises and venture capital in the U.S. grew considerably during the 1980s. The available data show that the involvement of foreign investors in both U.S. venture capital funds and the direct acquisition of high-technology firms in this country grew significantly over the past decade. This is not surprising, as the American venture capital sector is by far the most effective in the world, having helped to launch a number of extraordinarily successful high-technology companies in the late seventies and early eighties, including Apple, Intel, Microsoft, DEC, and Genentech. American entrepreneurs have also shown a singular ability to develop the kind of technologies that are capable of creating whole new markets from scratch, or revolutionizing the old. It is only natural that foreign investors would want to gain access to these opportunities.

Foreign involvement in U.S. venture capital and high technology received wide coverage in the media and provoked negative reactions from some observers, who argued that foreign investment transfers leading edge technologies from the U.S. to its global competitors, particularly to the Japanese. Others countered, however, that foreign investment provide much needed capital for high-technology innovation and development.

Table 4.1 presents the number of foreign acquisitions of U.S. high-technology firms between October 1988 and April 1992 (Spencer 1992, as cited in Broz et al. 1993). As these data show, Japanese investors were by far the most active of all, with roughly two-thirds (65 percent) of the total. The Japanese were the leaders in all the sectors examined. Their preferred investment options were computers, telecommunications, advanced materials, semiconductors, chemicals, and electronics. British investors occupied a distant second place, with 15 percent of the total.

Table 4.1
Foreign Acquisition of U.S. High-Technology Firms
1988 - 1992

	Japan	U.K.	France	Canada	Taiwan	Germany	Switz-erland	Austra-lia	South Korea	Nether-lands	Total
Number of firms											
Advanced Materials	40	11	2	0	1	0	1	2	0	1	63
Aerospace	19	5	4	3	0	1	0	0	0	0	32
Chemicals	25	6	11	3	0	4	1	0	0	1	54
Computers	93	13	8	4	8	0	3	1	3	1	142
Electronics	33	10	2	1	0	1	0	1	1	0	56
Semiconductor equip.	30	1	2	0	0	1	1	1	0	0	39
Semiconductors	51	1	2	1	1	3	0	0	0	0	60
Telecommunications	31	13	5	2	1	3	3	2	0	0	64
Biotechnology	17	2	2	0	0	2	3	0	0	0	27
Other	60	3	3	0	0	2	2	0	0	0	71
Totals	399	65	41	14	11	17	14	7	4	3	608
Percentage of total											
Advanced Materials	63	17	3	0	2	0	2	3	0	2	100
Aerospace	59	16	13	9	0	3	0	0	0	0	100
Chemicals	46	11	20	6	0	7	2	0	0	2	100
Computers	65	9	6	3	6	0	2	1	2	1	100
Electronics	59	18	4	2	0	2	0	2	2	0	100
Semiconductor equip.	77	3	5	0	0	3	3	3	0	0	100
Semiconductors	85	2	3	2	2	5	0	0	0	0	100
Telecommunications	48	20	8	3	2	5	5	3	0	0	100
Biotechnology	63	7	7	0	0	7	11	0	0	0	100
Other	85	4	4	0	0	3	3	0	0	0	100
Totals	66	11	7	2	2	3	2	1	1	0	100

Note: October 1988 through April 1992
Source: Spencer 1992

Table 4.2 shows the degree of ownership acquired by foreign investors. The data show that foreign investors seeked to attain control (measured as majority ownership) in more than half of all the firms acquired between 1988 and 1992. However, and in contrast to the conventional wisdom, Japanese investors showed greater willingness to become involved in non-majority owned high-technology enterprises (Spencer 1992).

Table 4.2
Minority vs. Majority Ownership by Foreign Firms Investing in U.S. High-Technology Firms
October 1988 - April 1992

	All firms	Japanese firms
Number of investments resulting in majority ownership	319	189
Number of investments resulting in a minority ownership	203	162

Source: Spencer 1992

Despite warnings about the threat posed by foreign investment in high-technology firms, the available data show that the size of this kind of investment peaked by the end of the 1980s and has been falling during the 1990s. This was due to the general recessionary climate and the perception of relative decay of U.S. competitiveness as a location for high-technology investment. As Figure 4.1 shows, the number of foreign acquisitions of U.S. venture-backed companies fell from a high of 33 in 1989 to just eight in 1991, considerably lower than at any point since 1987 (Devlin 1992a, as cited in Broz et al. 1993). Moreover, the importance of foreign investors in the pool of capital raised by private venture funds has also decreased substantially (Table 4.3). The participation of foreign investors in total capital raised peaked in 1985 (23 percent) and the actual size of the annual new capital committed by them peaked in 1987 with $586 million. In 1991, foreign investors contributed just $140 million, or 11 percent of the total pool. The data indicate that foreign investors are pulling back in their commitments to U.S. venture capital.

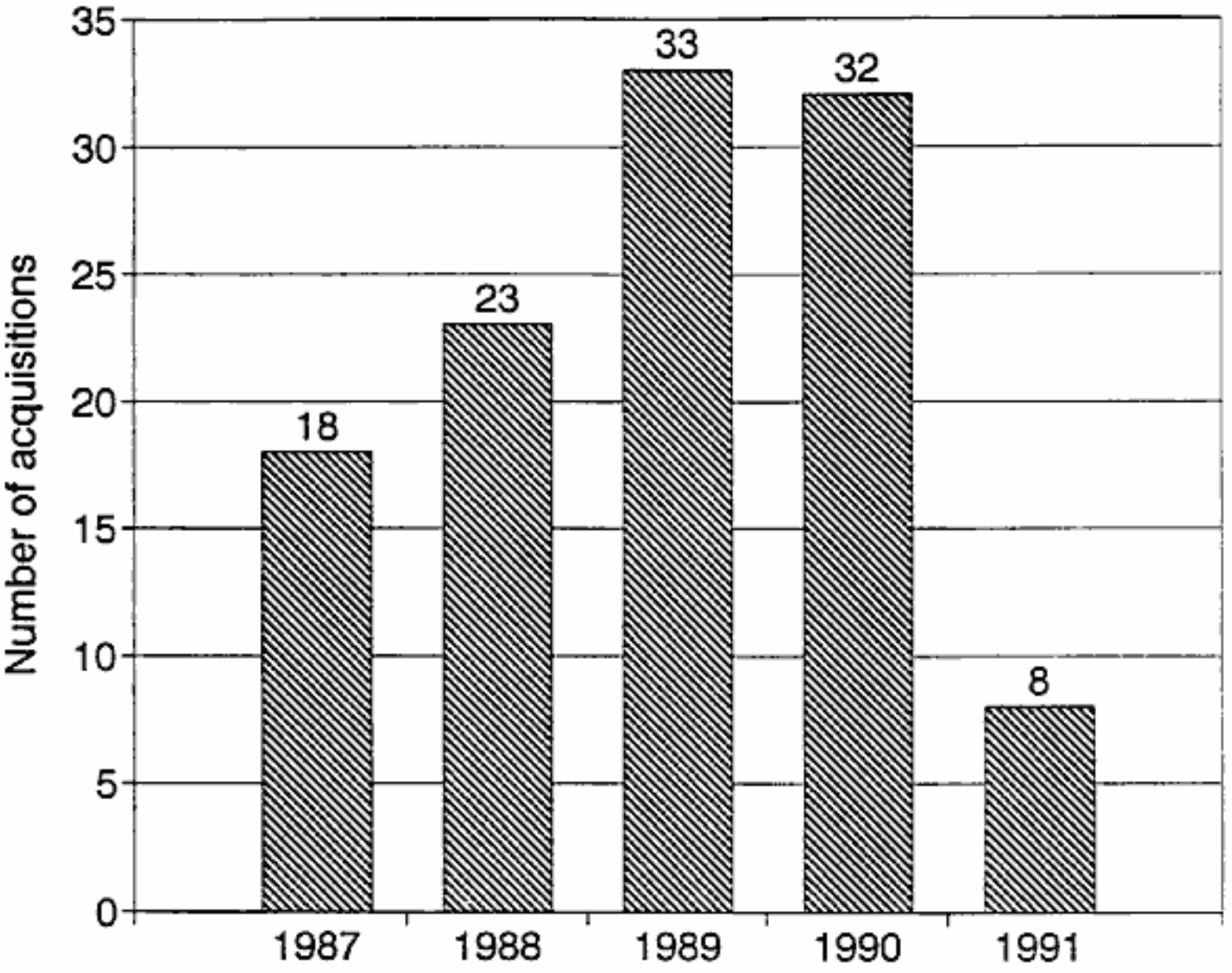


Figure 4.1: Foreign Acquisition of U.S. Venture Backed Companies 1987-1991

Source: Devlin (1992)

Table 4.3
Foreign Capital Committed to
Private Venture Capital Funds in the U.S.
(in millions of dollars)

	Foreign	Total	Foreign Total (%)
1980	53	661	8
1981	87	868	10
1982	185	1,423	13
1983	554	3,460	16
1984	594	3,300	18
1985	535	2,327	23
1986	365	3,320	11
1987	586	4,184	14
1988	365	2,810	13
1989	312	2,400	13
1990	129	1,847	7
1991	140	1,271	11

Source: *Venture Capital Journal*, several issues. Sahlman (1991)

JAPANESE INVESTMENT IN U.S. VENTURE CAPITAL

The acquisition of U.S. high-technology firms by the Japanese is the focus of a heated debate. This section examines the activity of Japanese investors in the U.S. venture capital industry, as well as their acquisitions of U.S. high-technology firms during this period. The growing strength of the yen and the large amounts of cash generated by the trade surplus turned Japanese firms into powerful international investors. Their acquisitions in the United States, ranging from landmark real estate -- such as the Rockefeller Center in New York -- to art masterpieces, entertainment, and high-technology companies, were received with mixed feelings by Americans. While Japanese investment brought abundant cash, many in the U.S. felt that this wave of Japanese investment would undermine American leadership in global economic activity, particularly in technology-intensive sectors such as semiconductors and computers.

Direct investments made by Japanese corporations in high-technology companies in the U.S., as well as the participation of the Japanese in the total pool of resources used by the U.S. venture capital industry, were visible and controversial. The ability to develop breakthrough technologies was perceived as the major advantage that the U.S. had in the economic competition with Japan. While the Japanese had become a superior manufacturing power in many respects, they seemed to lag in creating cutting-edge technologies. For this reason, Japanese investment in U.S. high technology was seen by some commentators to be dangerous.

According to this view, the Japanese strategy was to buy what they had not been able to produce by themselves, and in doing so, to take possession of the last competitive stronghold of the U.S.

Though only a few years have passed since the high point of this debate, it seems evident now that those fears were exaggerated. The activity of the Japanese as investors in the U.S. has receded and several changes in the Japanese economy have reduced the attractiveness of investments in the U.S. On the other hand, substantial Japanese investments in entrepreneurial U.S. high-technology companies have failed, forcing a revision of previous plans. Presently, Japanese investors seem to be concentrate on finding solutions to their problems at home.

It is important to point out that the Japanese venture capital industry is structurally different from that of the United States. Besides having a smaller pool of resources than their U.S. counterparts, Japanese venture capitalists have different sources of financing, seek different objectives, conceive the problem from a different point of view, and have been active for a shorter time. While venture capital started in the 1950s in the U.S., it took until the 1970s to appear in Japan. Japanese venture capital has had a history of fits and starts, where investments grow in times when traditional firms are cash-rich, and becomes minimal when the times turn difficult. The first venture capital boom took place around 1972, financed by the ample cash reserves accumulated by financial institutions during the 1960s and came to an end with the oil shock of 1973. The second boom took place in 1982 and ended in 1986, when several of the most promising high-technology investments that had received resources went bust. The third wave took place in the final years of the 1980s, and was characterized by cautious investments at home and bolder advancements in high-tech sectors abroad, particularly in the United States (Borton 1992). However, this last wave of high-technology investments in the U.S. began to recede by the early 1990s and had backed off substantially by 1992.

Whereas U.S. venture capital funds are financed by a wide array of types of investors that include pension funds, insurance companies, individuals, corporations, endowments, and foreign investors, in Japan the main sources of capital for venture funds are financial institutions. In fact, most of the funds are affiliated with banks and securities corporations. And while U.S. investors are mostly interested in the profitability of their investments, in Japan the funds and the investors have multiple interests, of which high profitability is only one. For the Japanese, product technology is the most important factor in the selection of an investment. The main purpose is to acquire technologies that will perform important strategic roles for the companies that the funds are associated with. These strategic roles can be related to the development of products, the expansion of access to foreign markets, the opening of sources of activity for the financial institutions associated with the funds, etc. (Weiner 1991). Given that the achievement of high profitability is one among many objectives, Japanese funds tend to wait longer to realize gains. Indeed, Japanese investors do not consider that the realization of gains happens exclusively when the venture is sold in the IPO market. They rather expect that a substantial part of the gains will be realized when the acquired technologies are integrated in products by other companies in the same group. Therefore, Japanese venture capitalists exert less pressure than their U.S. counterparts upon the entrepreneurs to develop quickly a successful product that would enhance the market value of the startup and facilitate the transit to an IPO. The

expectation of high returns through IPOs is also moderated by the fact that the IPO market has a low degree of development in Japan in comparison to the U.S. Indeed, there is a cultural resistance to acquisitions in Japan. The fact that a company goes public is considered as a sign of failure. In the U.S., on the contrary, this is the trademark of success.

Another difference between Japanese and U.S. venture capital funds is the conservatism of Japanese investors. While it has traditionally been accepted in the U.S. that the focus of venture capital activity is the financing of startup companies at the seed stage, in Japan most of the activity of venture capitalists is concentrated in later stage mezzanine financing, where the risks (and rewards) are smaller than in the seed and startup stages. Another factor in this low preference for risk is the fact that most Japanese venture capitalists have had their work experience in big financial firms, as opposed to U.S. venture capitalists who tend to have technical backgrounds. Since they largely ignore the technical intricacies of the companies they finance, Japanese venture capitalists tend to prefer a low risk compromise and to give greater autonomy to the management teams in these companies. U.S. venture capitalists get deeply involved in the day-to-day management of the firms they finance, and regularly intervene in decisions regarding managerial, personnel, and technical issues. Besides this, while the remuneration of U.S. venture capitalists is usually tied to the performance of their funds, the Japanese in the same jobs receive fixed salaries. Personal reward for success is not any different from regular pay.

The demand for external venture capital is also smaller in Japan, since in general technology-based entrepreneurship is lower. Japanese R&D scientists and engineers tend to make their careers in established companies. There is much less demand for venture capital from entrepreneurs. Taken together, these factors mean that the Japanese venture capital industry is less experienced in the management of the technical problems of high-tech firms, has less opportunities and motivation to realize big monetary gains through IPOs, and is not as comfortable with the financing of startup companies as is the U.S. venture capital industry. Despite this environment, there are Japanese investors who think that their country should develop a venture capital sector that is similar to that of the United States. The latest round of financing of young high-tech companies in the U.S. by Japanese investors is representative of this intention.

A number of factors at work during the late 1980s motivated a rise of Japanese venture capital investments in the U.S. First, the yen registered a substantial appreciation. Second, Japan enjoyed a big trade surplus with the rest of the world. Third, within Japan the rise of the stock market widened the capital base of corporations and financial institutions, adding to the pool of resources at their disposal. Fourth, many Japanese corporations in traditional sectors (steel, agricultural machinery, etc.) realized that the perspectives for long term growth in their core businesses were low, and that they should diversify aggressively to secure their survival into the next century. The preferred fields for diversification were high-technology sectors, where the potential for growth was perceived to be very large. Fifth, the U.S. was seen as an excellent place to invest by those firms seeking diversification, since it has a strong entrepreneurial tradition which had produced major success stories during the eighties, and

investments in the U.S. turned out to be cheap for Japanese companies given the appreciation of the yen relative to the dollar. Finally, Japanese venture capitalists faced a relatively open field in the U.S., since by the last years of the decade American venture funds had reduced their activity in the early stages of the financing of high-technology companies.

The demand side also favored Japanese investment. Indeed, American entrepreneurs welcomed Japanese resources with open arms. Japanese venture capital appeared at a moment when U.S. venture capital was scarcer than in the past. The Japanese had several characteristics that made them attractive providers of capital for startups. Their hands-off style, the lower pressure they put on achieving a quick IPO sale, lower profitability demanded, and their focus on technology made them good partners for entrepreneurs. In addition, Japanese investors tended to pay higher prices for equity than those that could be obtained from U.S. investors. Moreover, as a rule the Japanese offered things that the U.S. venture capitalists could not offer and were not interested in offering, such as the possibility to proceed quickly to a manufacturing stage (frequently at high-quality Japanese or other Asian facilities), as well as access to Japanese and Asian markets.

Japanese investment in venture capital in the U.S. grew rapidly during the second half of the 1980s. As shown in Table 4.4, the value of Japanese investments in U.S. venture funds grew from $18 million in 1983 to $54 million in 1989. At the same time, direct equity investments by Japanese firms in U.S. companies grew from $7 million in 1983 to $320 million in 1989. As noted earlier, one of the main sources of capital for Japanese investment was big corporations in mature sectors who wanted to diversify their activities in the long term.

Table 4.4
Japanese Investment in U.S. Ventures

	Minority equity investments in the U.S.		Investments in U.S. venture funds	
	No. of investments	Value ($ millions)	No. of investments	Value ($ millions)
1983	11	7	4	18
1984	15	44	14	28
1985	15	42	24	31
1986	20	142	9	33
1987	49	151	8	14
1988	47	176	22	46
1989	60	320	16	54

Source: *Venture Economics*, cited in Borton (1993)

It should be noted that even at its high point, Japanese venture capital investment was a small proportion of the total sources of venture capital in the U.S. According to Venture Economics, total new sources for venture capital added up to $2.4 billion in 1989; therefore, the Japanese contribution of $52 million represented just 2.25 percent of the total. Even if the

$320 million of direct investments are added to this figure, Japanese participation would still be a fraction of U.S. investment in venture capital activities. These figures point to the fact that, even at its peak by the end of the 1980s, Japanese venture capital investment was nothing comparable to an invasion, as frequently portrayed by the media.

The situation quickly changed in the 1990s. By the end of 1991, it became clear that the Japanese venture investment in the U.S. was facing difficulties. A number of factors contributed to these difficulties, but the most important were a number of significant failures. Kubota Corp, for example, a maker of tractors and pipe from Osaka, lost its $130 million investment in Stardent Computer when this firm closed (Bulkeley and Gupta 1991). Stardent was one of the most widely publicized Japanese ventures in the U.S. The company was the result of a merger between two small computer firms, and was expected to become a world leader in the production of graphics hardware for scientific computers. Despite the high hopes, the company missed its opportunity when it failed to deliver a marketable product quickly and other major firms released competitive products. Other Japanese venture investments also went sour. Mitsui & Co. lost close to $30 million in its investment in Gain Electronics Corp., a maker of gallium arsenide chips. Mitsui retired from the venture in 1988. Kobe Steel gave up its investment in PraireTek, a maker of disk drives for laptop computers, after having committed $19 million.

Even though Japanese investors understand that venture capital is a high-risk game, these and other failures shaped a retreat from the U.S. scene. According to Venture Economics, Japanese investment in U.S. venture capital partnerships was reduced to virtually zero by 1991 (Devlin 1992b). The Japanese seem to consider now that their lack of technical experience and their hands-off approach are not adequate to succeed in the venture capital activity in the U.S. The occurrence of these failures at a time when the Japanese economy is receding, the Tokyo stock market has lost its dynamism, and the Japanese banks are in trouble has prompted these investors to stay away from new venture capital commitments in the U.S. Recent setbacks may not signify a complete and permanent retreat by Japanese investors. Nevertheless, if Japanese investment in high technology in the U.S. picks up again, it is very likely to have a different character.

In fact, a general emerging trend is for cross-national U.S.-Japanese cooperation and joint funding of innovative new ventures. Two good examples of this are Kaleida Labs and General Magic, some of the hottest new startups in the potentially multi-billion dollar field of multimedia technology -- the integration and manipulation of computer, audio, video, and other types of information via digitization -- which were financed almost entirely by large U.S. and Japanese electronics companies. Kaleida Labs, a developer of multimedia operating system software, is backed by equity investments from IBM and Apple, along with $22.8 million in equal shares from Japanese electronics firms NEC, Sony, Hitachi, Sharp, Toshiba, and Matsushita. General Magic is financed by Apple Computer, Motorola, Sony, and Matsushita to develop standard operating system software for the new personal digital assistants -- palm-sized, pen-based computers which can send and receive messages and faxes (Choy 1993).

A CASE STUDY OF FOREIGN FINANCING OF U.S. HIGH TECHNOLOGY

The role of Japanese investment in U.S. high technology can perhaps be best illustrated through a case study of a U.S. high-technology firm. This section presents a case study that shows the types of arrangements that are taking shape between U.S. entrepreneurial high-technology firms and Japanese corporate investors. The names of the companies and the people involved in the case are withheld by request to protect anonymity. The case study firm is a producer of high density static RAMs, serving the workstation and high-end personal computer markets. Located in the Silicon Valley area in California, the firm was founded during the second half of the 1980s. The Japanese company is a very successful heavy industrial corporation which is seeking diversification into high-growth, high-technology fields. Their investment, which occurred in 1990, offers a striking contrast to the traditional venture capital investment in startup firms. While U.S. venture investors usually require a majority stake in startup firms, the Japanese investor has preferred to work with the U.S. firm in ways that are somewhat less constraining to the U.S. entrepreneurs. The Japanese investor has not tried to act as a manager of the firm, but rather has tried to build up the strengths of the high-technology enterprise as a strategic partner.

The case study firm was founded in 1987 by two entrepreneurs. Their professional experience was gained primarily in technical fields. The original capital came from two U.S. venture capital funds, and the number of U.S. investors grew to five during the following years. By 1990, the company had gone through three rounds of financing from U.S. venture capitalists. After the second round of financing, the company had built its first fabrication facility, a low-volume factory with a cost that was close to $50 million. The main products of the firm are high-speed, high-density static RAMs. These are produced for three distinct markets: military organizations, which represent close to a third of their sales, the workstation market, and the high end personal computer market. The company is geared to attend the market for static RAMs. The size of this market has been growing because high capability standards are increasingly reaching the lower ends of the computer market. As more memory is used in higher, more sophisticated applications, more static RAM and more speed are needed in order to realize the faster operation of microprocessors. As more machines are sold with these capabilities in market segments which were served by lower powered computers, demand for static RAMs has widened. The company is a world leader in the design and production of these devices.

By 1990, the company and the original partners sought the involvement of a new investor, one capable of acting as a strategic partner. By this point, it was clear that a strategic partner was needed to attain the firm's long term goals. The company not only needed more capital, but required other types of support to reach the next level in its strategic development. Two major objectives for the mid-to-long term were expanding manufacturing facilities and securing distribution channels overseas.

The search for a strategic partner encompassed the U.S., Europe, and Japan. During this stage the company used the services of a U.S. investment firm -- or match maker -- which had wide experience in high-technology ventures. The match maker helped the high-technology

concern clarify its own strategic needs and define the profile of the desired partner. The match maker performed the search and eventually identified a large Japanese company in a traditional, mature sector, which was seeking an opportunity for investment in the development of high technology. The Japanese company had been involved in a diversification effort for a number of years. It had already initiated a large project related to semiconductor production (including the construction of a factory) and was itself seeking a strategic partner to provide a stable, ongoing technology base for this project.

The cooperation agreement was attained fairly quickly, since the two partners were highly complementary. The Japanese partner received state-of-the-art technology, and the U.S. partner received capital, the support of a huge industrial organization in different areas, and access to high-volume manufacturing capabilities in Asia. This enabled the U.S. firm to attain simultaneously the strategic goals of getting its products manufactured in adequate volumes and having the time and resources to concentrate in the development of new generations of its technology. The Japanese partner allowed a significant expansion of fabrication facilities. The management of the U.S. firm preferred not to disclose the precise dollar amounts involved in this partnership.

According to the case study firm, Japanese investment provided five major benefits: capital in the form of a direct investment in the firm's equity; a licensing agreement, by which the Japanese investor pays for a license to use the firm's technology in some of its products; co-development meaning that the partner will share the costs of the development of the next generations of the technology; distribution since the Japanese conglomerate acts a distributor of the firm's products in the Pacific Rim; and manufacturing through an arrangement to produce different product lines between the facilities of the U.S. firm and those of the Japanese firm. As a general criterion, the facilities of the high-technology firm in the U.S. will be used to produce lower volume products and pilot lines of new products, while the facilities of the Japanese partner in Asia are used to produce high-volume, low-cost products. The Japanese partner maintains a team of technologists in the U.S. facilities, with the expectation that new inroads for technological progress will be discovered and explored during the regular activity of the firm.

According to the case study firm, Japanese investment had a number of advantages over traditional venture capital financing. First, it allowed substantial autonomy for the U.S. managers. Many entrepreneurs in the U.S. complain that venture capitalists bring multiple constraints, for example, they demand that the company ramp up quickly so that it can be liquidated via the IPO market. Entrepreneurs may feel that they are pushed in directions in which they do not want to go, or are forced to move too fast, without a chance to work out the production processes or the design bugs, steps that are key to delivering a high-quality product. Through the agreement with the Japanese investor, the case study company found a supplier of patient capital.

Association with a large Japanese investor provided the case study firm with an intangible but extremely valuable asset -- prestige and credibility. Not only did this help to improve relations with creditors, suppliers and clients who came to see this firm as one that can achieve stability and growth in the long term, but it also acted as a magnet to attract top technical and managerial talent. The prospective of working for a firm that has the financial backing to survive in the long term, the clout to be a major world player, and the capacity to concentrate in the development of new generations of technologies was extremely attractive to highly qualified engineers and managers. In our interviews, a number of employees indicated that the existence of the Japanese partner was a major factor in their decision to join the firm.

The general structure of this alliance sheds a new light upon some hypotheses that have been presented in the American debate on technology policy. In a provocative article in *Harvard Business Review*, Rappaport and Halevi (1991) argued that competitive advantage in the computer industry and in high-technology industries more generally does not reside anymore in the production of hardware. According to this argument, as a consequence of the fast increase in the number of hardware producers around the world the computer market has come to behave as a commodities market, characterized by an oversupply of undifferentiated products, cannibalizing competition, and falling prices and profit margins. Manufacturing facilities are moving from industrial countries to lower-cost, underdeveloped countries. In a nutshell, computer manufacturing is no longer an activity in which an economic world leader should concentrate its efforts. The industrial nations who do not understand this fact risk losing competitiveness. Thus, according to Rappaport and Halevi, the U.S. should abandon computer manufacturing altogether and concentrate instead in the production of software and in the design of advanced technologies. In this way, computer companies would become "computerless" since they would not really be engaged in the manufacturing of computers, but in the production of design breakthroughs to be used in machines that would actually be manufactured in lower-cost countries, even if sold by U.S. brands. This would be beneficial both to U.S. computer firms and to U.S. competitiveness since, in their view, the manufacturing of computers is a business with decreasing profit margins. According to Rappaport and Halevi, only breakthroughs in design technology provide substantial profits for the high-technology firms that are able to achieve them.

However, our case study contradicts this view. It suggests that U.S. high-technology firms face considerable competitive pressure in manufacturing, and highlights that U.S. brand markets are increasingly incapable of providing the funds required to support manufacturing. Thus, these firms are progressively being forced to turn to foreign investors for capital. The U.S. high-technology startups increasingly recognize that their main strength is the development of new generation technologies, and that they need to concentrate on the creation of new, innovative technologies to survive as important players in the field. Nevertheless, these firms do recognize that they require manufacturing to remain competitive. As our case study firm indicated, the use of subcontract manufacturing poses sizable risks. For example, a high-technology producer may give away an edge because other firms use the same subcontractors. It thus becomes increasingly difficult to create and sustain a differentiated product or to protect intellectual property. Moreover, it becomes impossible to use the manufacturing process as a

ground to generate incremental technological progress. One of the executives interviewed during the case study expressed it as follows:

> The "fabless" company [a semiconductor company without a fabrication facility] emerged because the high cost of capital associated with creating and expanding manufacturing facilities may be skipped using subcontractors for standard processing. But, I think the pendulum is starting to swing in the other direction, as these companies realize that they are using the same subcontractors hired by their competitors. They have nothing to distinguish themselves from the pack (personal interview by Richard Florida, 1992.)

SUMMARY

Venture capital is considered by many to be a source of competitive advantage for the U.S. economy, since it has played a crucial role in the development of successful high-technology companies. Venture capitalists are crucial for this new type of innovation process because they are situated at the center of the overlapping networks and are able to reach into large corporations, universities, financial institutions, and a variety of other organizations. This enables them to help to overcome a variety of financial, technological, and organizational barriers which stymie technological progress. They bypass the risk aversion of established financial intermediaries and the organizational inertia and extreme specialization of large corporations, and help entrepreneurs solve the multifaceted technological, organizational, and financial requirements of new business development.

Nevertheless, there are limits to venture capital. Venture capital has contributed to a process of chronic entrepreneurship in the creation of wave after wave of new startup companies which may at times weaken the capabilities of existing companies and lead to a sub-optimal allocation of technical and business effort as the proliferation of small high-technology firms may lack the resources and the scale required to be globally competitive. Venture financiers promote the creation of copy-cat companies which duplicate each other's efforts, create increased market pressures, and dilute the overall supply of human resources. The fragmentation of this model makes it difficult for firms to generate hybrid innovations via the combination of two or more technologies, or larger systems innovations that require the combination of previously unrelated technologies. Furthermore, venture capital contributes to the breakthrough illusion of American high technology, where tremendous effort is expended in the development of radical new innovations but the sources of productivity, value, profit and employment provide by downstream activities such as manufacturing are neglected. This pattern of development neglects the actual manufacturing of high-quality goods--and the potential profits that come with it.

International investment in venture capital and high technology is an issue around which there is heated debate. While some analysts have pointed out that foreign investors provide much needed capital for high-technology development, others argue that the United States is giving away a crucial edge in the international economic competition through this channel, since major competitors in the world markets are gaining access to crucial technologies developed by

American companies. The evidence shows that foreign investment in U.S. high-technology is not quite as significant as has sometimes been portrayed by the media, and is indeed receding given the current slowdown in global economic activity. The participation of foreign funds in the total U.S. venture capital pool fell from 23 percent in 1985 to 11 percent in 1991; and the number of U.S. venture backed companies acquired by foreigners fell from 33 in 1989 to eight in 1991.

The activity of Japanese investors in this field is a particularly sensitive issue. Japanese investment in U.S. high technology became quite visible since the 1980s and has been interpreted as dangerous by some commentators. According to this view, the Japanese strategy is to buy what they have not been able to produce by themselves, and in doing so, to take possession of the last competitive stronghold of the U.S. Such fears are clearly exaggerated. In 1989 Japanese funds only represented 2.5 percent of the total U.S. venture capital pool. In recent years the activity of the Japanese as investors in the U.S. has receded, and several changes in the Japanese economy have reduced the attractiveness of investments in the U.S. On the other hand, substantial Japanese investments in entrepreneurial U.S. high-technology companies have failed, forcing a revision of previous plans.

Indeed, the evidence suggests that international investment in U.S. high technology is on balance positive. It is apparent that new patterns of cooperation between U.S. entrepreneurial high-technology companies and foreign corporate financiers are under development. Besides capital, Japanese investors in U.S. high technology -- frequently mature companies in traditional sectors -- provide U.S. startups with substantial advantages such as access to high-quality manufacturing facilities and to distribution networks in foreign markets. This allows startup companies to focus their efforts on the development of high-technology breakthroughs, without having to neglect the possibilities of development that can be attained through the actual manufacturing processes and to gain greater access to major international markets. These new forms of cooperation go well beyond simplistic explanations that perceive the gains for one side in the deal as losses for the other. The emerging patterns of cooperation offer clear advantages to all involved.

CHAPTER 5

VENTURE CAPITAL AND TECHNOLOGY POLICY

With the coming of the Clinton Administration, the idea that the federal government should act as a venture capitalist is suddenly in vogue. In the executive branch and on Capitol Hill, direct government financing of innovative technologies and startup companies is increasingly seen as an essential element in spurring overall investment and long-term growth. There is growing sentiment that making government a venture capitalist will help spur investments in startup companies and critical technologies, and put the U.S. economy on the path to long-term growth.

The Clinton Administration's commitment to bolstering American competitiveness has been met by numerous proposals for a more direct government role in financing new technology. The Competitiveness Policy Council recommended that government agencies such as ARPA, the Department of Commerce, and the National Institutes of Health be allowed to make investments in business startups, both directly and through a proposed Technology Bank (Competitiveness Policy Council 1993). The National Competitiveness Act of 1993, which is being considered in both houses of Congress, seeks to create new government agencies and programs to invest in new companies directly and in venture capital funds as well (U.S. House of Representatives 1993a).

The argument for greater government involvement in venture capital suggests that private venture investors are under-investing in new startup companies and that government intervention is required to fill this gap (U.S. House of Representatives 1993b, 1993c, 1993d, 1993e). According to this view, venture capitalists are putting an increasing share of their time and money into so-called later stage activities, such as follow-on investing and leveraged buyouts (LBOs). Therefore, an insufficient amount of venture capital is going to seed and startup activity, creating a growing capital gap in the funding of new startup companies. Since entrepreneurial startup companies are considered the engine that powers innovation, technology development, and economic growth, government venture capital is required to generate entrepreneurial business formations, increase the pace of innovation and, in doing so, stimulate economic growth.

This chapter examines recent trends in the venture capital industry; the role and function of venture capital in the process of technological innovation and in the development of high-technology industry; and the potential efficacy of government intervention in this area (Wilson 1985; Bygrave and Timmons 1992; Florida and Kenney 1990). A number of policy implications follow from this analysis. The main conclusion is that the venture capital market does not need government's help, and the federal government is the wrong institution to play the role of venture capitalist.

IS THE U.S. UNDERINVESTING IN VENTURE CAPITAL?

The case for more government involvement in venture capital argues that the U.S. economy is under-investing in startup companies and other forms of entrepreneurial activity related to high-technology development. However, a brief review of the evidence shows that this is not the case. Figure 5.1 provides a straightforward comparison of venture capital in the world's three largest economies: the United States, Japan, and Germany. The total pool of venture capital in the U.S. ($35 billion in 1992) is more than 10 times greater than that of Japan or Germany. Indeed, the cumulative pool of venture capital in Japan ($2.2 billion) or Germany ($2 billion) is roughly equal to what the U.S. raises each year (Weiner 1991; Anslow 1991; Bygrave and Timmons 1992). Both Japan and Germany have seen increasing venture capital investments since the late 1980s, but the United States continues to raise and invest far more venture capital than its primary economic competitors.

A big part of the case for government involvement in venture capital turns on the simple the fact that venture capital investment -- particularly investment in new startup companies -- has declined over the past few years. While it is indeed true that venture capital investment has declined across all stages and types of activity, it is mistaken to read this trend as sufficient reason for government intervention. Figure 5.2 provides the baseline data here, charting the annual amount of venture capital investments over time. Venture capital investments increased sharply during the mid eighties, then fell just as dramatically. However, even during the so-called lean years of 1990 and 1991, venture capitalists invested a total of more than $3 billion in more than 2,000 entrepreneurial companies. This is two to five times the amount of venture capital invested during the late 1970s, when some of the most innovative and successful high-technology startups in history were formed including DEC, Intel, Apple, Microsoft, and Genentech among others (Bygrave and Timmons 1992, Chapter 4). In 1992, as the country began to pull out of the recession, U.S. venture capital investments were up again, in excess of $2.2 billion.

It has also been argued that private venture capitalists are abandoning seed and startup investments in new entrepreneurial businesses in favor of later stage investments in proven companies, leveraged buy-outs and merchant capital. In testimony before the House Subcommittee on Technology, Environment and Aviation, W. Andrew Grubbs, of Venture First Associates, a venture capital fund which specializes in seed and startup investments stated that: "The amount of money from this pool that we call 'venture capital' that actually goes into starting new high-tech companies is less than 2 percent. 2 percent!" This 2 percent figure has since been frequently repeated by proponents of government venture capital and has come to be accepted as accurate. But a look at the evidence reveals that this statistic is incorrect. It is true that the amount of venture capital devoted to seed and startup investment declined from an average of about $500 million per year in the mid-1980s to about $150 million in the early 1990s (Figure 5.2). However, the portion of funds going to seed and startup investments remained roughly 10 percent of all venture capital investments in both years. The biggest decline, in fact, occurred in LBO and acquisition financing, which fell from about $1 billion in 1988 to just $40 million in 1991. This reflects a refocusing of venture capitalists' efforts toward

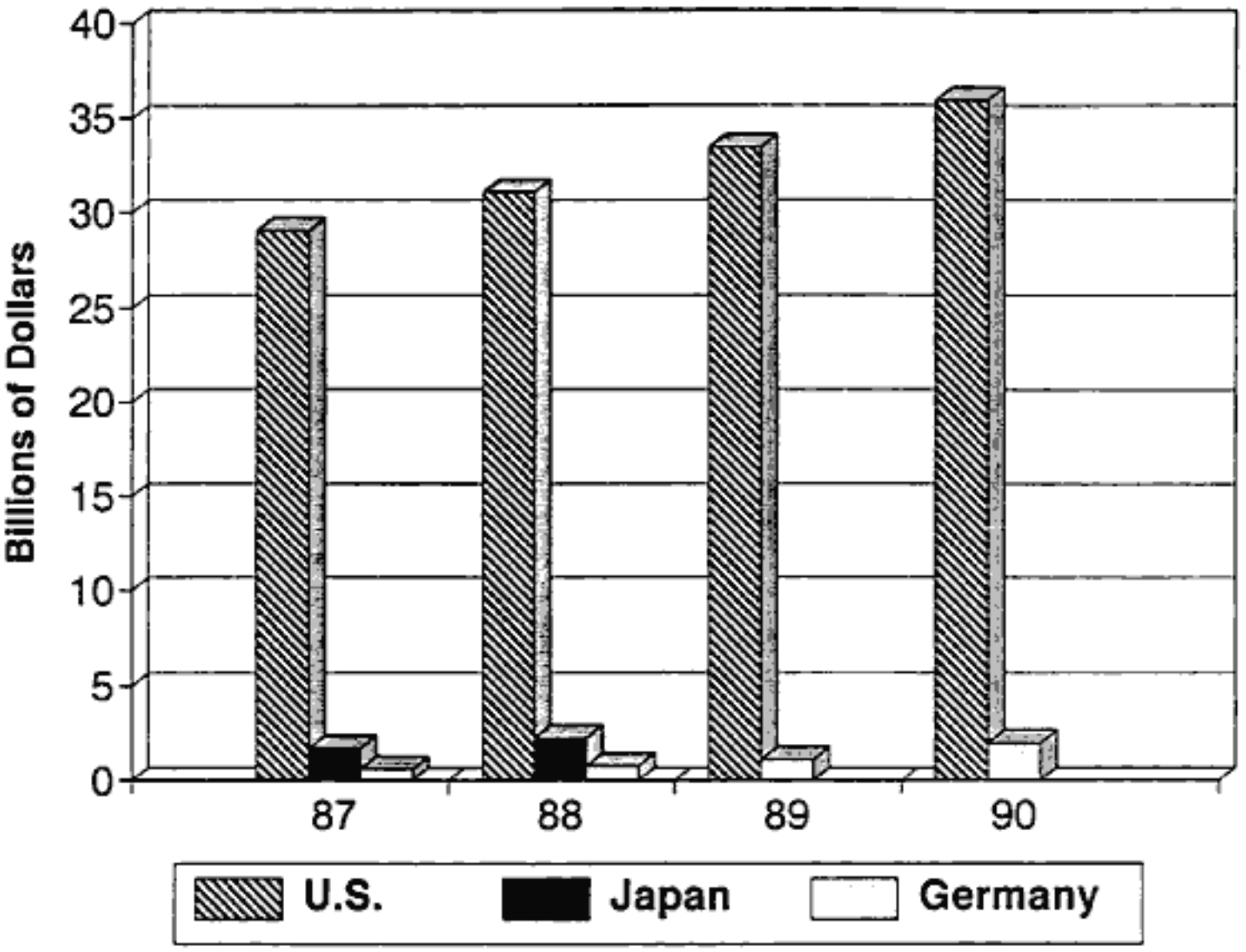


Figure 5.1: Venture Capital Pool in the U.S., Japan, and Germany

Source: Venture Economics

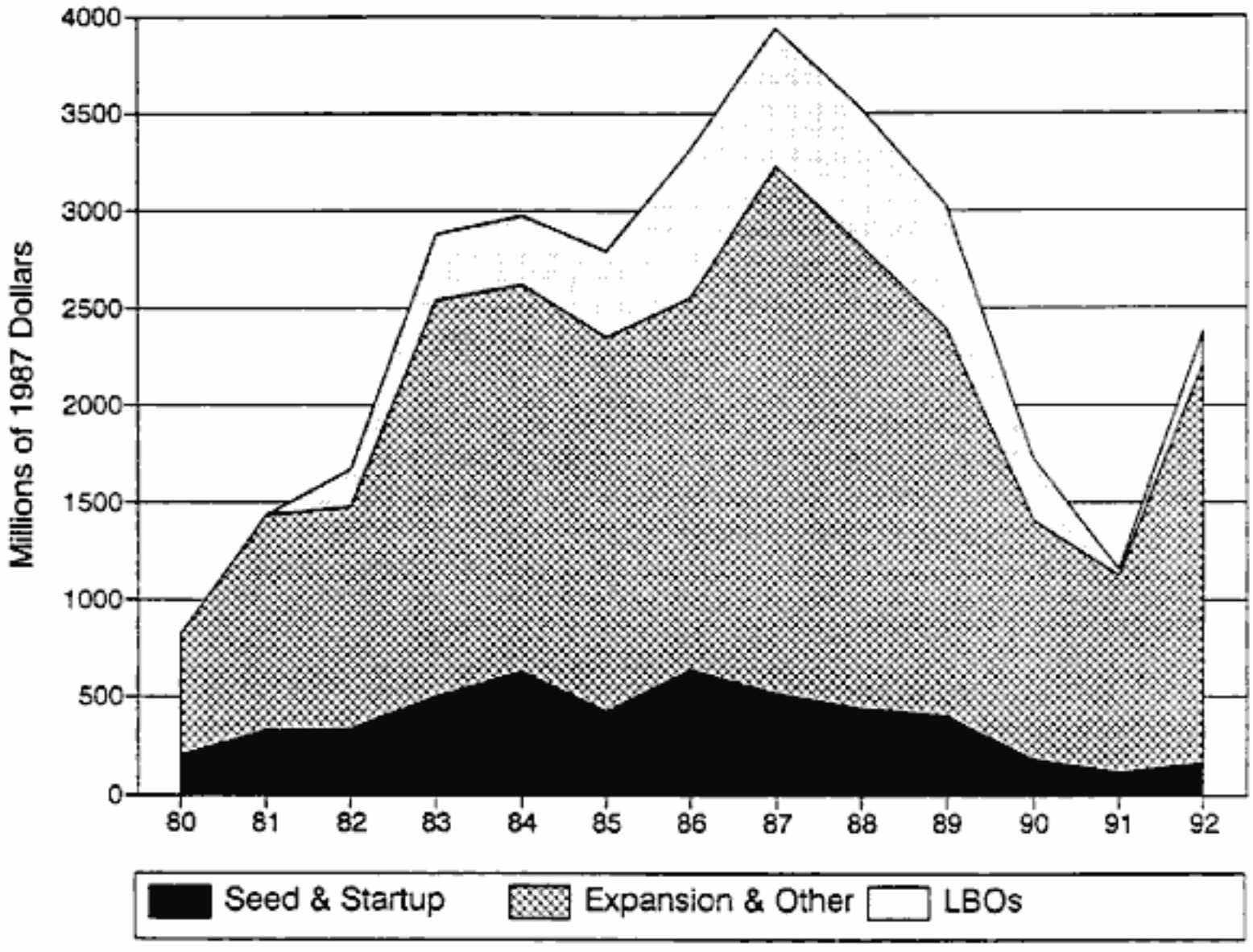


Figure 5.2: Venture Capital Disbursements by Stage (1987 Dollars)

Source: Venture Economics

the creation of new entrepreneurial firms and the development of innovative technologies. This is a quite desirable result and one that is happening without any special government intervention. Venture capital investments in some critical high-technology fields, like software, actually increased during the early 1990s. In 1991, venture capitalists invested more that $330 million, roughly one-quarter of all investments, in 185 software companies.

Part of the explanation for the temporary fall-off in venture capital investment can be found in a related decline in the amount of money committed to the venture capital industry by outside investors. Figure 5.3 charts the annual amount of new capital committed to venture capital funds in the United States over the last 20 years. The data clearly show a decline in new commitments in 1990 and 1991, particularly when compared to the boom years of 1986 and 1987. However, the average $1.4 billion in new capital commitments in 1990 and 1991 is almost six times greater than the roughly $250 million per year committed to venture capital during the mid-to-late 1970s and considerably more than the $950 million committed in 1980 or the $1.1 billion committed in 1981. It is just slightly less than the $1.6 billion committed in 1982. Venture capital commitments exploded after 1982, fueled by changes in the tax code and the economic boom, reaching exceptional and unsustainable highs during the mid- to late-1980s.

In fact, these swings in venture capital investments and commitments provide considerable evidence of the market's ability to adjust quickly to changing economic conditions. Thus, government intervention to correct the mythical capital gap of the early 1990s is not only unnecessary, it would be based upon a flawed reading of historical trends in the industry. Government intervention may even obstruct the industry's ability to react to changing market conditions in the future.

The argument in favor of government intervention could be more acceptable if venture capital was the only, or even the primary, source of capital for new business formations. It is not. Venture capitalists are a relatively minor source of capital for new enterprises. Although comprehensive data on the actual level and breakdown of funding sources for new enterprises is impossible to obtain, a few proxy measures convey the relatively minor role played by institutional venture capital in the financing of new enterprises. According to the annual White House report on the "state of small business," between 600,000 and 700,000 new businesses are incorporated in the United States each year (Executive Office of the President 1991). The Small Business Administration estimates that an average of 10,000 new high-technology companies were formed each year between 1976 and 1986 (Phillips and Brown 1989); but venture capitalists invest in only 1,000 to 1,800 new companies per year (Venture Economics 1992a). This is just 10-20 percent of high-technology companies and less than 1 percent of all business startups. The majority of capital for new enterprises comes either from entrepreneurs themselves using personal savings and ongoing earnings to bootstrap their businesses, or from wealthy relatives, friends, and other so-called angel investors.

Venture capital investment comprises just a small fraction of the nation's overall commitment of resources to innovation. While venture capitalists invest between $1.5 and $4 billion each year -- and this sum is spread in a wide range of activities -- the nation as a whole

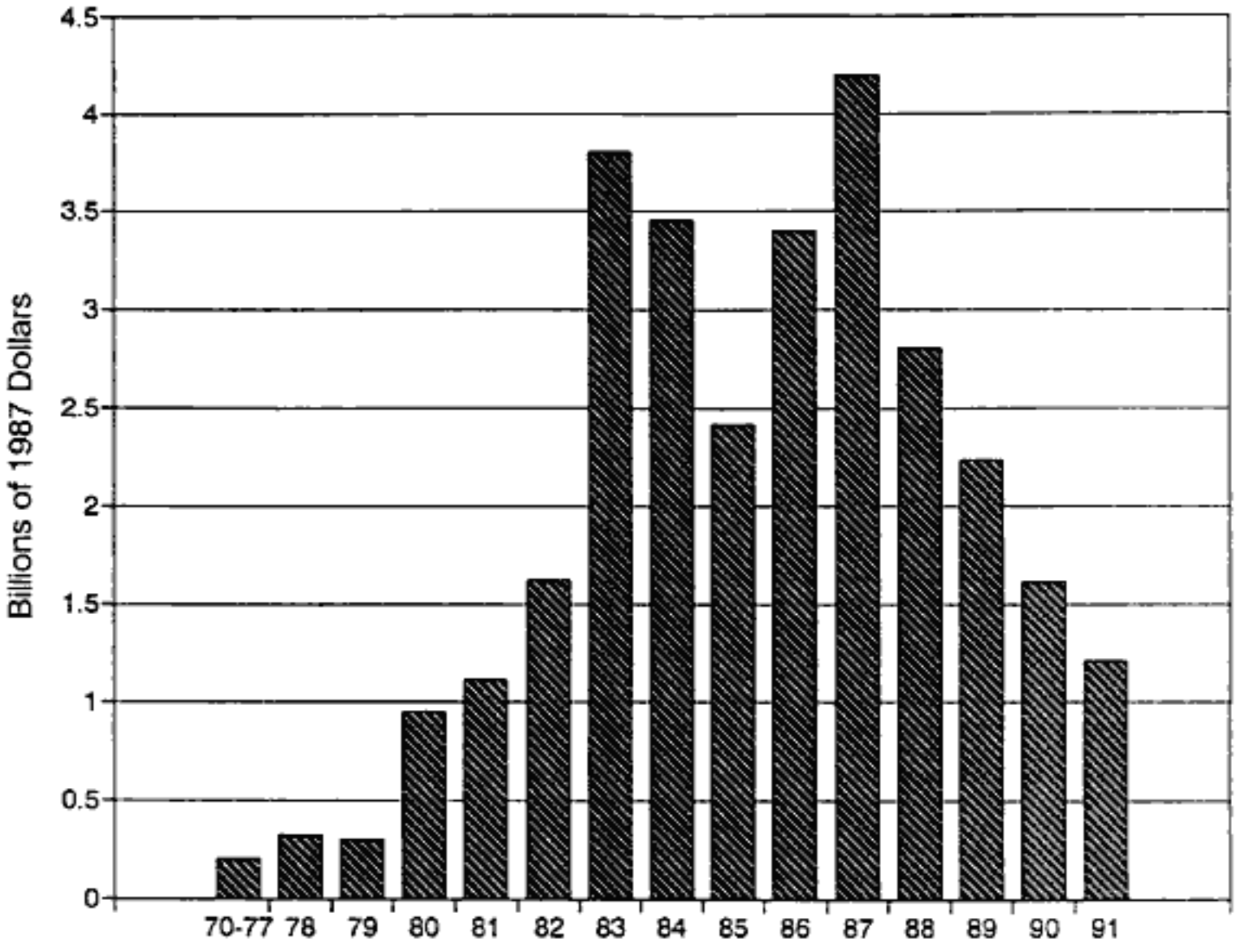


Figure 5.3: New Capital Commitments to Venture Capital Funds In the U.S.

Source: Venture Economics

spends more than $150 billion per year on research and development, with nearly $80 billion of this total coming from the private sector (National Science Foundation 1993). Even during peak years, venture capital investment has represented less than 5 percent of private sector R&D spending, and just 2.5 percent of total R&D spending.

Global corporations are pumping more and more of their own capital directly into startup companies, and are beginning to replace venture capitalists as a source of funding for highly innovative startup companies. Pharmaceutical companies have become major players in the financing of medical and biotechnology companies through joint ventures, strategic partnerships, and acquisitions, reducing the need for additional venture capital financing in that sector (Devlin 1992a). From the beginning of 1990 to the middle of 1991, an 18 month period, corporations provided over $1.4 billion in direct equity investments in startup companies -- more than 50 percent of the total venture capital investments during the period. Japanese companies reduced their investments in venture capital funds to virtually zero in 1991, as they moved to invest in startups directly (Devlin 1992b).

The substitution of direct corporate investment for venture capital is, on balance, a positive development. Direct corporate investment provides a steady stream of patient capital for startup companies, as well as access to corporate capabilities and facilities in manufacturing, marketing, and distribution. This stability allows new startups to avoid the high degrees of corporate control frequently demanded by venture capitalists in return for their investments -- demands for which the latter have come to be known as vulture capitalists. Furthermore, alliances between fledgling startups and large companies make sense for the U.S. economy as a whole, because they offer a way to help turn new innovations into successful commercial products. Such alliances combine the innovative capabilities of small, entrepreneurial firms with the financial backing and distribution networks of larger, more established companies. These resources are required to commercialize innovations successfully and to fully capture the downstream profits associated with new product development.

EFFICIENCY IN THE VENTURE CAPITAL MARKET

It has been suggested that the venture capital market is inefficient and a problematic allocator of capital to critical high-technology sectors. The evidence of the past few years, however, indicates that the venture capital market has been extremely efficient at getting capital where it needs to go. The real question that needs to be considered, because it is the one that could inform the policy debate, is not whether the share of venture capital going to startups has moved up or down, but quite simply: What is the efficient level of venture capital in the U.S. economy? We turn to this issue now.

The intervention of government as a supplier of venture capital has been proposed as a way to replenish the pool of resources available for high-technology firms. But this pool may not need to be refilled to its past peak levels. Venture capital was widely available in the mid to late 1980s; indeed, there was an excess supply. Present proposals come at a time when the

market is beginning to recover from what industry insiders see as the excesses and overfunding of the late 1980s. During this period, billions of dollars of new capital poured into the industry from pension funds, endowments, corporations, and individuals. Investments hit record highs. The venture capital pool increased from less than $5 billion in 1980 to nearly $20 billion in 1985 and more than $35 billion in 1990.

This capital glut caused five problematic trends to emerge in the venture capital market (Bygrave and Timmons 1992). First, investments of less than top quality, which would have not been funded in other circumstances, received venture money. This violated the cream-skimming principle that is essential to good venture capital investment: only a very low percentage of the alternatives under consideration should be funded in a typical year. The fact that there was too much money chasing too few good ideas led to poor investments.

Second, fund managers were forced to look for bigger deals, and therefore to move away from startup companies. Investing in startups is a hands on business that imposes heavy burdens of oversight and assistance upon the management of venture capital firms. As the amounts of capital under management by the funds grew well beyond previous standards, fund managers realized that they would not be able to use these resources to finance small startup units. The size of individual investments had to be increased to reduce the burden of oversight of portfolio companies. Funds turned their attention to latter-stage deals, such as mezzanine financing and LBOs, which consume more capital and less time.

Third, attractive investments became more costly for venture capitalists. Greater amounts of funds to invest and new investors competing for the same opportunities meant that venture capitalists were forced to either accept lower equity stakes in return for their investments, or invest higher amounts of funding to secure their typical 51 percent shares.

Fourth, the capital glut exacerbated a problem that has plagued the established high-technology companies for years -- defections of key people to start new firms. Despite the merits of entrepreneurship, these defections may prove to be detrimental for the economy as a whole. An entrepreneur's former company may be forced to abandon promising projects and find it difficult to pursue previous breakthroughs. On the other hand, startup companies, with their limited capital base, lack of distribution and marketing networks, and less experienced management teams, often are unable to sustain any initial success they achieve. In short, although venture capital may result in the commercialization of an idea or product that would have not be developed otherwise, it can also pull ideas out of strong, established, well financed companies and put them in the hands of entrepreneurs who are not capable of fully exploiting them.

Fifth, the influx of new capital brought a sizeable number of inexperienced venture capitalists into the business. Indeed, just one-quarter of all funds have one partner with more than ten years experience (Venture Economics 1992a). Many of these new venture capitalists lacked the savvy, or the contact base, or the judgement to identify good deals. A herd mentality developed as venture capitalists copied each other's investments. This follow-the-

leader syndrome meant that more startup companies were being funded than could hope to survive in industries like computer disk drives, notebook personal computers, and biotechnology. Devastating industry shake-outs and huge losses were the result (Sahlman and Stevenson 1985).

The venture capital industry responded the way financial markets are supposed to: it corrected itself. Profits on venture capital investments went into a virtual free-fall, and investors redeployed their capital. As Figure 5.4 shows, the internal rate of return for venture capital funds, which hovered in the range of 25 to 35 percent for funds formed in the mid-1970s, and 15 to 25 percent for those formed in the early 1980s, plummeted to less than 5 percent for funds established during the mid-to-late 1980s (Venture Economics 1992b).

Investors began pulling their money out of venture capital and investing it elsewhere. The venture capital market fell off sharply in 1990 and 1991. It only recovered in 1992, when it reached a total of $2.3 billion, spurred by record markets for initial public offerings -- which increased from an average of just 39 between 1988 an 1990 to 116 in 1991 -- and by the general economic recovery.

In sum, the lesson of the 1980s is that more venture capital is not necessarily better. An excessive supply of venture capital may lead to more startups, but it can hurt the economy as a whole. On the other hand, the market is quite capable of regulating itself to supply the appropriate levels of venture capital that are needed at any given moment. It would be an ironic mistake for government to intervene at the present time, just when the venture capital market is returning to operation at efficient levels.

GOVERNMENT'S ROLE IN VENTURE CAPITAL

Government has tried to get involved in venture capital in the past, but its track record has not been good. The Small Business Investment Company (SBIC) program, founded in 1958 and often touted as a model of good government, has a history littered with mismanagement, failure, and abuse. In the program's heyday during the early 1960's, more than 700 SBICs were established. Less than 10 years after the program's inception, dozens of these SBICs went bankrupt (National Association of Small Business Investment Companies 1988). Only 272 were still operating in 1972.

By the early 1980s, the role and function of the SBICs had been eclipsed by innovations in the private sector, particularly the emergence of the venture capital limited partnership as a mechanism for attracting private funds to the venture capital industry. Today, SBICs make up just 5 percent of the total venture capital pool.

During the 1980s, state governments got into the venture capital business as part of an overall strategy to develop high-technology enclaves (Fisher, Sheenan, and Colton 1986). According to a recent study (Eisinger 1991) 23 states were running 30 different direct venture capital programs in 1990. While 11 of these state programs used private managers to invest

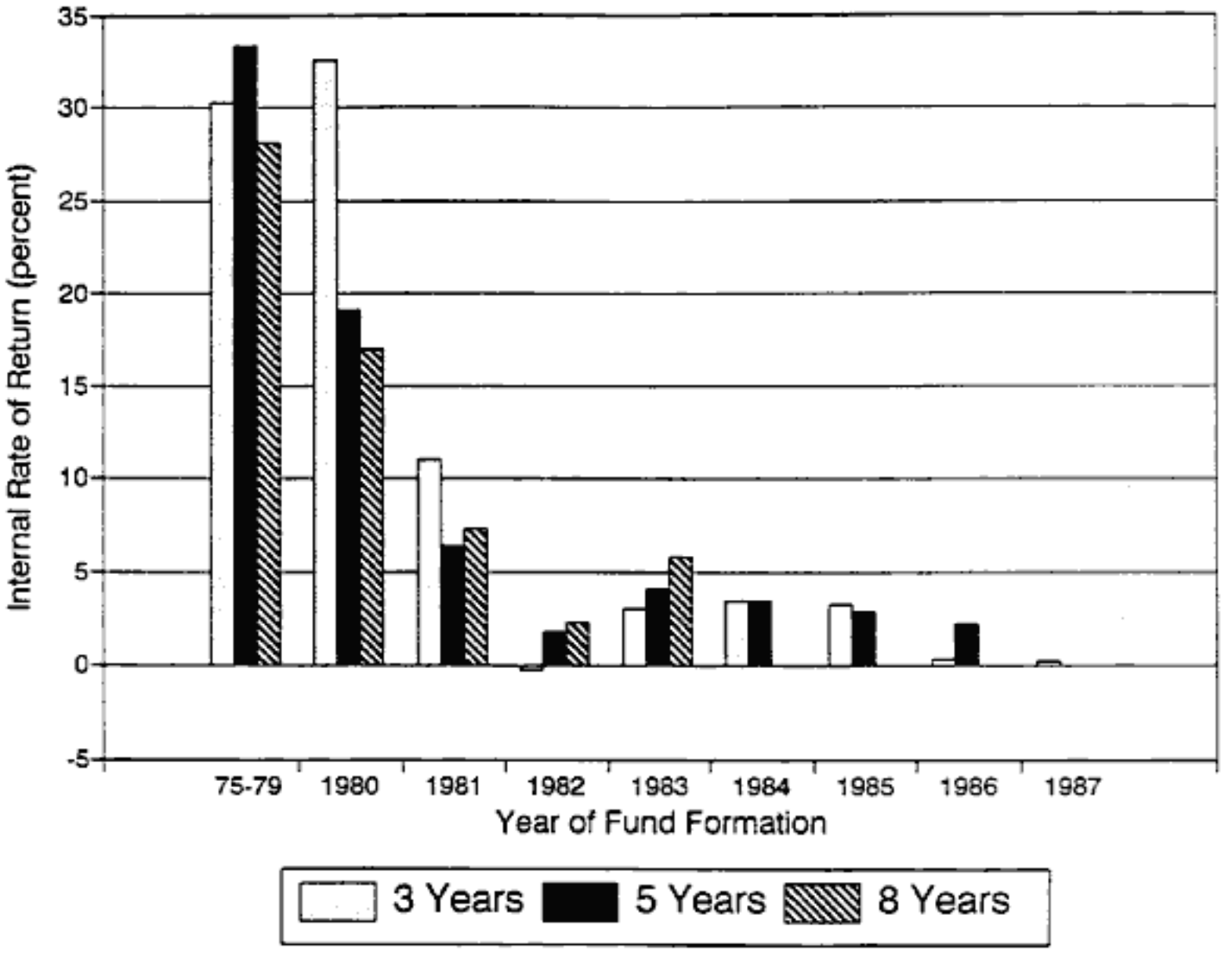


Figure 5.4: Internal Rate of Return of Venture Capital Funds

Source: Venture Economics

state funds, 19 were organized as state corporations with authority to select and manage direct investments in advanced technologies, targeted businesses, or products. By 1990, the states had generated a total of $192 million in public venture capital.

States created these venture pools to compensate for perceived regional gaps in the availability of venture capital that were contributing to disparities in high technology industry and employment. This thinking, however, was misguided, largely because it ignored the fact that capital is highly mobile and flows to the technologies and areas that promise the highest rates of return. Within a few years, the states saw most of their locally subsidized venture capital get exported to Silicon Valley, Route 128, or other places which have the entrepreneurial networks, support structure and technological infrastructure required to generate and sustain a high level of promising high-technology startups (Florida, Kenney, and Smith 1990) -- regional capital gaps exist because there are too few deals to attract venture capital, not because capital markets are inherently biased or inefficient. The majority of the remaining capital provided by the states went to local companies which failed to generate any profits. Not surprisingly, the few successful programs that exist have operated in states such as Massachusetts, where the technological infrastructure to support high technology business development exists.

State venture programs fail to measure up to privately provided capital on every relevant measure of performance. Evaluations indicate that most state programs have lost money or generated rates of return which are considerably lower than those of private funds. The programs have also failed in terms of more conventional economic development criteria, such as business generation or job creation. Even the most favorable evaluations conclude that the programs have created a very small number of new businesses and generated only a limited number of jobs. One survey of 28 public venture capital programs -- in which only 14 supplied job generation data -- produced a figure of 17,683 jobs at an average cost of $7,632 of public investment per job (Thompson and Bayer 1990). Other studies suggest that these findings considerably overstate the extent of job creation from these programs. A comprehensive audit of nine state and local investment programs in Illinois found a huge discrepancy between the number of jobs reported as being created and the number of jobs that were actually created (Illinois Office of the Auditor General 1989). The audit concluded that public investment produced just 694 jobs, less than 10 percent of the 7,501 jobs these programs claimed to have created.

Currently, many states are reducing their commitments to venture capital and critical technologies or are pulling out altogether. Recognizing the limits of these high-technology approaches, a number of the Midwestern manufacturing states are moving toward a more integrated approach to technology and economic policy, emphasizing the development of a broad business climate and economic infrastructure which is conducive to world-class economic performance across traditional and high-technology industries alike (Florida et al. 1992).

In sum, the results of these government and federal efforts indicate that government is ill-equipped to deal in the high-risk, high-return world of venture capital, where tremendous profits from one or two home-runs offset nine or ten losers. Aside from being all too vulnerable

to pressures to invest in pet projects in key congressional districts, government managers are simply not suited to the task. Venture capitalists do more that just pick winners; they are involved in hands-on monitoring and management of startup enterprises. They must have considerable education, experience, and business acumen to achieve success. These individuals have been dubbed technological gatekeepers, for they sit at the center of specialized networks of entrepreneurs, financial institutions, and business services that serve to enhance the prospects for the success of portfolio companies (Florida and Kenney 1988b). This is not something government agencies and bureaucrats can do effectively. As the economist Allan Meltzer recently pointed out:

> Why, in general, is government less efficient? One big reason is that products and companies do not leap from the drawing board with "winner" or "loser" stamped on their blueprints. Someone has to decide to make additional investments in companies that appear to have good prospects, thereby putting more money at risk, or to shut down companies that no longer appear promising. Government is more likely to delay closing the failures and more likely to pump in additional money to cover mistakes or misjudgments. (Meltzer 1993)

Even Silicon Valley entrepreneurs, who would presumably benefit the most from a greater involvement of government in the supply of venture capital, are not unanimously supporting these proposals. T.J. Rogers, the CEO of Cypress Semiconductor Corp. and a classic example of successful entrepreneurship in high technology, is an articulate critic of government intervention in this area. He has brilliantly synthesized the shortcomings of governmental action:

> Think for a moment about the realities of life at Cypress and then extrapolate them to the chip industry and Silicon Valley as a whole. Our company has 150 product designers. We have more than 70 technologists. We sell more than 1,500 products. We are working right now on 50 different new products -- from high-speed computer memories to data communications chips. With my technical training and my managerial background, it takes me 16 hours a day to stay on top of this organization. Cypress is but one $250 million company in a $50 billion semiconductor industry. Thus, if you take the details I have just described and multiply them by 200, you have a sense of the complexity of the chip industry. If you take that level of complexity and multiply it by another factor of ten or more, you have the complexity of Silicon Valley. How can the government possibly hope to cope with the details of Silicon Valley? How could the government even know who the players are in any given week, let alone pick winners and losers? (Rogers 1993)

Even if the premise that there is a shortage of venture capital was accepted, it would still be irrational for government to get into the costly business of direct financing. There are numerous more powerful and efficient ways through which government can affect the flow of capital, such as altering the tax rate on capital gains, liberalizing restrictions on private investors, and providing regulatory relief for public venture capital funds.

VENTURE CAPITAL AND THE BREAKTHROUGH ILLUSION

The U.S. venture capital system for financing technology startups is not the problem. This system is, by every account, a source of comparative advantage, one of the great strengths of the U.S. economy. The real problem lies elsewhere: in the difficulties U.S. corporations -- both startups and large corporations -- have in turning new ideas and new technologies into a continuous stream of quality products. This can be referred to as the breakthrough illusion of the U.S. economy -- our failure to turn breakthrough innovations into successful commercial products (Florida and Kenney 1990).

Venture capital -- especially too much of it -- contributes to this problem by creating simultaneously an external pool of capital, and powerful incentives to commercialize technology by pulling it out of existing companies and forming new ones. One of the problems that has become evident in Silicon Valley is that many new ideas lead to the formation of a new startup companies. This can be a wasteful and inefficient process. In this environment of chronic entrepreneurship, existing firms suffer from raids and defections of key scientists, technologists and management personnel. Promising projects are abandoned and companies find it difficult to follow-through on breakthroughs they have made. In addition, small, with their limited capital base, lack of distribution and marketing networks, and less experienced management teams, often have a hard time sustaining the success they attain through new product development. While venture capital can result in the commercialization of an idea or product that would otherwise not have been developed, it can also pull ideas out of strong, established, well-financed companies and put them in the hands of fledgling entrepreneurs, who are not capable of fully exploiting them. As one of Silicon Valley's most successful entrepreneurs put it:

> One of my guys comes to me with a new idea and I can't finance it beyond a two-year time horizon. But he can go down the street and get three to five million in venture capital to launch his company. Venture capital represents a huge pool of R&D money. The problem is how can we figure out a way not to have every new idea develop into a new company. How do we push these ideas within existing companies? (As quoted in Florida and Kenney 1988)

This point deserves emphasis: for the system of venture capital-backed innovation to succeed, the maintenance of a delicate balance is required. Too much venture capital may lead to more, but it can be detrimental from the point of view of the U.S. economy as a whole.

Furthermore, the U.S. possesses what is arguably the world's most innovative and comprehensive financial system. It is an important hub in global financial markets, renowned for its ability to create new financial institutions and instruments to address changing market needs -- witness the venture capital market, futures trading, and the securitization of mortgage markets. The venture capital industry is seen by many experts to be perhaps the most innovative and best performing segment of the U.S. capital allocation system. A recent study of corporate investment directed by Michael Porter of the Harvard Business School and sponsored by the Council on Competitiveness concluded that:

> The United States performs well in high-risk that require five-to-seven year investments and in funding emerging industries . . . In these cases, investors recognize that current earnings are irrelevant and seek other value proxies, such as patents and new product announcements which are more supportive of investment. Indeed, long-term prospects may be over-valued in some emerging industries. (Porter 1992. See also Sahlman 1991)

The U.S. venture capital industry does a good job -- an impressive job -- of channeling capital to industries and sectors where the rate of return is highest. As the previous chapter has documented, venture capital is extremely mobile, flowing from four or five major financial centers such as New York, Chicago, Boston, and the San Francisco Bay area to regions like Silicon Valley where high-quality investments are concentrated. In fact, two major venture capital centers, New York and Chicago, serve mainly to collect and export venture funds to high-technology regions like Silicon Valley and the Route 128 area around Boston.

This provides a telling contradiction of the capital gap myth promoted by advocates of government-as-venture-capitalist. During the 1980s, state and local economic development policy makers argued that regional gaps in the location and availability of venture capital were producing disparities in high-technology industry and employment. They claimed that government intervention in the form of locally subsidized venture capital pools was required to compensate for these capital gaps and stimulate local high-technology. But few of these programs generated any success at all, as the public venture capital was either invested in bad deals or was exported to good deals in other regions. Simply put, the evidence suggests that venture capital does not suffer from capital gaps with regard to technology or region. Indeed, venture capital flows to technologies and areas which offer a high rate of return. As we have shown, venture capital itself is highly mobile and flows to sources of profit, wealth, and productivity. When investments are not made, it is usually for good reason. The reason is typically that the investments themselves do not have what it takes to generate a sufficient return, not that the capital markets are biased, inefficient, or otherwise in need of government help.

The main problem facing the U.S. technology system is neither too little venture capital nor lagging critical technology. Rather it lies elsewhere, in R&D laboratories, factories, and startup companies themselves, which produce an impressive array of breakthrough technologies

but still fail to provide the follow-through required for long-term economic success. This is something that corporations -- not government -- need to address. The fundamental dilemma facing this nation is a long legacy of corporate mismanagement, which has left too many of America's largest corporations unable to restructure themselves to meet the test of global competition.

SUMMARY

Government's focus on quick-fix solutions like venture capital may make political sense, but it misses a much deeper problem in the U.S. economy and public policy. It is increasingly recognized that the problems confronting the U.S. technology system and the broader U.S. economy are systemic in nature. The United States, like all other technologically advanced nations, is caught up in a shift to a new age of industrial capitalism -- a shift to a high-performance economy -- where the keys to success are harnessing the ideas and innovative capabilities of all workers, from the R&D lab to the factory floor, to turn out the high-quality, state-of-the-art products the world's consumers want to buy (Florida and Kenney 1993a, 1993b; Drucker 1993).

Government interventions in the venture capital market, or in the production of critical technologies, can do little to address this underlying transformation. A systematic reshaping of government policy is required to support the new economy. Indeed, it is increasingly apparent that the current policy environment of regulatory, tax, and fiscal policies which grew up to meet the requirements of the old, mass-production economy is ill-equipped to meet the requirements of the emerging, high-performance economy. Worse yet, it may even be an obstacle to the emergence of that new system. American firms and managers operate within a maze of economic and policy incentives which were well suited to a mass-production environment, but which frequently create disincentives for needed restructuring along high-performance lines. Bank lending policies, for example, typically require that small and medium-sized manufacturers put up their inventory as collateral for bank loans -- a practice that impedes their ability to adopt the just-in-time inventory and delivery practices that are required of world-class, high-performance manufacturers.

The critical task for government is not to provide finance or invent new technologies, but to help put in place the incentive structure, business climate, and economic infrastructure required for this new, high-performance economy to flourish. The federal government could begin by eliminating biases in the tax code for real estate and other speculative investment; developing a more flexible and responsive system of financial and industrial regulation; drastically reducing mission-oriented military spending -- which enables companies to avoid the restructuring and commercial discipline required to compete in world markets; and shifting responsibility for technology and productivity-oriented programs and activities from the federal to the regional, state, and local levels, giving them the flexibility to develop the economic climates required for success in the new economy.

The bottom line of this analysis is clear. The brief review of the evidence provided here suggests that government involvement in venture capital is not necessary, is not likely to succeed, and may divert government's scarce resources from other, far more effective and efficient uses.

The venture capital market works very well. It channels money to technologies and industries that offer high rates of return, and plays a crucial role in the capability of the American economy to develop new breakthrough technologies and entrepreneurial startup companies. In fact, the U.S. venture capital industry is frequently cited as a great strength of the U.S. financial system and is envied by our major competitors around the world.

Government is not well suited to act as a supplier of venture capital. Research on previous federal small business financing programs and state and local venture capital programs overwhelmingly indicates that government is unable to perform the role of venture capitalist. In brief, the venture capital market does not need government's help, and the federal government is the wrong institution to play the role of venture capitalist.

APPENDIX

HISTORICAL EVOLUTION OF VENTURE CAPITALISM: REGIONAL INVESTMENT AND THE RISE OF INDUSTRIAL AMERICA

by Mark Samber

A historical perspective can help us to better understand current trends in venture capital and their implications for public policy. This appendix traces the history of venture capitalism since the dawn of the American industrial revolution. It shows, rather conclusively, that a key strength of the American economy has been the ability to create new forms of venture capital to finance and propel the growth and development of new technologies and industries. The rise of venture capital in the late 20th century to finance the new high technology industries of semiconductors, computers, software, multimedia electronics, and biotechnology reflects and reinforces this more general historical trend.

Venture capital calls forth an image of wealthy individuals and their syndicates grappling over predictions of which new start-up firms will yield the greatest investment return. These industrial concerns are usually linked to some yet-to-be-exploited technological innovation, usually in biotechnology, microelectronics, space-age polymer design, and/or computer software development. These types of firms abound in the portfolios of modern venture capitalists, in large part because conventional sources of finance capital consider the investment risks too high (Yntema 1947; Rubel 1975; Rubel and Novotny 1971). Since the early 1970s a staggering amount of venture capital has been invested across these fields.

Popular conventions aside, we associate venture capitalists with the economic expansion of the post-Second World War economy. But this understanding is only part of the picture. Undoubtedly venture capital had its birth and maturation in the postwar economy, but some very essential historical underpinnings occurred seventy-five years before the first venture capital firm ever contemplated its initial investment. This paper highlights the institutional developments that enabled venture capital to take off.

In 1946, Boston financiers of the New England Council, MIT faculty, and Harvard Business School administrators and faculty pooled their management skills, financial connections, and technological talents to establish the American Research and Development Corporation (ARD). Since heralded as the first venture capital firm, and largely responsible for changing the economic face of the region and beyond, ARD has occupied a mystical lure to public policymakers, venture capitalists, and entrepreneurial academicians alike (Etzkowitz 1990; Flanders 1945). ARD had to go through the same process of financial legitimation as the industrial concerns. It was capitalized with $3 million, underwritten in part by Morgan Guaranty Trust Co., a sign that some established financial intermediaries took the venture seriously. ARD was concerned with long-term returns and would place management in when they felt that the

founder was in over his head (look at the story of High Voltage Corporation and the Van De Graaf generator for a good illustration). ARD was charged with raising a $5 million risk-capital pool to use as seed money for the Boston region's scientist-entrepreneur base. Unable to reach that goal because investors thought the idea too far flung, the firm did raise $3 million and went on to fund the hugely successful Digital Equipment Corporation. ARD was ahead of its time for most financiers, but right on time in the historical evolution of venture capitalism as this paper will demonstrate.

Although the formation of ARD in 1946 seems a sudden change in the landscape of technologically-driven economic institutions, its founding did not occur in a historical vacuum, nor without prior or extraregional influences. The very nature and mission of ARD signified the formalization of a host of practices and processes already commonplace throughout the industrial regions of the United States. The novel characteristic of ARD was its visionary goal shared by a critical group of academicians and financiers. Although the vehicle to deliver that goal underwent enormous structure change throughout the early twentieth century, the main objective -- to earn maximum returns on investment -- remained the same.

In this essay, three periods of industrial growth will be reviewed in light of the manner of how capital investments help spur economic activity and bring to fruition industrial transformations: the ante-bellum New England manufacturing economy, westward railroad expansion and urbanization, and industrial maturation. From the early 1800s through the late 1850s the growth of integrated textile mills, machine tool manufacturers, shoe manufacturers, shipbuilding, and timber industries coincided with the emergence of new capital markets and lending institutions. The post-bellum mass manufacturing revolution saw newer forms of capital markets and institutions replace old ones and added new levels of complexity and sophistication to the process of acquiring capital. Spanning the late 1870s to the Great Depression, this era of laissez-faire capitalism was a boon to the industrialist interested in augmenting his manufacturing interests through very "high-risk" ventures. Numerous depressions and economic panics from 1870 to 1925 contributed substantially to the credit crunches endured by businesses -- this was the case in the periods 1871 to 1877, 1893 to 1898, and the years 1907 and 1921. Successive developments in technology, finance, and industrial organization over these decades provide the basis for the emergence of institutionalized venture capital in the postwar period. Reiner labels the investment behavior during these formative decades proto-venture capital activity. Pointing to shifts in technology, investor's psychology, markets, and institutional practices that began to change the environment of venture financing, Reiner exposes characteristics of venturism before they appear in their modern form.

As Reiner has argued, the context for understanding the post-Second World War emergence of venture capital lies with these macroeconomic transformations of the twentieth century. Other contemporary scholars of venture capitalism have recognized the similarities of industrial entrepreneurs with modern venture capitalists. John Wilson (1985) likens the pioneering industrialists of the late nineteenth century, to twentieth century "brokers of risk," both were confronted with new corporate challenges to the American "competitive edge."

An examination of the investment activities of entrepreneurs and industrial capitalists during the late-nineteenth and early-twentieth centuries will begin to determine whether or not their behavior reflects the investment practices commonly associated with modern venture capitalists: equity participation and moderate levels of management control. The persistence of certain investment patterns demonstrates that venture capital and entrepreneurial investing are parts of a larger system of capital formation and therefore inextricably linked to the growth of the American economy. Establishing a continuity of investment behavior between modern venture capitalists and Gilded Age industrialists may bring into focus the reasons why modern venture capital emerged and illustrate the contrasts between the two.

In order to compare contemporary and historical investment practices, the following questions serve to indicate the entrepreneurial spirit. First, were the kinds of business investments of Gilded Age industrialists and entrepreneurs on the cutting edge of technology? (Cutting edge technologies can loosely be defined as products or processes that exploit new markets, reorganize firm structure according to some new management vision, or introduce more efficient production process methods.) Second, what was the nature of the investors' relationship to the management structure of the firm? Third, did wealthy industrialists develop formal or informal networks of investment syndicates to which they turned for information, capital, or advice? Fourth, were there discernible patterns of investment activity along geographic lines? In other words, was there a locational consideration in the mind of the industrial entrepreneur? Fifth, was investment in a prospective enterprise considered a "high risk" by the established financial community? Finally, were there discernible patterns of investment activity based upon initial manufacturing sector involvement of the capitalist? Stated another way, would an initial interest in electrical railroad equipment lead an industrialist into railroad rolling stock investment, or perhaps into other electrical transportation systems? (Florida and Kenney 1988d)

This historical retrospective on the process of capital investment in the rise of American mass production industries should demonstrate clear but overlooked continuities in the relationship between technological innovations, industrial development, and investment capital.

THE TRANSFORMATION OF NINETEENTH-CENTURY INVESTMENT PRACTICES

Lance Davis, one of the foremost economic historians of capital formation in American industry, argues that the American economic scene has been plagued by regional and interindustry bouts with capital immobilities. According to Davis, industrial tycoons of the late-nineteenth and early-twentieth centuries had a talent to overcome these capital immobilities. Their entrepreneurial vision compensated for the market's failure to provide enough investment capital to fledgling industries. As a result, the role of entrepreneurs in the stimulation of new and leading edge technology-intensive industries was paramount (Davis 1963). The decline of these individuals' importance in the capital marketplace indicates a decrease in the inflexibility of capital as new institutions developed to formalize the role of entrepreneurial industrialization. Davis argues that capital immobility became acute in the post-bellum decades because capitalist

firms required external finance as a result of industry's westward migration, technological innovations in manufacturing that increased throughput, and the requisite greater capital requirements of these changes. As evidence of capital's immobility, Davis points to the New England textile industry. The region had the most advanced capital markets in the nation, yet none of the capital moved into the South despite the South's intricate involvement in the existence of a textile industry in Boston. In the West, capital immobility was experienced in nearly all industries, and local pooling of capital was necessary to help these industries manage the well developed eastern capital markets. Throughout the nineteenth century capital remained a major obstacle to developing industries. Local pooling, however, was a viable recourse, and in regions like Pittsburgh, was essential to the development of a securities exchange, clearinghouse, commercial bank financing, and industrial expansion.

Lance Davis' argument about the source of industrial finance in the American textile industry pushes the theory that capital accumulation has two sides: the saving of capital and the mobilization of capital. Both depend on the age of the firm and the historical period of the firm. Davis attempts to analyze a firm's capital structure in relation to a particular historical period and the age of the firm within that period. For example, he finds, in the historical period 1827-1860, a firm's equity was its most important source of capital but that the relative importance of this source declined as the firm matured and as the historical period waned. Davis seeks to understand why equity was not a more sought-after form of capital accumulation. After all, equity was readily available to New England textile firms because of the development of formal equity and bond markets in Boston and New York. One possible diminishing effect is that a multiplicity of capital-generating markets lent more opportunity for choice in accumulating capital. Not only were stock and bond markets developing, but by the 1890s long-term loan capital from credit intermediaries such as banks, trust companies, and life insurance companies flooded the market with opportunity. Also changing during this time period was the make-up of institutions involved in industrial credit markets. These new intermediaries shifted some of their resources from purely government securities and mortgages to industrial investment markets (Goldsmith 1958). These changes -- more diverse players in the market -- led to an increase in the percentage of loans to equity for capital accumulation. Moving in a countervailing direction was the percentage of retained earnings that a firm had available for capital mobilization as the age of the firm increased (Davis 1957; Davis and Payne 1958; Johnson and Supple 1967).

Through a statistical study of Boston, Davis shows that the Boston credit market -- divided into long-term and short-term -- also was characterized by geographic distinctions. The short-term market was integrated into a larger Northeast regional market, encompassing New York as well. The long-term credit market remained wholly situated in the Boston area, reflecting a more intimate relationship between lenders and borrowers. The types of actors in each credit market also differed. Analysis of eight different types of lenders and different categories of loans shows that the long term market was dominated by savings banks and trust companies (Goldsmith 1958; McGouldrick 1968). Loans between 30 days and 12 months were dominated by commercial banks. Most interestingly, mercantile houses remained active credit providers throughout the ante-bellum years, and that their activity increased significantly during tight credit market periods when mills found it difficult to borrow money. A major part of this

analysis has to do with interest rates and tracking their fluctuations (hovering around 6 3/4 percent). In most respects, the pre-Civil War markets behaved much like the modern credit markets except for the phenomenon of lower long-term interest rates than short-term interest rates. Since 1929 that is a rare occurrence; during 1840-1860, it was the normal state of things (Davis 1958; Davis 1960).

The rise of industrial securities began to loosen the immobility of capital, as newly formed companies sought out stock offerings to raise capital quickly. In a seminal article by Thomas Navin and Marian Sears, the growth of stocks and bonds indicates a venture capital-like behavior pattern and set of preconditions for investments in industrial securities. They cite an investor's knowledge of manufacturing processes, competence and continuity of management, and innovative business approach as high priorities for running a successful industrial enterprise (Navin and Sears 1955). Spurred on by a mismatch of resources and needs, the impetus for industrial securities came about during severe financial crisis. Problems of capital inflexibility (due to the absence of a industrial securities market) and uncertain management succession were compounded by increasingly competitive market conditions. The pressure exerted by these forces set in motion the transformation of the traditional business institutions into modern industrial corporations. One of the most significant developments to crush capital immobilities and usher in a sea-change in the practice of industrial financing was the impact of the 1893-1897 depression on the then fledgling industrial securities markets. Navin and Sears argue that the 1893-1897 depression was a turning point for the fortune of industrial securities, which had previously been scarred by a lack of confidence in their performance value and investment quality. Poised on the precipice of a new industrial order, Navin and Sears argue, the American economy could not have pushed forward without the accomplishment of a host of institutional and social changes (Navin and Sears 1955). One of these was the creation of a market for industrial securities, without which there would have been a much slower movement toward big industrial concerns.

Concomitant with the rise of increasingly complex capital markets was the appearance of corporate trusts. The role of trusts is important in considering the rise of marketable industrial securities because trusts provided a vehicle for enormous amounts of capital to be commingled and leveraged against future investments. Trusts pooled the stock values of smaller companies into one large "trust" whereby the value of the trust's certificates was greater than the sum of its parts, thereby giving the syndicate a big investment advantage. The gradual acceptance of corporate securities as capital aided trust formation because the principals involved in creating trusts were first to risk their money on corporate securities. As a result of this, preferred stocks became the first widespread security partly because they had been an accepted part of railroad securities, and because investors could use their share of preferreds as capital raising devices, regardless of the profitability of the corporation (Pontecorvo 1958).

Parallel to the development of trusts, corporate mergering soared between 1898 and 1905. This movement toward the consolidation of business operations under one management umbrella required massive amounts of capital buyouts, and contributed to the rise of industrial securities markets. Perhaps the most famous and notorious, a merger and acquisition occurred between

Andrew Carnegie's and John D. Rockefeller's steel interests, to the tune of $1 billion. Mergers, both large and small, created major publicity around industrial concerns which delighted investment bankers bent upon getting public offers for newly generated stock (Navin and Sears 1955). The publicity attracted greater numbers of speculators, meaning more capital flowing into the entrepreneurial coffers.

These processes of corporate recapitalization -- Mergers and Trusts -- fueled the fire for more marketable industrial securities. Firms like Westinghouse began using brokerage houses and investment bankers to market securities as a method of recapitalization. In 1891, August Belmot & Co., a leading investment banking firm, helped organize Westinghouse's stock issuance after an ill-fated attempt to secure local investment capital from the region's leading venture capitalist, Andrew Mellon. The decision by Westinghouse to approach the New York investment banking community indicates the growing complexity of capital markets and industrial financing. Even though Pittsburgh bankers could have handled Westinghouse's account the draw of New York was more appealing.

In the aftermath of the merger frenzy, many large corporations were saddled with new forms of debt and huge amounts of capitalization. The prevalence of large corporate bureaucracies ebbed the effects of entrepreneurial decision making for capital investments. Salaried managers, unlike vested proprietors and entrepreneurs would be more prudent with the assets of the firm as shareholders held sway over their tenure in the firm. Thus, the very process that facilitated capital mobilization reinforced a new form of industrial financing counterproductive to the entrepreneurial investing which made the new corporate entities possible; capital stagnation set in.

Not all investment capital arteries became clogged after the turn of the century. The continuity of foreign capital presented a less constrained alternative source of funds usually earmarked for "risk oriented" ventures. The argument has been made (Davis, Easterlin, et al. 1962) that foreign capital investments were mainly targeted toward innovative and risky ventures and that by the time the consumer economy of the mid-1910s approached its investment maturity level, that is the point at which returns to scale of invested capital diminishes, foreign capital ceased to be an important and free flowing source of funds. Of the many ways industrialists sought to obtain capital to finance expansion, the infusion of foreign capital became a widespread option for cash-starved manufacturers in the mid-nineteenth century and remained so into the twentieth. The enclaves of immigrant groups in Boston, New York, and Philadelphia maintained close ties with their home countries in Europe. Add to this equation the familiarity of the older established European financial institutions like the Rothschilds and Lloyds with American financiers such as J.P. Morgan, Cornelius Vanderbilt, Henry Villard, and Nathaniel Thayer, and participation by European capitalists in new ventures became an attractive prospect. According to Thomas Cochran, the recommendation or participation of a Cornelius Vanderbilt or John Murray Forbes "was a sufficient guarantee to attract foreign capital" (Cochran 1950; Josephson 1962).

Throughout the transformation of investment financing the federal government played an important, if sometimes indirect role. Legislation like the Sherman Act of 1890 and the Federal Reserve System Act of 1914 spoke directly to the business community's practice of trust formation and the strain it placed on the national banking system. In the 1920s the federal government began to involve itself in credit market activity (Davis, Esterlin, et al. 1962). The separation of commercial and investment banking, mandated by the Glass-Steagall Act of June 1933 defined the practices and helped to settle the financial disarray of the depression. Banks in the Federal Reserve System were required to divest themselves of securities, reduce their bond writing and underwriting capacities to only federal, state and municipal bonds, and board membership could not be shared between FRBs and security houses. First Boston formed in the wake of these changes in 1934 as a leading investment banking house; the commercial banking concern of the First National Bank of Boston was the original firm before the legislative changes. Morgan Stanley followed suit in September 1934, organized out of JP Morgan and Company and Drexel & Co. (a Philadelphia firm not in the lineage of Drexel Burnham Lambert). In the aftermath, three types of investment firms carved out niches in the market: (1) the old liners Kuhn & Loeb and Lehman Brothers; (2) the new houses, Morgan Stanley and First Boston, and (3) the new partnerships of former commercial banking officers like Smith Barney and Kidder Peabody. This new community had a very tight-knit kinship of investment partners (Carosso 1973; Carosso 1970a).

Yet homogeneity and informal networking were not new facets of a new and complex industrial financing infrastructure. As Barry Supple's article in the Business History Review shows, the entrepreneurial aspects of business formation, most notably financing, revolved around community identity and the social mobility and status achievement of a group of German-Jewish emigres. According to Supple, the German-Jewish financial community remained a close-knit group in part due to the common language, religion, and courtship customs. Even after achieving success in the financial field, Jewish financiers continued to converse in the native tongue, adhered to their religious heritage, and promoted intermarriage between the sons and daughters of German-Jewish banking firms and financial houses. Also providing us with an important glimpse at the nature of the business finance community is Supple's analysis of the similarities between the growth of the Jewish financial houses and the growth of the Yankee houses -- both relied on their cultural roots in Europe to tap into established bases of capital (Supple 1957).

With all these financial forms in place (structural and technological), why did venture capitalism, as it is now recognized, not emerge as a formalized concept until 1939? Indeed the kind of investing characterized by Gilded Age industrialists flowed freely into high-risk ventures, not unlike the role of venture capital. Essentially, the environment of large-scale financing for small-scale ventures and the availability of investment capital that would sustain a segmented financial market did not yet exist. According to Catherine Reiser, only after a sharp decline in informal venture investing, the cessation of institutionally financed venture capital-like functions, the rise of internal corporate venture financing, and the rise of government financing in the wake of the New Deal, did the need for formalized venture capital become salient.

FROM RELATIONSHIP BANKING TO INSTITUTIONAL INVESTMENT SYNDICATES: THE TRANSFORMATION OF INDUSTRIAL FINANCING IN NEW ENGLAND

Recently Naomi Lamoreaux wrote about "insider lending" as the key to industrial growth and investment opportunities for the region's industries. Lamoreaux identifies the major function of lending institutions in the region. As banks formed throughout the region's towns, they provided basic savings and loan functions. The lending aspect became a focal point for all commercial transactions; savings were not a significant component in a bank's commercial ventures. These early-nineteenth-century banking institutions were virtually unlike their modern counterparts. Banks had no branches and often only had few employees and a handful of directors. As far as bank operations were concerned, they differed considerably from modern practices as well. Banks had deposits, but most lending capital came in the form of bank-issued notes and bank capital stock.

The most important type of early loan for commercial purposes was the accommodation loan. A borrower would request a loan from a bank, having guaranteed endorsers sign the note. These were common forms of short term debt that borrowers used to invest in manufacturing plant and equipment. As these transactions became more popular, some banks repeatedly renewed the notes, converting short-term notes into long-term debt.

The role of banking in creating new investment opportunities for manufacturing reflects the nature of banking, unfettered by extensive regulations, and the burgeoning industrial community, placing high demands on the capital markets of New England. Common bank practices fed a system of investment not wholly unlike modern venture capitalism. Banks often lent capital to their own directors, who in turn, funnelled those funds into manufacturing enterprises. In effect, the growing percentage of banking institutions with entrepreneurial directorates, often interlocked and engaged in mutual ventures, created an environment in which risky investments in manufacturing technology obtained virtual carte blanche through their insider positions in the institutionalized capital market. In New England this was not the case. Most bank relationships with entrepreneurs were cozy because entrepreneurs often sat on the bank boards. This led to an environment of relationship banking. As the New England system evolved and industrial economic development enjoyed success, the intimacy between banks and manufacturers began to erode and the very system of high-risk ventures declined.

From the relationship banking exemplified in New England emerged an institutionalized system of industrial financing and investment. In Vincent Carosso's landmark study of American investment banking, the major patterns of industrial financing in the United States throughout the late-nineteenth and early-twentieth centuries are identified. The close-knit ties between private bankers, the largest group of industrial financiers, and businessmen created an era of banking known as relationship banking. According to Carosso, the bulk of these relationships involved fledgling industries on the cutting edges of their respective technological fields. As railroad securities and bond offerings developed further during the 1870s and 1880s, the personal networks of bankers and railroad industrialists formalized. "Bank representation on railroad directorates . . . was an institutionalization of the close personal ties that commonly

had existed between bankers and railroad officials" (Carosso 1970b). The structure that emerged to serve the burgeoning railroad industry provided the example for industrial firms to follow. As the increase in industrial partnerships and corporate reorganizations gathered steam in the 1890s, investment syndicates emerged to provide needed investment capital. These syndicates emerged because the immense size of industrial capitalization prevented any one firm from bearing the burden of underwriting corporate financing. In the wake of these changes, railroad securities declined on the securities markets and industrial securities assumed the predominant role in the marketplace. Sophistication on the part of investment bankers was necessary to accommodate the investment needs of these new firms.

The significance of the railroad on the transformation of the American landscape is a well known fact. It opened up the vistas of the West for agricultural settlement, mining prospects, commercial trade, more efficient communication, and the fulfillment of a spirit of manifest destiny. Similarly, in the realm of economic development the railroads have been identified as providing a huge spark in the engine of the second industrial revolution. Though contested by some historians, most economic historians agree that the rapid development of the railroad ushered in new paradigms of economic organization, manufacturing processes, financial accounting, communication, and management coordination and control. On a macroeconomic level, the railroads also created increased demands for manufactured parts, generated huge demands for labor, and solidified the existence of a "free" and national market for goods and services. In addition to all this, the railroads stimulated another significant transformation in the American economy: the expansion of capital markets.

The standard type of nineteenth century American railroad bond was secured by the mortgage on the road's property and was convertible to stock at the holder's option. The main difference is New England where stock subscriptions financed the railroads. Al Chandler believes the pattern of railroad finance in New England was similar to its manufacturing capital campaigns. Boston's financial self-sufficiency led to success and surplus which became a well-spring for western lines in Pennsylvania and Maryland. Boston replaced Philadelphia as the financial center of railroading. Even the westernmost operations (the Michigan Central Line and the Pittsburgh & Shawmut Railroad) were Boston financed operations, indicating the closely knit community of Boston financiers (McGouldrick 1968). The 1847 panic changed all that for Boston. Bond issuances now replaced common stock offerings and Boston reeled from the changes.

The greatest strides of railroad expansion came between the 1840s and 1880s, concomitant with the growth and sophistication of capital markets and the rise of the American system of manufacturing. In 1849, at the beginning of the railroad boom, invested capital in the railroad industry totaled $318 million. By contrast the amount of invested capital in manufacturing industries stood at $533 million. By 1889, admittedly before the great merger movement and phase of manufacturing consolidation and incorporation, the railroad's invested capital soared to $9,680 million and manufacturing industries rose to $6,525 million. Increasing invested capital by greater than a factor of 30 reflects a substantially rapid rate of growth. According to Thomas Cochran it was the result of primarily securing the capital through New York, Philadelphia, and Boston security markets.

THE ENTREPRENEURIAL TRADITION RECAST: FORGING INDUSTRIAL REGIONS

Like Boston and the surrounding hinterland of New England, the economic activities in the Pittsburgh region progressed with the help of intimate networks of banking houses, entrepreneurs, speculative markets, and innovative industrial enterprises. Although commonly thought of as an iron and steel region, Pittsburgh's various other industries attracted tremendous amounts of capital and made many a millionaire in the waning decades of the nineteenth century. The story of these fortunes illustrates the venturist behavior and high risks undertaken by industrial capitalists. It also illustrates the confluence of technology, developing financial intermediaries, entrepreneurial vision, and regional scale economies, separately discussed in this paper.

Alfred Chandler, leading historian of American business, argues that entrepreneurial activity was the mainstay of economic opportunities in the nineteenth century. Entrepreneurial activity was, by its nature, profit seeking and dependent upon the demands of the market for the goods or services the entrepreneur had to offer. Chandler is interested in the new conditions that affected entrepreneurial opportunity in nineteenth-century America (Chandler 1963). Mercantilism, fueled by the cotton crops of the South had an enormous effect on the growth of trading centers in New Orleans and New York, which in turn engendered increased urbanization. This shift toward economic independence created new opportunities for entrepreneurial activity. Railroads also created new opportunity as new markets for industrial products and as hasteners of the demand for products across vast distances thereby expanding markets. This engendered further developments in other industries which paved the way for additional entrepreneurial opportunity. The solidification of the urban-industrial metropolis on the American landscape provided a sustained spark for entrepreneurial activities. In Pittsburgh, Andrew Carnegie's decision to shift his mill investments from steel rails to structurals in 1887 more than symbolized the firm place of urban metropolis in American entrepreneurial activities (Chandler 1963).

As the center of industrial manufacturing shifted westward with the growth of iron production and demographic changes, so too, did the importance of financial institutions shift westward from the coast to local private banking firms. One of the pivotal families in Pittsburgh's industrialization has been the Mellon family: icons in American economic growth, and the embodiment of Alfred Chandler's 19th-century entrepreneurs. From their early holdings in real estate and banking, Judge Thomas Mellon and his Sons, Andrew W. and Richard B., amassed an impressive array of manufacturing investments ranging from oil exploration and aluminum production to structural steel manufacturing and railroad car companies. Such diverse investments were uncommon among turn-of-the-century industrialists because most financiers wanted to retain close control of the management structure and lacked the financial and personal wherewithal to succeed in "venture capital" investments. Thus, the gift of management Andrew and Richard Melon parlayed across manufacturing, public service utility, financial, transportation, and mining industries was not only rare, but unparalleled.

The eventual control of nationally prominent industrial concerns stemmed from extensive real estate, banking, and agricultural properties amassed under the conservative investment behavior of Judge Thomas Mellon. In 1869, the Judge, along with his two sons, Andrew and Richard established a banking house in Pittsburgh. Judge Mellon built the bank on the principles of sound lending and a diverse customer base (Koskoff 1978). The fact that Judge Mellon ensured that "its investments covered almost every phase of commercial activity" was not lost on the Andrew and Richard during their forty-year reign over investment capitalism in Pittsburgh. This resulted in a network of closely interwoven financial and industrial enterprises.

The first major investment by Andrew Mellon involved underwriting Henry Clay Frick's coke metal business in 1871. This early partnership demonstrates Mellon's astute ability to "pick a winner" and his shrewd business style. According to the terms of the loan contract, as the H.C. Frick Coke Company expanded its Connellsville mining operations, providing more metallurgical coke for the nation's steel industry, profits from the loan accrued to Andrew and Richard Mellon. Unlike many of their later investments, the deal with Frick did not provide the Mellons with equity in the firm, nor did it stipulate extensive hands-on control of the firm. Perhaps in this contract Mellon recognized the determination and managerial potential of Frick.

In subsequent Mellon ventures, the laissez-faire approach used to finance the Frick Coke operations was not repeated. The evidence from all subsequent successful investments suggests the Mellons' abandoned their behind-the-scenes management style and assumed a more ruthless style. In 1889, Arthur Vining Davis and Charles Martin Hall, inventors of an electrolytic process for commercially viable aluminum production approached the Mellon brothers for a $4,000 loan to develop a full scale manufacturing plant to produce aluminum. Davis and Hall approached the Mellons because by 1889 their reputation for commercial lending placed them at the top of Pittsburgh concerns. The deal Andrew Mellon struck with Davis and Hall consisted of a larger line of credit, real estate in Pittsburgh's mealworking district along the Allegheny flood plain, and management and equity participation in the new firm: The Pittsburgh Reduction Company. This one investment would eventually come to pass as the Mellon brothers' largest and most profitable undertaking.

Soon after the Pittsburgh Reduction Company had its aluminum smelting up and running, the Mellons were approached by George Westinghouse in late 1891 for a loan to help finance Westinghouse's increased production of air brakes in anticipation of pending federal rail safety compliance regulations. Like Davis and Hall, Westinghouse sought Andrew and Richard Mellon because their lending reputation overshadowed all other local financial interests. The Mellons drove a hard bargain with Westinghouse. They demanded a high percentage of equity in his air brake and electrical equipment divisions, a counteroffer which Westinghouse deemed untenable; he had been given a similar ultimatum when launching the air brake company in 1869, by Robert Pitcairn, then Vice President of the Pennsylvania Railroad. Westinghouse came away from the deal empty handed, and with a bitter distaste for the baronial Mellons (Hersh 1978; Harvey 1928). In subsequent refinancing attempts, the Westinghouse Company looked outside the exclusive Pittsburgh enclave.

Fueled by enormous profits from their earlier successes, the Mellon ventures became bolder and began to settle into a discernable pattern. Preference for chemical process-industry investments, high equity participation, and tight managerial reins reflected the Mellons' strategy. The investment portfolio gained a new constituent in chemicals in 1895, after a visit from the inventor of a chemical abrasive known as carborundum. Edward Acheson, entrepreneur/inventor came to the Mellons in search of loans for his small electrochemical business. Familiar with the aluminum process, the Mellons were impressed with carborundum and its cutting powers. They immediately established an interest free loan in return for company stock and directorships. This equity financing approach came to be the hallmark of Mellon-financed industrial ventures and most certainly facilitated Andrew Mellon's rise to directorship on fifty national corporations before summarily resigning from them all in 1920 (Mellon and Sparkes 1948).

Continuing their preference for chemical process industry investments, the Mellons funded personal friend John M. Guffey's petroleum exploration in the Eastern Texas oilfields near Spindletop during the summer of 1900. Despite the enormous oil reserves Guffey found, his management skills concerned the Mellons and in 1903 they forcibly removed him from J.M. Guffey Petroleum Co. and reorganized it under the Gulf Oil and Refining Co. The strategy for this move consolidated the exploration, transportation, and refining of petroleum into one integrated centrally managed firm under their stewardship. The resulting conglomerate went head to head with the Standard Oil Trust, chipping away at its domination of the lucrative American petroleum products market.

All Mellon ventures did not revolve around manufacturing or industrial process firms. Some included street traction lines, municipal water authorities, public utilities, and land development companies in industrial boomtowns throughout the Southwestern Pennsylvania region. But one nonmanufacturing investment stands head and shoulders above the rest, and reflects the Mellon brothers' penchant for chemical process investments. In 1909 Mellon read an account of an applied Chemistry Lab at the University of Kansas and spent the next two years convincing the founder, Robert Kennedy Duncan, to relocate in Pittsburgh. Given Mellon's extensive industrial investments the R&D prospects of Duncan's "The Chemistry of Commerce" meshed with the Mellon empire of chemical interests. In 1913, the Mellon Institute of Industrial Research opened as a center for metallurgical and chemical research, operating in close association with local industry through fellowships and formal contract research.

The last significant piece of the industrial chemical empire created by the Mellons in Pittsburgh saw the establishment of Heinrich Koppers Company. Koppers was lured from Chicago, where he had first ventured into the American market from his native Germany, and, the Mellons quickly acted to invest in Koppers' by-product coking methods. In 1915, the Koppers Company became another part of the Mellon family of process firms. Two years later, under the Alien Property Act, the Mellons assumed 70 percent of the firm's interest after Heinrich Koppers was forced to surrender all his equity in the company.

Rounding out the clearly venturist portfolio of Mellon investments were two very important endeavors into the fabricated metals industry: the McClintic Marshall Construction

Company of Pittsburgh, and the Standard Steel Car and Wheel Company of Butler, Pa. The story of McClintic Marshall recalls the Alcoa story. In 1899, two engineer inventors, Howard McClintic and Charles Marshall, approached the Mellons looking for a loan to start a new business. Both gained experience in structural steelmaking and bridge construction at the region's leading bridge firms (Ambridge, Fort Pitt Bridge Works, and Keystone Bridge). The Mellon brothers, aware of the skyscraper building boon and recognizing the potential to compete with industry heavyweights, responded to the investment pitch with their tried and true demand for substantial equity participation and management control. For the next thirty-two years, McClintic Marshall remained in the hands of the four principals, all profits accruing to them, until purchased for a handsome price by Bethlehem Steel. Standard Steel Car, like McClintic Marshall, experienced virtually the same growth pattern under almost the same conditions. Established after a loan pitch from David T. Schoen, former proprietor of Schoen Pressed Car Co., which he lost in a takeover battle to local competitors, Standard Steel Car presented an opportunity for the Mellons to compete with an industry leader. Eventually Standard Steel Car would merge with the industry's reigning railroad car builder, Pullman Car Company of Chicago.

The small banking and real estate business that began with Judge Mellon during the dawn of Reconstruction rose to an impressive array of business investments at the twilight of the Gilded Age. In four decades, the Mellon empire became the foremost capital investment house in the country. Characterized by demands for equity participation and tight-fisted management, the Mellon brothers swiftly gained control over vast industrial operations. The manner and style in which the Mellons made investments reflects the approach taken by early venture capitalists. Both sought high profits from risky ventures. Both invested in the latest technology. Both used their investments to leverage against new ventures. Both demanded equity positions in the firm.

The Mellons were not alone in their venture capital-like prospecting and entrepreneurial domination. As the twilight approached the Pittsburgh empire, further west a new manufacturing infrastructure cast its shadows on a barren landscape. Henry Kaiser led the transformation of the West into an industrial region by the 1930s. Kaiser and other visionary entrepreneurs of the West saw industrial growth coming out of a successful construction campaign that included roads, bridges, tunnels, and dams. A key to his success lay in his ability to curry favor with the big bureaucracies in the federal government created by the New Deal. Much of Kaiser's success in the West rested on two of his personality traits: his brash confidence in making a manufacturing venture work, and his deep-seated resentment of eastern domination of the West's industrial growth. Kaiser boldly established manufacturing capacities in new industries, often without the technical expertise, and vigorously pushed for the construction of the world's largest steel plant, much to the chagrin of US Steel and other eastern establishment types. The wartime boom, and federal pressure to end Alcoa's aluminum monopoly gave Kaiser a considerable push in the development of western manufacturing. Kaiser's hard-fought battles for these basic industries and infrastructure made possible the success of Aerospace, high-technology, and entertainment (Foster 1985).

PRECURSOR TO MODERN VENTURE CAPITAL: FORMALIZED NETWORKS FOR INNOVATION

Huge industrial combines, dizzyingly complex financial institutions, dormant entrepreneurialism, and increased federal meddling characterized the capital markets of the 1910s and 1920s. By 1929, the pattern of raising investment capital for industry had become complex and fixated on the needs of large and established industries (Kuznets 1961). The institutionalization of lending in nearly two dozen forms, and the expansion of services provided by the older core intermediaries like commercial banks and insurance companies made the capital marketplace a highly specialized and sophisticated vehicle for capital delivery to investment-starved corporations. These forms included Federal Reserve Banks, commercial banks, savings banks, savings and loan associations, credit unions, the Postal savings system, personal finance companies, life insurance companies, private pension funds, federal pension funds, land banks, mortgage companies, investment companies, investment bankers, securities brokerage houses, government lending institutions, and trust funds. Similarly, the shift from predominantly equity investment capital financing to debt financing after 1900 removed the element of personal involvement in the management of the firm, especially when coupled with a general increase of incorporated firms and a decline in limited partnerships. The problem of attracting capital to one's firm for plant or equipment improvements no longer revolved around convincing a wealthy industrialist to purchase equity in the firm, or reinvesting retained earnings, but became a matter of what method of financing would a firm choose, and which institution would handle the underwriting and selling.

It was common practice in the 1870s and 1880s, when commercial banks dominated the capital markets, for start-up technologies to approach established industries for investment capital. Take for instance Andrew Carnegie's venture into steelmaking, which was funded through equity gained in partnerships with established iron producing families of Phipps, Kloman, and Shinn. Similarly, George Westinghouse's air brake concern became a reality only after John Pitcairn, Pennsylvania Railroad President, secured an equity investment in the company. The establishment of H.J. Heinz also fits the equity participation model. L. Noble, a successful brick firm backed the Heinz food pickling idea and the company was launched as Heinz & Noble Co.

The problems of raising capital to invest in manufacturing became all too acute in the 1930s as the Great Depression ravaged all potential investment opportunities for small and medium sized enterprises. Justifiably, anyone or any institution with lending capital refused to lend it to even the most secure borrowers. The established securities markets and capital lending institutions were tentative in raising capital for even the low-risk investment requirements of the established industries (Carosso 1970b). In the private sector, financiers like Jock Whitney and Laurence Rockefeller began organizing risk-capital pools. These pooled resources of finance capital were targeted toward "high tech" projects that would turn around the industrial manufacturing sector by providing a jolt to the system and lift the whole nation out of the economic doldrums (Wilson 1985). The group most aware of the problem was the generation of Laurence S. Rockefeller and Henry Ford II. Children of the generation that had lived through the transformation of American industry and financial intermediaries, and had amassed huge

fortunes, elites like Laurence Rockefeller needed new ways of creating more wealth as old ones ossified.

The scarcity of available capital set in motion public as well as private efforts to resolve the capital crunch. Posing a grave threat to the economic stability of the country, lagging small business investment needed federal intervention. The Commerce Department commissioned studies to stem the ebbtide of capital. One of the most significant accomplishment of the Commerce Department studies, in addition to the National Bureau of Economic Research programs, was the eventual formation of the Small Business Administration in 1953 and its SBIC program for high risk investments in 1958. The need for SBICs came about primarily to redress two shortcomings of the open capital and securities markets. First, in the trough periods of the business cycles, lenders looking to persevere in adverse business conditions became tight-fisted and refused to extend capital to prospective entrepreneurs (Kuznets 1961). As a result, small businesses lacked avenues to obtain capital, either in the form of debt financing or equity investments. Second, established money lenders, especially in economic downturns, totally ignored high-risk ideas. Small business ventures fall into the high-risk category, as do new technologies, and therefore both struggled to secure capital. This was of grave concern to the business community.

The upshot of all this renewed attention to start-up capital was a bifurcated program of supplying capital to stressed markets. In the public sector, it wasn't until the early 1950s that a formalized program was set in motion, and even then the amounts it invested were relatively small. Private syndicates, most notably the Rockefellers' and the Whitneys' started their "new venture" investing as soon as World War II ended.

The embodiment of this new desire for small business financing forged a relationship of university and industry entrepreneurial endeavors to fill in the gaps that established industrial concerns avoided. A few elite academic institutions presented themselves to the venture-minded investors as logical and beneficial partners in any new form of economic investment activity based on the latest technologies. MIT led the field of academic contenders (Etzkowitz 1990). Given MIT's historical commitment to industrial-academic partnerships dating back to the vision of MIT benefactor, William Barton Rogers, and their early role in academic consulting, the entrepreneurial spirit permeated many faculty. The faculty were also ones who pursued academic and business careers. Many departments, like electrical engineering, got into the act. The Massachusetts Institute of Technology sponsored ARD (a venture capital firm), the idea for which grew out of MIT's longstanding and respected industrial liaison program. During the 1930s, with a more articulate patent application procedure (evidence that MIT recognized the pecuniary advantages of proprietary technology), MIT began to look into direct industrial involvement with companies like Raytheon. Regional leaders such as Ralph Flanders, Vannevar Bush, Karl Compton, and Horace Ford had a vision for turning the Boston-Cambridge region into a center for technology-intensive enterprise. Ironically, they looked to the example of the Mellon Institute in Pittsburgh, sponsored by Andrew Mellon as a testbed for his industrial investments for a model of commercially exploitable industrial research activity. Compton linked up with a private development agency (the New England Council) to address the decline

in particular New England Industries like machine tools. The role of this partnership was to identify the problem (like a lack of reinvestment in the region), come up with new products (MIT research), get access to the funds, and provide continuing management support (Etzkowitz 1990). One of the problems identified was with small firms that had become lame. Revitalization was not feasible so they assessed the situation, and realized a new vehicle for small manufacturing growth was needed in the region. After the war ended, ARD was formed and the first venture capital company was well on its way toward revolutionizing regional economic investment.

In 1939, at the annual meeting of the American Investment Banker's Association, the term venture capital was first applied to the problem of stimulating investment in small-scale manufacturing and commercial ventures. To overcome the pitfalls of financing new industrial ventures in the mid-twentieth century, a combination of public and private partnerships embarked on a path toward institutionalizing the process of capital formation in high-risk and new-technology industries. With government sponsorship (the SBIC), academic resources (MIT and HBS), and Eastern establishment elite wealth (Whitney, Rockefeller, the New England Council), a formalized system of making available capital for new technology ventures was formed. The Great Depression and World War II put the brakes on an already slowing movement of capital into new manufacturing ventures. Yet other obstacles stood in the way of a dynamic industrial process insatiably creating new capital opportunities through technology and economic prosperity. One of these was the domination of large scale corporate bureaucracies. As a result of the Depression, virtually all new investment in manufacturing ceased. Changes in capital structure in industrial financing point to the growing distinction between venture capital and industrial capital, setting in place a corporate reliance on debt financing. Additionally, the type of debt financing has shifted more towards short term as opposed to long term. This combined with the secular development of the financial intermediaries has had an effect on long-run corporate finance patterns. The increase of debt financing of physical capital formation translated into a corollary decrease of cash and marketable securities on hand on the asset side of the corporate balance sheet; between 1937 and 1979, D/A ratios of U.S. manufacturing corporations moved from .26 to .55. In other words, the available corporate capital for risk investment has declined while the amount of debt companies have been saddled with has increased. Rather than reinvest their profits on expected future gains, companies borrow more with the hope that they will one day realize those gains.

PAST AND PRESENT OF THE VENTURE CAPITAL INDUSTRY

One of the clear findings in this history of industrial financing and investment shows that despite substantial formal and structural differences between the investment environment of the 1880s and the investment environment of the post-Second World War period, common threads exist. Albeit the Gilded Age investments lacked an institutionalization and sophistication of the Cold War investments, but those differences become smoothed over when one examines the overall intent and approach to investment. In other words, when you ask the question why invest in a particular firm or industry, the common threads that run through the answer are high yield potential, vanguard technology, and rugged individualism of capitalist idealism.

RISK

One of the main characteristics of a typical venture capital investment is high risk. Unlike many of their traditional financial counterparts venture capitalists do not practice a stringent risk averse behavior. To filter out the element of risk would also deprive the venturist of handsome profits, thereby eliminating the incentive to engage in the venture. Clearly the lack of risk runs counter to the concept of venture capitalism. Most ventures today, such as genetic engineering firms, artificial intelligence software firms, and experimental chip technology firms entail a significant risk factor. In many cases the risks are high because the market for a product does not exist, or federal regulations could snuff any chances for entering a market (as with many biotechnologies).

ENTREPRENEURIALISM

Entrepreneurs flirt with risk by the very nature of their activities. According to the patron saint of modern entrepreneurial theory, Joseph Schumpeter, the entrepreneur is responsible for economic growth. His analysis of modern industrial capitalism heralds the role of individual entrepreneurs; they are catalysts in the engine of capitalism. The very essence of industrial development hinges upon the agency of individual entrepreneurs armed with vision, instinct, and capital resources. The whole dynamism of capitalist development depends upon the ability of entrepreneurs to stimulate new investment, exploit new markets, harness new technologies, and create new demands when old ones diminish. These Schumpeterian entrepreneurs have been a part of the American industrial experience. One of the greatest threats to the forces of creative destruction as harnessed by entrepreneurs is the settling in of bureaucratic inertia (Livesay 1989; Landes 1979). A scholar of the entrepreneur in American business, Thomas Cochran writes, "Problems regarding the entrepreneur in capital formation do not differ greatly from those in general economic growth..." and "In the early phase of industrialization most initial financing was of local origin and there was an intimate relation between entrepreneurs and investors. Expansion of the business was usually financed by reinvesting profits" (Cochran 1955).

Characterizing entrepreneurs are the practices of equity participation and management in the firm. With the bureaucratization of firms, management equity in the firm declined as salaried professionals increased. Venture capital firms reflect a commitment to management control and equity participation. Studies by Steve Rubel and William Wells both showed that often more than thirty percent of the time spent on venture capital investments was time spent on coordinating management operations (Noone and Rubel 1970).

In response to the institutional and economic model-dominated field of business history, Harold Livesay set out to study individuals in the bureaucratic context. He sought to challenge the Schumpeterian inspired contention that bureaucracies stifle entrepreneurial activity in the business community. Livesay studied Andrew Carnegie, Howard Stoddard, and Henry Ford II; three entrepreneurs who "made a difference." His two theses are that the continuing significance

of firms in which controlling ownership remained in the hands of a few was widespread, and that new firms continually appear on the business playing field without the modern cadres of bureaucratic managers (Livesay 1977).

TECHNOLOGICAL INNOVATION

Technology is a critical variable in a venture capitalist's decision to include a firm in his portfolio. Throughout the nineteenth century changing production methods and new capital goods garnered the attention of wealthy entrepreneurs. From products as simple as the reaper to complex ones like the air brake, new technologies presented investment opportunities. In the mid-twentieth century the same degree of technological salience can be found. The investment strategies at J.H. Whitney & Co., ARD, Continental Capital (the first West coast SBIC), and Arthur Rock & Co., all placed a premium on "high-technology" investments.

Capital investment seems to gravitate toward industrial sectors that fill the demand for new capital goods. In other words, technological changes that engender product innovations on a capital goods scale (e.g., new synthetic materials, automobiles, automatic lathes, alloy tool steel, and the telephone) require large amounts of invested capital. Entrepreneurs are therefore drawn to these types of technological developments, and as a result provide the necessary capital forming functions. The other side of capital investment rests with the search for improved products or more efficient methods of producing capital goods. According to David Weintraub and George Perazich, economists with the WPA in the 1930s, this aspect of technological change receives less entrepreneurial attention than capital goods developments. Much of the R&D support for non-capital goods innovations comes in the form of corporate research agendas designed to safeguard the entrepreneurial investments made in the relevant capital goods ventures.

Technological improvements result in lowering the capital expenditures per unit of capacity since they create more efficient use of raw materials and greater productivity of equipment. As a result, the amount of capital investment in technological improvements at the outset is less than capital invested in technological revolutions which create new industries or the demand for entirely new goods. According to Weintraub, an economy that is increasingly reliant upon capital investment in technological improvements rather than revolutions, i.e., one that is reaching a point of maturation, will have difficulty providing investment opportunities for capitalists unless new capital demands are created. Technological changes increase the productivity of capital and labor, though along different curves: labor costs per unit of product continually decrease after the adoption of the new technological process, whereas capital requirements per unit of product increase sharply at first, and then fall progressively over time.

Technology persists as a critical aspect in a high-risk venture portfolio. New technologies by their nature are untested and risk-inherent. Before the institutionalization of commercial debt financing, when equity participation was a common practice among wealthy industrialists, the innovative technologies were the ones receiving investments. After the formalization of debt financing and up to the emergence of formalized venture capital networks,

equity participation decreased and new technologies became product realities only in extreme cases. With the revival of equity financing, in the form of venture capital investment, critical new technologies received their start-up money.

GEOGRAPHIC AND MANUFACTURING SECTOR CONCENTRATION

Do investors rely on previous successes and failures in a particular industry or region to guide their subsequent investment strategy? Examining the characteristics of investment in the ante-bellum New England economy, the age of railroad expansion, and the mass production economy of the second industrial revolution demonstrates the degree to which these factors influenced capital ventures of nineteenth century industrialists.

Florida and Kenney, authors of numerous studies on the patterns of regional venture capital investment in the United States, argue that venture capital firms can be clustered into three major areas San Francisco, New York, and Boston. These are major centers of venture capital because they have well established financial institutions, highly concentrated and diversified communications and transportation infrastructures, and are centered in the midst of high concentrations of technologically intensive manufacturing enterprises. They also conclude that venture capital firms based in financial districts are mainly export-oriented, while those in technology regions are home growers as well as magnets for outside venture capital. There is a high level of agglomeration of venture capital investments and of coinvestment, and inter- and intraregional syndication. The flow of venture capital funds to other regions in the country shows the generation of venture capital in a region relative to the export of venture capital of that region. Venture capital is an integral part of the well developed technology infrastructures or "social structures of innovation" which characterize established high technology regions (Florida and Kenney 1987).

Ed Malecki, a regional economic geographer, posits that venture capital's significant contribution to the American economy is that it develops technological changes on a regional level. Because one critical aspect of venture capital is technological change, the link is clear. Malecki argues that a region's economic development potential cannot be fully realized without some attention to the innovate process of manufacturing, and that regions that have thought of these implications stand in a better position to capitalize than regions that have not. But he voices a note of caution about jumping on the state-sponsored "spin-off" bandwagon, noting that most of the evidence to support the theory that regions with "environmental" conditions that favor entrepreneurial activity, such as venture capital, universities, and positive entrepreneurial successes, is anecdotal based on the case of Boston and Silicon Valley (Malecki 1983). Generalizing across all regions of venture capital from these two cases is tenuous at best.

The presence of a regional consciousness in entrepreneurial decision making in the nineteenth century, and during the birth of formalized venture capital is quite clear. One of the basic mandates of ARD was to develop the regional manufacturing capability of New England, another was to facilitate the availability and flow of investment capital to the region's faltering

small and medium-sized manufacturers. It is evident that the choice of the New England Council as management partner confirms the regional importance of ARD. In the nineteenth century, the same degree of local concern was present as well, if not even more paramount because of the relative autonomy of industrial regions and their remoteness from a national capital network. The case of the Mellon family domination of western Pennsylvania industry and finances and the New England mercantile-textile-financial linkages demonstrate the regional-mindedness of nineteenth-century entrepreneurs and financiers.

These four elements: risk, entrepreneurialism, technology, and regionalism exist throughout the economic landscape regardless of structural changes taking place. Although the rise of venture capitalism as a formalized and identifiable means to earn profits was not a seamless part of the growth of American capitalism, risk, entrepreneurialism, technology, and regionalism were the common threads. The pursuit of profits lead investors down different paths, but all toward the same goal. The differences between an 1891 investor in fabricated metals and a 1991 investor in genetic engineering stem from the investment mechanisms each individual had at his disposal, not from any fundamental difference in the impetus, goal, or risk of the investment.

A very simple way of describing the contrast between nineteenth-century investment and venture capital investment boils down to the manner in which the capital was raised. In the nineteenth century, and up to the great merger movement of 1898, most capital formation took place through equity participation. As commercial banks were joined by stock markets, pension funds, trusts, insurance funds, and government institutions in the capital formation business it became more difficult for borrowers to get equity financing. In the next thirty years the combination of this more complex system of financial intermediaries and the general fever associated with large industrial combines, weakened the small-scale investment practices that had so characterized industrial developments in the nineteenth century. After the shortcomings of the new system became all too apparent in the Depression, a concerted effort was made to channel funds into smaller and highly risky ventures, in effect resurrecting the practice of equity financing. The main difference being that "venture capital" would become another institutional variant of capital formation rather than an informal practice reserved for the wealthy.

What remained unchanged during the transformation from proto-venture capitalism to full-blown venture capitalism is the emphasis on cutting edge technology. Although it is hard to make the case that alloyed steel tools and refrigerated boxcars are high technology just like integrated circuits and high-voltage capacitors, taken in their context they are. Just as today's cutting edge technologies are tomorrow's standards, yesterday's high technologies are today's standards, or even obsolete. (The personal computer industry clearly demonstrates this.) Similarly, the levels of risk remain high throughout the transformation of industrial capital investment. Despite the emergence of formalized networks and institutions of venture capital, risk and technology remain key components of the entrepreneurial investment patterns.

REFERENCES

Abernathy, William and James Utterback. 1978. "Patterns of Industrial Innovation," Technology Review 80.

Alic, John and Martha Caldwell Harris. 1986. "Employment Lessons from the Electronics Industry," Monthly Labor Review February 1986: 27-36.

Amemiya, T. 1984. "TOBIT Models: A Survey," Journal of Econometrics (January-February): 3-61.

Anslow, Maurice. 1991. "European Fundraising Slows," Venture Capital Journal (July): 15-16.

Arthur, W. Brian. 1990. "Silicon Valley Locational Clusters: When Do Increasing Returns Imply Monopoly?" Mathematical Social Sciences 19: 235-51.

Arthur, W. Brian. 1988. "Urban Systems and Historical Path Dependence," in Cities and Their Vital Systems Jesse Ausubel and Robert Herman (ed.), (Washington, D.C.: National Academy Press, 1988): 85-97.

Arthur, W. Brian. 1986. "Industry Location Patterns and the Importance of History," (Stanford University, Center for Economic Policy Research, Working paper no. 84, June).

Bean, Alden, Dennis Schiffel, and Mary Mogee. 1975. "The Venture Capital Market and Technological Innovation," Research Policy 4: 380-408.

Borton, James. Venture Japan (Chicago, Illinois: Probus Publishing Company, 1992).

Broz, Joseph S., David C. Cranmer, Mark F. DeSantis, and Beverly Fleisher. 1993. Aspects of Performance in the High-technology Sector A report for the Executive Office of the President. Office of Science and Technology Policy. Issues in Science and Technology Policy. Working Paper.

Bulkeley, William, and Udayan Gupta. 1991. "Japanese find U.S. High-tech a Risky Business," The Wall Street Journal November 8, 1991.

Bullock, Matthew. 1983. Academic Enterprise, Industrial Innovation, and the Development of High-technology Financing in the United States (London: Brand Bros.).

Bygrave, William, and Jeffry Timmons. 1992. Venture Capital at the Crossroads (Boston, MA: Harvard Business School Press, 1992.)

Bygrave, William, and Jeffry Timmons. 1986. "Networking among Venture Capital Firms," (Unpublished Paper, Babson College).

Carosso, Vincent P. 1973. "The Wall Street Money Trust from Pujo through Medina," Business History Review 47. (Winter): 421-37.

Carosso, Vincent. 1970a. "Washington and Wall Street: The New Deal and Investment Bankers, 1933-1940," Business History Review 46. (Winter): 425-45.

Carosso, Vincent P. 1970b. Investment Banking In America: A History (Cambridge: Harvard University Press).

Chandler, Alfred. 1963. "Entrepreneurial Opportunity in Nineteenth-Century America," Explorations in Entrepreneurial History 1. (Fall): 106-24.

Charles River Associates. 1976. An Analysis of Capital Market Imperfections (Cambridge: Charles River Associates, Inc.).

Choy, Jon. 1993. "Shaping a New Industry: U.S.-Japan Alliances in Multimedia," JEI Report No. 10A. Washington: Japan Economic Institute. (March 19).

Clark, Gordon, Meric Gertler, and John Whiteman. 1986. Regional Dynamics (Boston: Allen and Unwin).

Cochran, Thomas. 1955. "The Entrepreneur in American Capital Formation" in Capital Formation and Economic Growth. National Bureau of Economic Research. (Princeton: Princeton University Press): 339-45.

Cochran, Thomas. 1950. "The Legend of the Robber Barons," Pennsylvania Magazine of History and Biography (July): 311.

Competitiveness Policy Council. 1993. Technology Policy for a Competitive America: Report of the Critical Technologies Subcommittee Washington, D.C. (March).

David, Paul, and Joshua Rosenbloom. 1990. "Marshallian Factor Market Externalities and the Dynamics of Industrial Localization," Journal of Urban Economics 28: 349-70.

Davis, Lance E. 1963. "Capital Immobilities and Finance Capitalism: A Study of Economic Evolution in the United States, 1820-1920," Explorations in Entrepreneurial History (Fall).

Davis, Lance E., Richard Easterlin, et al. 1962. American Economic Growth (New York: Harcourt Brace).

Davis, Lance E. 1960. "The New England Textile Mills and the Capital Markets: A Study of Industrial Borrowing 1840-1860," The Journal of Economic History 20. (March): 1-31.

Davis, Lance E. 1958 "Stock Ownership in the Early New England Textile Industry," in Business History Review 34. (Autumn): 204-22.

Davis, Lance E., and Peter Lester Payne. 1958. "From Benevolence to Business: The Story of Two Savings Banks," Business History Review (Winter): 386-406.

Davis, Lance E. 1957. "Sources of Industrial Finance: The American Textile Industry. A Case Study," Explorations in Entrepreneurial History 9 (April): 189-203.

Devlin, Kathleen. 1992a. "The 1991 Venture Backed M&A Market," Venture Capital Journal (February).

Devlin, Kathleen. 1992b. "Japanese Capital Heads Home," Venture Capital Journal (April).

Devlin, Kathleen. 1992c. "Disbursements Hit 10-Year Low," Venture Capital Journal (June).

Dorfman, Nancy. 1983. "Route 128: The Development of a Regional High-technology Economy," Research Policy 12: 299-316.

Drucker, Peter. 1993. Postcapitalist Society (New York: Harper Collins Business).

Early, Steve, and Rand Wilson. 1986. "Do Unions Have a Future in High-technology," Technology Review October.

Eisinger, Peter. 1991. "The State of State Venture Capitalism," Economic Development Quarterly Vol. 5 No. 1, February: 64-76.

Etzkowitz, Henry. 1990. MIT's Relations With Industry: Origins of the Venture Capital Firm (SUNY Purchase, unpublished paper).

Executive Office of the President. 1991. The State of Small Business Washington, D.C.

Ferguson, Charles. 1988. "From the People Who Brought You Voodoo Economics," Harvard Business Review (May-June): 55-62.

Ferrari, Paul. 1991. "Corporate Investments on the Rise," Venture Capital Journal (September): 36-38.

Fisher, Peter, Michael Sheehan, and Roger Colton. 1986. Public/Private Enterprise as an Economic Development Strategy for States and Cities (Report prepared for the U.S. Department of Commerce, Economic Development Administration).

Flanders, Ralph. 1945. "The Problem of Development Capital," The Commercial and Financial Chronicle (November 29).

Florida, Richard, and Donald Smith. 1993. "Venture Capital Formation, Investment and Regional Industrialization," Annals of the American Association of Geographers Vol. 83 No. 3 (September): 434-51.

Florida, Richard, and Martin Kenney. 1993a. "The New Age of Capitalism: Innovation-Mediated Production," Futures July/August: 637-51.

Florida, Richard, and Martin Kenney. 1993b. Beyond Mass Production: The Japanese System and Its Transfer to the U.S. (New York: Oxford University Press).

Florida, Richard, et al. 1992. Rebuilding America: Lessons from the Industrial Heartland Prepared for the Council of Great Lakes Governors. Pittsburgh, PA: H. John Heinz III School of Management and Public Policy. (December).

Florida, Richard, Martin Kenney, and Donald Smith, Jr. 1990. Venture Capital, Innovation, and Economic Development (Washington, D.C.: Report to the U.S. Economic Development Administration).

Florida, Richard, and Martin Kenney. 1990. The Breakthrough Illusion: Corporate America's Failure to Move from Innovation to Mass Production (New York: Basic Books, forthcoming).

Florida, Richard, Donald Smith, Jr. and Elizabeth Sechoka, 1990. "Regional Patterns of Venture Capital Investment" in Milford Green (ed). The Venture Capital Industry (London: Croom-Helm).

Florida, Richard, and Donald Smith. 1990. "Venture Capital, Innovation, and Economic Development," Economic Development Quarterly.

Florida, Richard, and Martin Kenney. 1988a. "Venture Capital and Technological Entrepreneurship," Journal of Business Venturing (Fall 1988): 301-19.

Florida, Richard, and Martin Kenney. 1988b. "Venture Capital and Technological Innovation in the U.S.," Research Policy 17: 119-37.

Florida, Richard, and Martin Kenney. 1988c. "Venture Capital's Geography: A Comment on Leinbach and Amrhein," Professional Geographer 40,2 (May): 214-17.

Florida, Richard, and Martin Kenney. 1987. "Venture Capital, High-technology, and Regional Development," Regional Studies 22, 1: 33-48.

Foster, Mark. 1985 "Giant of the West: Henry J. Kaiser and Regional Industrialization, 1930-1950," Business History Review 59. (Spring): 1-23.

Freeman, Christopher, J. Clark, and L. Soete. 1982. Unemployment and Technical Innovation (London: Frances Pinter).

Friar, John, and Mel Horwich. 1986. "The Emergence of Technology Strategy: A New Dimension of Strategic Management," Technology in Society 7:143-78.

Friedman, Benjamin. Ed. 1985. Corporate Capital Structures in the United States (Chicago: University of Chicago Press).

Gaston, Robert. 1989. Finding Private Venture Capital for Your Firm (New York: John Wiley and Sons).

Gertler, Meric. 1987. "Capital, Technology and Industry Dynamics in Regional Development," Urban Geography 8, 3: 251-63.

Gertler, Meric. 1984. "Regional Capital Theory," Progress in Human Geography 8, 1: 50-81.

Gertler, Meric. 1983. "The Dynamics of Regional Capital Accumulation," Economic Geography 150-74.

Gilder, George. 1989. Microcosm: The Quantum Revolution in Economics and Technology (New York: Simon and Schuster).

Gilder, George. 1988. "The Law of the Microcosm," Harvard Business Review (March-April).

Goldsmith, Raymond. 1958. Financial Intermediaries in the American Economy Since 1900 (Princeton University Press).

Gordon, Richard. 1990. "Global Research and the Process of Innovation in Small and Medium-Sized Enterprises: The Case of Silicon Valley," (Santa Cruz, CA: University of California Santa Cruz, 1990, mimeo).

Green, Milford, and Rod McNaughton, 1988. "Inter-urban Variations in Venture Capital Investment Preferences," Urban Studies.

Green, Milford. 1987. "Patterns of Preference for Venture Capital in the United States, 1970-1985," Environment and Planning C 7,2 (May): 205-22.

Gupta, Udayan. 1990. "Venture Capital Dims for Den, but Not to Worry," Wall Street Journal (24 January).

Harrison, Bennett, and Sandra Kanter. 1978, "The Political Economy of State Job Creation Business Incentives," Journal of the American Institute of Planners 44:424-35.

Harvey, George. 1928. Henry Clay Frick: The Man (New York: Charles Scribner's & Sons).

Hayashi, Alden, 1988. "The New Shell Game: Where Was This U.S. Chip Really Made," Electronic Business (March 1, 1988): 36-40.

Hersh, Burton. 1978. The Mellon Family: A Fortune in History (New York: William Morrow & Company).

Hoover, Edgar, and Raymond Vernon. 1962. Anatomy of a Metropolis (New York: Anchor Books).

Horsley, Keogh and Associates. "Unpublished Data on Returns to Venture Capital Funds," Rochester, New York.

Illinois Office of the Auditor General. 1989. Management and Program Audit of the Department of Commerce and Community Affairs' Economic Development Programs July.

Jaffe, Adam B. 1989. "Real Effects of Academic Research," American Economic Review (December): 957-70.

Janeway, William. 1986. "Doing Capitalism: Notes on the Practice of Venture Capitalism," Journal of Economic Issues 20, 2 (June): 431-41.

Johnson, Arthur M., and Barry E. Supple. 1967. Boston Capitalists and Western Railroads: A Study in the Nineteenth Century Investment Process (Cambridge, Harvard University Press).

Josephson, Matthew. 1962. The Robber Barons: the Great American Capitalists, 1861-1901 (Connecticut: Matthew Josephson).

Kassalow, Everett. "The Union's Stake in High-tech Development," in Archie Kleingartner and Carolyn Anderson (Eds.) Human Resource Management in High-technology Firms (Lexington, MA, Lexington Books) 157-82.

Koskoff, David E. 1978. The Mellons: The Chronicle of America's Richest Family (New York: Thomas E. Crowell Publishers).

Kozmetsky, George, Michael Gill and Raymond Smilor. 1985. Financing and Managing Fast Growth Companies: The Venture Capital Process (Lexington, MA: Lexington Books).

Krugman, Paul. 1991a. Geography and Trade (Cambridge, MA: MIT Press).

Krugman, Paul. 1991b. "Increasing Returns and Economic Geography," Journal of Political Economy 99, 31: 483-99.

Kuznets, Simon. 1961. Capital in the American Economy: Its Formation and Financing (Princeton: Princeton University Press).

Landes, David. 1979. "Watchmaking: A Case Study in Enterprise and Change," Business History Review 53. (Spring): 1-39.

Leinbach, Carl, and Thomas Amrhein. 1987. "A Geography of Venture Capital in the U.S.," Professional Geographer 39,2: 145-158.

Liles, Patrick. 1977. Sustaining the Venture Capital Firm (Cambridge, MA: Harvard University, Management Analysis Center).

Livesay, Harold. 1989. "Entrepreneurial Dominance in Business Large and Small, Past and Present," Business History Review 63. 2(Spring): 1-21.

Livesay, Harold. 1977. "Entrepreneurial Persistence Through the Bureaucratic Age," Business History Review 51. (Winter): 415-43.

Luger, Michael. 1984. "Does North Carolina's High-Tech Development Program Really Work?" Journal of the American Planning Association (Summer): 280-89.

Malecki, Edward. 1987. "Hope or Hyperbole? High-tech and Economic Development," Technology Review 90,7 (October) 50.

Malecki, Edward J. 1983. "Technology and Regional Development: A Survey," International Regional Science Review (Vol. 8, No. 2.): 89-125.

Markusen, Ann, Peter Hall, and Amy Glasmeier. 1986. High-tech America (Boston: Allen and Unwin).

Marshall, A. 1900. Elements of Economics of Industry (New York: MacMillan).

McGouldrick, Paul. 1968. New England Textiles in the Nineteenth Century: Profits and Investment (Cambridge: Harvard University Press).

McNaughton, Rod and Milford Green. 1986. "Patterns of Venture Capital Investment in the United States," (Paper presented at the East Lake Division of the American Association of Geographers).

Meltzer, Allan. 1993. "Why Governments Make Bad Venture Capitalists," Wall Street Journal (May 5).

Mellon, William Larrimer, and Boyden Sparkes. 1948. Judge Mellon's Sons (New York: privately printed, 1948).

Miller, Roger, and Marcel Cote. 1985. "Growing the Next Silicon Valley," Harvard Business Review (July-August): 114-23.

Myrdal, Gunnar. 1957. Economic Theory and Underdeveloped Regions (New York: Harper and Row).

National Association of Small Business Investment Companies. 1988. Historical and Program Highlights of the SBIC Program and Private Venture Capital Investment Washington, D.C.: NASBIC (February).

National Science Foundation. 1993. National Patterns of R&D Resources 1992 Washington, D.C.

Navin, Thomas, and Marian V. Sears. 1955. "The Rise of a Market for Industrial Securities, 1887-1902," Business History Review 29. (June): 103-38.

Nelson, Richard, and Sidney Winter. 1982. An Evolutionary Theory of Economic Change (Cambridge, MA: The Belknap Press of Harvard University).

Nelson, Richard, and Sidney Winter. 1977. "In Search of a Useful Theory of Innovation," Research Policy 6: 36-76.

Noone, Charles, and Stanley Rubel. 1970. SBICs: Pioneers in Organized Venture Capital (Chicago: Capital Publishing Company).

Peltz, Michael, and Marc Weiss. 1984. "State and Local Government Roles in Industrial Innovation," Journal of the American Planning Association 50,3 (Summer): 270-79.

Phillips, Bruce, and H. Shelton Brown. 1989. "Myths and Facts: The Role of Small High-technology Firms in the U.S. Economy," (Washington, D.C.: U.S. Small Business Administration).

Piore, Michael, and Charles Sabel. 1984. The Second Industrial Divide: Possibilities for Prosperity (New York, Basic Books).

Pontecorvo, Giulio. "Investment Banking and Security: Speculation in the Late 1920s," Business History Review 34. (Spring 1958): 166-91.

Porter, Michael. 1992. Capital Choices: Changing the Way America Invests in Industry Washington, D.C.: Research report presented to the Council on Competitiveness and co-sponsored by the Harvard Business School. (June).

Rappaport, Andrew, and Shlomo Helevi. 1991. "The Computerless Computer Factory," Harvard Business Review (September-October).

Reich, Robert. 1987. Tales of a New America (New York: Times Books).

Reiner, Martha Louise. 1989. The Transformation of Venture Capital: A History of Venture Capital Organizations in the United States (Berkeley, CA: Graduate School of Business Administration, Ph.D. dissertation).

Roberts, Edward, and Oscar Hauptman. 1985. "The Process of Technology Transfer to the New Biomedical and Pharmaceutical Firm," Working Paper. (Cambridge, MA: MIT Sloan School of Management).

Rogers, T.J. 1993. "Get the Amateurs Out of High-Tech," Upside June: 32-44.

Rothwell, Roy. 1984. "The Role of Small Firms in the Emergence of New Technologies," OMEGA: The International Journal of Management Science 12,1: 19-29.

Rothwell, Roy. 1983. "Firm Size and Innovation: A Case of Dynamic Complementarity," Journal of General Management 8,3 (Spring).

Rubel, S.M. and Company. 1975. Analysis of Venture Capital Industry Investing: 1968-1975 (Chicago: S.M. Rubel and Co.).

Rubel, Stanley, and Edward G. Novotny. How to Raise and Invest Venture Capital (New York: Presidents Publishing House, 1971).

Sahlman, William. 1991. "Insights from the American Venture Capital Organization," Background paper for the Council on Competitiveness and the Harvard Business School project on corporate investment (July).

Sahlman, William, and Howard Stevenson. 1985. "Capital Market Myopia," Journal of Business Venturing 1,1 (Winter): 2-30.

Saxenian, Annalee. 1990. "The Origins and Dynamics of Production Networks in Silicon Valley," (Berkeley CA: University of California at Berkeley, Department of City and Regional Planning, unpublished paper).

Saxenian, Annalee. 1985. "Silicon Valley and Route 128: Regional Prototypes or Historic Exceptions?" in Manuel Castells (ed.) High-technology, Space, and Society Sage Urban Affairs Annual Reviews, Vol. 28 (Beverly Hills, CA 1985): 81-105.

Sayer, Andrew, and Kevin Morgan. 1987. "High-technology Industry and the International Division of Labour: The Case of Electronics," in Michael Breheny and Ronald McQuaid (Eds) The Development of High-technology Industries: An International Survey (London, Croom-Helm, 1987).

Schumpeter, Joseph. 1942. Capitalism, Socialism and Democracy (New York: Harper & Brothers).

Schumpeter, Joseph. 1934. The Theory of Economic Development (Cambridge: Harvard University Press).

Scott, Allen, and Michael Storper. 1988. "High-technology Industry and Regional Development: A Theoretical Critique and Reconstruction," International Social Science Journal.

Spencer, Linda. 1992. High-technology Acquisitions Summary Charts, October 1988 through April 1992 (Washington, D.C.: Economic Strategy Institute, May 1992).

Stallman, Linda and Bruce Rayner. 1990. "Vibrant Foreign Sales Can't Mask Discouraging Indicators," Electronic Business (January 22, 1990).

State of Minnesota, Office of Science and Technology. 1988. State Technology Programs in the United States (St. Paul: Department of Trade and Economic Development, July).

Stiglitz, Joseph. 1982. "Information and Capital Markets," in Financial Economics: Essays in Honor of Paul Cootner edited by William F. Sharpe and Cathryn Cootner, (Englewood Cliffs, NJ: 118-58.

Stohr, Walter. 1986. "Regional Innovation Complexes," Papers of the Regional Science Association 59: 29-44.

Supple, Barry. 1957. "A Business Elite: German-Jewish Financiers in Nineteenth-Century New York," Business History Review 31. (Spring): 143-78.

Thompson, Chris, and Kristin Bayer. 1990. The Geography of the 'Entrepreneurial State': Public Venture Capital Programs in the USA -- An Exploratory Survey Paper presented in the annual conference of the Association of American Geographers, Toronto, Canada. April.

Thompson, Chris. 1989. "The Geography of Venture Capital," Progress in Human Geography pp. 62-98.

Thompson, Wilbur. 1968. A Preface to Urban Economics (Baltimore: Johns Hopkins Press).

Timmons, Jeffry, and William Bygrave. 1986. "Venture Capital's Role in Financing Innovation for Economic Growth," Journal of Business Venturing 1: 161-76.

Tyebjee, T., and A. Bruno. 1984. "A Model of Venture Capital Investment Activity," Management Science 30, 9: 1051-66.

U.S. Congress, Joint Economic Committee. 1984. Climate for Entrepreneurship and Innovation in the United States (August 27-28).

U.S. Congress, Joint Economic Committee. 1984. Venture Capital and Innovation (A Study Prepared for the Joint Economic Committee of Congress).

U.S. House of Representatives. 1993e. Testimony of John Carruthers, Andrew Grubbs, John Hodgman, and Jeffry Timmons on HR 820, National Competitiveness Act of 1993, before the House of Representatives, Subcommittee on Technology, Environment and Aviation. Washington, D.C. (February 16).

U.S. Office of Technology Assessment. 1984. Technology, Innovation and Regional Economic Development (Washington, D.C.).

U.S. Semiconductor Industry. 1989. "Meeting the Global Challenge: Advanced Electronics Technology and the Semiconductor Industry" Cupertino, CA, Semiconductor Industry Association.

U.S. Small Business Administration, Office of Advocacy. 1988. Capital Formation in the States (Washington, D.C., January).

Venture Economics. Guide to Venture Capital various years (Needham, MA: Venture Economics).

Venture Economics. 1992a. Venture Capital Yearbook 1992 (Needham, MA: Venture Economics).

Venture Economics. 1992b. 1992 Venture Capital Investments Benchmarks Report (Needham, MA: Venture Economics).

Venture Economics. 1990. "Competition Reshaping the U.K. Venture Industry," Venture Capital Journal (January): 11-15.

Venture Economics. 1989. Trends in Venture Capital, 1989 Edition (Needham, MA: Venture Economics).

Venture Economics. 1983. "Regional Patterns of Venture Capital Investment," Prepared for the U.S. Small Business Administration. (Washington, D.C.).

Venture Capital Journal (various issues).

Watkins, Charles. 1985. Programs for Innovative Technology Research in State Strategies for Economic Development (Washington, D.C.: National Governors' Association, Center for Policy Research and Analysis).

Weiner, Susan B. 1991. "The rules differ in Japan," Venture Capital Journal October 1991.

Wilson, John. 1985. The New Venturers: Inside the High Stakes World of Venture Capital (Reading, MA: Addison-Wesley Publishing).

Yntema, Theodore. 1947. Meeting the Special Problem of Small Businesses (New York: Committee for Economic Development).