Industrial and Corporate Change, Volume 20, Number 6, pp. 1677–1723
doi:10.1093/icc/dtr061

# How venture capital became a component of the US National System of Innovation

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Venture capital (VC) is a relatively recent addition to the US national system of innovation (NSI). Tracing the history of the VC industry in the US provides an interesting example of how NSIs can add new institutions, and in the process be transformed. The history encompasses important exogenous events, endogenous developments, and actions by individual actors. The story of the development of VC is set in the technological trajectories where it has experienced its greatest success, the information, communications, and biomedical industries. The emergence of VC is intimately related to various government actions, and yet the paper does not attribute a *deus ex machina* role to government actors. While NSI theory provides the framework, it is also recognized that VC is geographically localized in a few regions, and a regional innovation system perspective is also valuable.

**JEL Classifications:** G24, N22, L26.

## 1. Introduction

> The distinction between the entrepreneur and the capitalist was facilitated in the second half of the 19th century by the fact that changing methods of business finance produced a rapidly increasing number of instances in which capitalists were not entrepreneurs and entrepreneurs were not capitalists . . . If providing the capital is not the essential or defining function of the entrepreneur, then risk bearing should not be described as an essential or defining function either, for it is obviously the capitalist who bears the risk and who loses his money in case of failure (Schumpeter, 1949).

Venture capital (VC) has become a much admired method for funding entrepreneurs and innovation. Many leading US technology firms have their roots in entrepreneurs funded by venture capitalists. While VC continues to be a very small portion of the US financial system, it has become an important financial

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intermediary for, and component of, the US national system of innovation (NSI).[1] This article traces the history of the US venture capital industry, which was intimately related to the emergence of an organizational ecology (Aldrich and Fiol, 1994) consisting of other institutions including, most importantly, start-up firms, but also lawyers, investment bankers, and other service providers or, in short, an entrepreneurial support network (Kenney and Patton, 2005). The outcome of this evolution was that venture capitalists became key financiers of a distinct component of the larger US NSI. However, the historical process of the formation of VC as an institution was a trial and error process where a number of organizational forms were established, until the VC limited partnership emerged as the dominant and now iconic form (on organizational forms and selection, see, for example, March, 1991; Carroll and Hannan, 2000).

While new organizational forms can emerge and coalesce into industries for a variety of reasons, to understand the evolution of the US VC industry the investment opportunities enabled by the pace and persistence of change in the information and communication technologies (ICT) and biomedical fields must be recognized. This observation about the role of new technologies in catalyzing new institution formation is not unique to this study of the VC industry. In a similar manner, creation and later dominance of the corporate central research laboratory was intimately related to the emergence of the chemical and electrical technologies, the growth of the giant corporation, and the adoption of the German research university model in the US (see, for example, Noble, 1977; Reich, 1985; Wise, 1985; Geiger, 1986; Hounshell and Smith, 1988; Leslie, 1993; Murmann, 2003). Technical changes and the opportunities to form firms to exploit them are a vital part of this history.

The integration of VC in the US NSI is really the integration of an ensemble of interlinked institutions many of which, but not all, co-evolved interactively (Nelson and Winter, 1982). For example, the US reaction to the Soviet launching of Sputnik was to initiate a Space Race, which was not meant to benefit the then young and weak VC industry or the firms it funded—and yet, it did. Serendipity was important, especially at the inception of the ecosystem of which VC is now a part. At that time, the firms and the ecosystem were incoherent with no political power or even presence. As sociologists have observed, an industry must create legitimacy to become accepted socially (Meyer and Rowan, 1977) and overcome the liability of newness (Stinchcombe, 1965). Legitimacy proved to be important for the VCs—and it would occur in two ways: the VCs would experience excellent investment returns and their portfolio firms would have successful public offerings. To become a recognizable part of the US NSI, VCs had to fulfill both of these criteria.

The development of VC as a social institution was a process during which a number of organizational forms emerged. Some of these forms such as public

[1]On the concept of NSIs see Lundvall (1992); Nelson (1993); Freeman (1995); Edquist (1997).

stock small business investment corporations (SBICs) disappeared almost entirely, while others such as private small business investment corporations continue to exist but are of little significance, yet others appear and disappear intermittently (public stock VC firms), and still others, such as corporate venture capitalists, continue to exist but are not recognized as the dominant model. In an alternative path, it is certainly possible that any of these models could have become dominant. Finally, it was also possible that VC might have remained a small footnote and never become a significant component of the NSI—a result that would not be surprising as, despite great effort, VC is still not a significant component of NSIs in many nations.

This paper is organized as a chronological narrative culminating in the VC limited partnership, and in many respects is teleological and as such presents the final organizational form—the limited partnership—as the culmination of an evolution. The first section briefly reviews the literature on the history of the VC industry, but does not explore the now voluminous, but largely ahistorical, literature in finance, economics, and sociology on VC. The historical discussion begins with an examination of how new ventures secured financial support prior to the Great Depression with particular attention to the fledgling automotive and aviation industries. An examination of the wide-ranging discussions that emerged during the Great Depression and World War II about creating organizations to provide VC-like financial assistance for small businesses follows. The next section, which extends from 1946 to the late 1950s, discusses the formation and activities of the four pioneering VC firms. In the late 1950s, there were a number of developments ranging from the launch of Sputnik, the creation of Shockley Semiconductor and the Digital Equipment Corporation, and the Congressional creation of the small business investment corporations that dramatically expanded the VC industry. This is followed by a discussion of the period from roughly 1960 to the early 1970s, by which time the VCs had become a small but coherent set of financial intermediaries, a few of their investments began to mature, and the limited partnership organizational form had begun its ascent to dominance. The next section, covering the 1970s, examines the most tumultuous period in the history of VC due to legislative and technological developments. However, this is also the period when today's VC industry emerges. The final historical section deals with the routinization of the industry and the widespread recognition that it had become a part of the US NSI. The concluding remarks reflect upon the role of VC and its concomitant ecosystem in the US NSI.

## 2. Previous institutional research on VC

While VC has received an enormous amount of scholarly attention, there have been fewer examinations of its historical roots and how it came to be a significant part of the NSI. Books by Bygrave and Timmons (1992) and Gompers and Lerner (1999) are notable overviews. The two grounded historical studies, a PhD dissertation by Reiner (1989) and an article by Gompers (1994), are also excellent sources. Regional

histories include Liles (1977) on New England and Reiner (1989) and Kenney and Florida (2000) on the San Francisco Bay Area. Firm histories include studies of American Research and Development by Ante (2008) and Hsu and Kenney (2005) and of Greylock by Elfers (1995). The role of the Rockefellers is best discussed in a history of the firm Itek by Lewis (2002). The role and development of the SBICs has received significant attention (Zeigler, 1961; Bean, 1996), but not their role in the development of VC. Etzkowitz (2002), in a book on MIT, includes a discussion of its role in the formation of ARD. While being vital contributions, these do not consider the process by which the VC industry came to be an important part of the US NSI.

VC is only a small fraction of total US R&D spending. Despite its small size, there is evidence that VC-funded firms are particularly successful at innovation. Kortum and Lerner (2000) demonstrated that the ratio of VC to total US R&D averaged less than 3% from 1983 to 1992, but firms funded by VCs accounted for 8% of the patents during that period. Of course, the patent productivity of VC-financed firms is only an imperfect indicator, as the key issue is the ability to find and fund innovative firms. In another less scientific measure in 2011, 22 of the top 100 US firms in terms of capitalization were established since 1960.[2] Of these 12 were VC financed—and all of these were technology-based firms, except Home Depot. The other 10 firms included four retailers, four from the financial sector, Comcast, and Nike. Every one of the top 20 US biotechnology firms on US exchanges was VC backed (for the list of biotechnology firms, see Wikipedia 2011). For the Internet, VC-backed publicly listed leaders include Akamai, Amazon, AOL, Google, eBay, Monster Worldwide, Priceline, RealNetworks, Salesforce.com, and Yahoo!. There are also a number of earlier leaders that failed or were acquired and these include: Excite, Lycos, and Netscape. Moreover, there appears to be a new wave of VC-backed successes including: Facebook, Groupon, Hulu, LinkedIn, and Twitter, to name a prominent few. These successes illustrate that venture capitalists have financed many now important firms in the US economy, but, more importantly, these financings created new firms, industries, economic spaces, and changed the conduct of everyday life.[3]

VCs only rarely fund basic research; rather their goal is to fund development and marketing (Zider, 1998: 132). Controlling for the firm size, industry and patents, Gompers *et al.* (2005) found that the most prolific spawners of VC-funded entrepreneurs were firms that had previously been backed by VCs. While much has been made of university spin-offs, Zhang (2009) found that only 8.6% of all firm founders

[2]This was compiled by the author from the website http://247wallst.com/page/real-time-500/ on May 2, 2011.

[3]On the classification of firms with high-growth potential, see Wong et al. (2005).

could be traced to a university.[4] These data suggest that VC success can ignite virtuous circles of VC-funded firms generating yet more entrepreneurs, a phenomenon best exemplified in Silicon Valley by the numerous generations of Fairchild Semiconductor spin-offs.

While there is a long history of VC funding of biomedical startups, biotechnology is in many respects unique in that VCs, initially in the San Francisco Bay Area but soon after in Boston and San Diego, played a central role in the transformation of what had previously been university-based scientific research into the foundation for new firms (Kenney, 1986a; Zucker *et al.*, 1998; Powell *et al.*, 2007). The availability and, indeed, willingness of VCs to make early investments in university research results is responsible for the emergence of a biotechnology industry that is organizationally distinct from the pharmaceutical industry (Kenney, 1986b).

In 1960, the US NSI roughly resembled that of other nations, with the exception, of course, that as a nation it invested far greater sums in R&D than any other and had more large firms with a significant research commitment. Independent inventors continued to be important, but they had few sources of institutional assistance. However, to understand how VC came to be such an important component of the NSI it is necessary to go further back in history.

## 3. Financing new ventures prior to the birth of formal VC

Americans have had an enormous enthusiasm for technological innovation (Hughes, 1989; Smil, 2005). In the last two decades of the nineteenth Century, the emerging science-based firms began to establish internal R&D laboratories (Noble, 1977; Mowery and Rosenberg, 1989). The laboratories manifested a recognition that their business models depended upon new products and processes that could be developed by scientists and engineers. Even with the establishment of corporate research laboratories, invention by independent inventors continued. And yet, according to the findings of Lamoreaux and Sokoloff (2007: 13), there was a decline of independent inventors in the late nineteenth century and one of the reasons "may have been the growing difficulty that inventors and innovators faced in obtaining outside sources of finance." While accepting this financial explanation, it is also possible that the mechanical, electrical, and chemical technological trajectories driving this enormous wave of entrepreneurship no longer generated opportunities conducive to new firm formation (in the case of autos, see Abernathy and Clark, 1985).

In the late nineteenth century, with their increased professionalization, banks, as institutions, were less inclined to invest in early-stage ventures. To illustrate, in a study of the financing of entrepreneurship in Cleveland from 1870 to 1920

[4]This data excluded student-established firms and thus would miss many successful IT firms such as Excite, Google, Sun Microsystems, and Yahoo!

Lamoreaux *et al.* (2006) found that "formal financial institutions played a supporting or secondary role—that venture capital was mainly mobilized more informally." Their conclusion is likely not idiosyncratic to Cleveland, Ohio, or to particular industries. What their conclusions suggest is that banks use available data to evaluate lending risk, while venture capitalists must consider uncertainty regarding the entrepreneurial skill of the team, markets, and the technology. These were and continue to be dramatically different skills. Bankers understood this and separated their fiduciary responsibility and role as bankers, from their willingness, as individuals, to invest in entrepreneurs.

The early auto industry illustrates the role of informal investors in supporting entrepreneurs. While there is no comprehensive study, Rubenstein (1992) found that auto entrepreneurs received funds from friends, family, and local "men of substance." In the Midwest, particularly Detroit, there were successful businesspersons willing to invest in fledgling firms (Rubenstein, 1992: 39). In contrast, eastern financiers were reticent to fund early-stage automobile industry startups. The consistent theme is the importance of local investors in funding entrepreneurs.

The last wave of automobile startups formed immediately after World War I, but they largely failed as the industry consolidated (Seltzer, 1928: 66). The pace of new architectural innovations slowed and innovations became more incremental as the dominant design for automobiles appeared (Abernathy, 1978; Abernathy and Clark, 1985). As a contemporary economist observed, "during the early period very frequent and often radical improvements were being introduced by the engineers," but these innovations largely came to an end by 1920 (Griffin, 1928: 145). Though there is no direct archival evidence, it seems probable that Detroit investors no longer perceived attractive investment opportunities in automobiles, or worse, may have experienced investment losses as the industry consolidated. What is certain is that Detroit ceased to be a hotbed of investment in new firm formation.

### *3.1 Aviation*

Even while the automobile industry grew and consolidated, another industry, aviation, emerged, and later had a more direct influence on the birth of the VC industry. As was the case with automobiles, the initial aviation entrants were tinkerers, assembling planes from parts similar to those used in early automobiles. And yet, the airplane evolved into an ever more complicated and technically sophisticated product. As aviation evolved into aerospace, government-supported military aviation would provide research funds and an early market for small firms developing sophisticated technology.

In the decades prior to World War II, opportunities in aviation attracted wealthy investor enthusiasts, who not only loved flying, but hoped for financial return. For example, though initially self-funded, after their historic flight the newly famous Wright Brothers secured investments from wealthy East Coast families and financiers

such as the Cabots, Cornelius Vanderbilt, August Belmont, and Russell and Frederick Alger (Rae, 1965: 100). Enthusiasm for flying, relatively low entry barriers, and continuing technological change ensured a constant flow of entrepreneurs leaving established aviation firms to launch new ventures.

In aviation, there were experiments with VC-like organizations. For example, in 1926, Daniel Guggenheim created a $2.5 million fund (later increased by a further $500,000) to promote "the whole art and science of aeronautics and aviation [and] to bring about such an advance in the art that private enterprise will find it practicable and profitable to 'carry on'" (Lomask, 1964: 63). In 1927, the fund provided a $150,000 loan to the first US airline, Western Airlines, which was so successful that within one year it was repaid. The fund invested in a variety of projects meant to catalyze aviation as an industry, thus, in certain respects, performing VC functions.

Laurance S. Rockefeller began making VC-like investments during the Great Depression. One of his first investments was participating in the 1938 refinancing of Captain Eddie Rickenbacker's Eastern Airlines. In 1938, J. S. McDonnell Jr, an airplane designer at the Glenn L. Martin Aircraft Company, launched a new firm in St. Louis supported by Laurance Rockefeller (Rockefeller Archive, 2006; Time Magzine, 1949).[5] In 1940, immediately prior to US entry in to World War II, Laurance wrote a letter to his father asking for permission to sell some of the oil stocks in his trust fund, so he could make further investments in various aviation industry firms. He wrote, "I have already invested almost $100,000 in various small companies in the aeronautics industry and as a result of which the Assistant Secretary of the Navy, Mr. James Forrestal, had asked me to organize a company to aid his department in managing and financing certain companies in which they are particularly interested and need help in following" (Rockefeller, 1940). Though his father's response is not in the Archive, we can assume that he allowed him to tap his trust fund. Laurance Rockefeller had discovered an investment niche in aviation and, particularly, in aviation industry-related firms supplying the military—and it proved to be quite lucrative.

With the onset of World War II, the aviation industry became extremely profitable (Rae, 1965: 99). As war-driven demand exploded, not only did the large prime contractors profit, but also small electronics and scientific instrument firms, such as Hewlett Packard and Raytheon, mushroomed. The military imperative of improving speed and performance demanded ever more sophisticated technology. Price was not the overriding concern. Moreover, building the sociotechnical system for which the airplane was the center required ground control, antiaircraft targeting systems, radar, in-flight control, and fire control; all of which were the product of technical expertise

[5]Glenn L. Martin Aircraft Company was the source of a number of aircraft entrepreneurs, including William Boeing, Donald Douglas, and Lawrence Bell respectively, during World War II (Glenn L. Martin Maryland Aviation Museum, 2006).

and increasingly depended upon electronics. Small entrepreneurial firms with sophisticated technical capabilities able to make unique components or test systems found ready markets among the large prime defense contractors. These products were purchased at very high mark-ups by the prime contractors holding "cost-plus" federal contracts. Such prices meant backers of such firms could reap attractive returns. Aviation and affiliated industries, particularly where electronics were involved would become a key early VC investment field.

## 4. The Great Depression and World War II

The Great Depression rocked the US economically, politically, and financially. It also created the conditions for a fundamental reorganization of the US financial system. In the 1930s, congressional hearings on the 1920s stock boom uncovered a plethora of abuses by the financial sector, including the fact that investment bankers deliberately concealed information from the public, particularly in regards to initial public stock offerings (Pontecorvo, 1958). In 1933, the Glass–Steagall Banking Act fundamentally changed bank operations by forcing them to sever their commercial bank function of taking deposits and making loans, from investment banking activities and the ownership of equity positions in industrial firms (Chernow, 1990: 360–363).[6] In 1934, Congress authorized the formation of a Securities and Exchange Commission empowered to curb such abuses by requiring greater information disclosure, limiting opportunities for stock market manipulation and insider trading, and empowering the SEC to curb other abuses. The immediate, though unintentional, side effect of these reforms was further disruption of the channels for allocating funds to small firms (Weissman, 1945: 41).

The Great Depression had a severe impact on Main Street raising concern about the changing nature of US political economy; one outcome was that support for small business became a political and ideological issue. Voicing support for small business was politically popular, particularly when they were contrasted to the financial "plutocrats." Roosevelt Administration pledges of support for small business created dilemmas for conservative Republicans opposed to federal government economic intervention. Even though VC as an articulated concept did not yet exist, the importance of this debate was that it provided ideological justification for legislation aimed at supporting small business.

[6]On November 12, 1999, President Clinton signed into law the Gramm-Leach-Bliley Act, which repealed Glass–Steagall. As a parenthetical note, this was part of a loosening of the New Deal safeguards against security fraud that were put in place after the stock market boom of the 1920s collapsed into the Great Depression. It is ironic that in the next decade, after two enormous stock market collapses, many of the descendants of these same banks would be under investigation for practices that resembled those of approximately 70 years earlier.

In the late 1930s, a cadre of elite academics including Karl Compton, the MIT president, and Vannevar Bush, an MIT engineer who was actively involved in the creation of Raytheon, and other prominent New England businesspersons came to believe that new firms commercializing new technologies could be the key to New England, and US, industrial recovery (Hart, 1998; Etzkowitz, 2002). They recognized the growing strength of the Chandlerian firm in the economy, but in contrast to populists, they did not see this as the central problem, as they accepted them as more efficient and expected that they would displace small firms within their industries. Their solution was to encourage new startups to commercialize new technologies, such as those being developed at MIT. These new businesses were to be the ones that would grow to be large businesses: the new Horatio Alger would be the technically trained engineer–entrepreneur. For them, the obstacle to establishing these new firms was a shortage of risk capital, which they believed was due to the changes caused by the Depression that discouraged wealthy individuals from risking their capital in untested firms (Liles, 1977; Etzkowitz, 2002; Hsu and Kenney, 2005).

In 1936, just as Americans thought the economy was recovering from the Great Depression, the stock market and economy experienced another sharp decline. This prompted intensified debate in government and academic circles about how to assist small business. This debate was more sustained and presaged post-war actions. To illustrate, in 1938, Joseph Nicholson (1938: 31–34) wrote in the *Harvard Business Review* that neither existing financial mechanisms, nor government agencies could adequately address the problems of small business finance. In 1939, the wealthy Boston retailer, Lincoln Filene, released a study recommending that constraints on banks be loosened so they could provide small business financing (Lincoln and Therese Filene Foundation, Inc., 1939). It suggested the creation of local industrial development trusts using private funds contributed by banks and corporations in exchange for various governmental subsidies. In 1939, the Logan–Voorhis bill was introduced in Congress calling for the creation of a system of intermediate credit banks meant to provide capital to small business with deposits insured by the federal government. Later in the same year, the Roosevelt administration proposed federal insurance on up to 80% of the principal on long-term loans to small business. Yet, another bill in 1939 sought to establish a "Federal Industrial Loan Corporation" to make equity investments in small businesses and guarantee bank loans to them (Hanes, 1939; Zeigler, 1961: 81). The United States appeared determined to act.

Investment bankers also proclaimed their interest in providing new firm financing. In the mid-1930s, investment bankers resumed making private placements for these small firms and were able to arrange public offerings for a few. Speaking at the 1936, Investment Bankers Association convention, Goldman Sachs executive Sidney Weinberg pointed out in the first 9 months of the year that 70% of the industrial common stock issues were for less than $1 million (quoted in Reiner, 1989). And yet, investment bankers were quite particular as to the types of firms they would assist, as they had no interest in the vast majority of needy small firms with only limited

growth potential. Even more, in practice, they had limited interest in raising capital for fledgling small firms as the total commission was too small.

Still, concern mounted. To get the US moving again Lammot du Pont (1938), the president of E. I. Nemours du Pont Corporation, testified before a 1938 Senate Committee investigating unemployment that what was needed was "venture capital." This appears to have been the first time that the term would be used in a way that would be recognized today. In an approving January 13, 1938, editorial, the *Wall Street Journal* (1938a: 6) adopted du Pont's phrase "venture capital" and defined VC as an "investment without definite assurance that the funds will produce at the outset income commensurate with the commitment." In another editorial on January 24th, the *Wall Street Journal* (1938b: 4) opined that "there is no 'venture capital' to speak of [in the US economy] because there is no venture spirit on the part of capital owners or those who normally would be borrowers of that capital." Notice the *Wall Street Journal* used the term "borrowed" indicating that insight into the equity nature of VC was not yet entirely clear.

The term "venture capital" proved to be attractive to the financial sector. On October 9, 1939, in his presidential address to the Investment Bankers Association, Jean Witter of the San Francisco brokerage firm Dean Witter & Company called for the creation of new forms of finance, or, as he put it, VC to spur "new enterprise creation and expansion" that would lead to job creation. As virulent anti-New Dealers, the investment bankers proclaimed that VC would not come into existence if "heavy taxes take most of any profit when a transaction is successful (Witter, 1939: 6)." The complaints about capital gains and personal taxes in discouraging investment for "jobs" became a constant refrain of investment bankers and the financial sector proponents of VC.[7]

The investment bankers understood the needs of VC, as Witter (1939: 11) indicates:

> The securities of any business in the experimental stages are not suitable for public offering. That early financing must be done by individuals close to the management of the new undertaking who are conversant with its risks and able to take an active part in the solution of its problems. I digress to say that, because the problem of promoting new enterprise is sometimes confused with that of financing small businesses. But the needs of small business must not be confused with the appeals of unproven business for capital funds.

This distinction between the financial needs of small business as a class and startups, that is, "unproven" businesses, which are a small segment of small businesses, is vital. Witter did not answer the question of who should provide the capital.

[7]See, King (1993) for the political debates about the trade-off between federal taxes and investment that have continued since World War II.

There were a number of proposals regarding how to create and structure a new institution to provide capital to small business generally, and few mentioned VC. In 1943, the *Harvard Business Review* published an article entitled "Massachusetts Prepares for Tomorrow" in which the author highlighted the importance of VC as part of a solution to the looming unemployment problem and an expected inability to meet consumer demand (Culliton, 1943). In the same year, the American Council on Public Affairs, a Washington, DC, think tank, published a book maintaining that new firms could perform important economic functions for society by reallocating resources; being outlets for investment goods; introducing new products, processes, and sales mechanisms; intensifying competition; and contributing to the economic and social advancement of individuals (Oxenfeldt, 1943: 18). With the end of World War II, the debate about the need for small business support continued. In 1945, the first chapter in the book *Small Business and Venture Capital* was entitled "Can Democracy Survive Big Business?". Flanders (1945), the Chairman of the Boston Federal Reserve Bank and later the Republican Senator from Vermont, published an influential manifesto on the subject of small business finance, *The Problem of Development Capital*, making the case for new organizations specialized in providing capital for innovative, entrepreneurial enterprises.

Financial support for small business was now on the US policy agenda. And yet, after nearly a decade of debate there was still no consensus on either what types of firms should be supported or what the proper mechanisms for providing financial support should be. The discussion remained confused as suggestions for programs proliferated and disagreement about goals continued.

## 5. Pioneering the VC firm, 1946 to the mid-1950s

The end of World War II left the United States the most powerful, wealthy, and technologically sophisticated nation on the planet. Radar and atomic bombs had made a profound impact, as had German rockets and jet fighters. There was a soaring belief in the opportunities and benefits that science and technology offered. In 1945, the President of the United States, Franklin D. Roosevelt, requested that Vannevar Bush, then the President of Carnegie Foundation, prepare a report on how the new scientific and technological knowledge could assist the postwar US economy by stimulating the formation of new enterprises and industries. By doing this, the President was endorsing a Schumpeterian vision. Bush (1945) responded with his report, *Science: The Endless Frontier*, which openly expressed the faith that technological and scientific research would be at the heart of the postwar economy.

With the call for support for and investment in small firms, Bush articulated a faith that there were profitable investment opportunities in small technology-based firms. Bush's inspirational report of how scientific research could result in economic benefit was the quintessential expression of the faith a group of Boston area academic

administrators and business persons had that commercializing university research in new firms could form the basis of a local economic recovery. They believed that the technologies that had advanced so rapidly during the war could be founts of riches. This was not simply rhetoric. For example, the fledgling Hewlett Packard that had been formed in 1938 finished 1941 with revenues of $106,458 (Malone, 2007: 90) and in 1945 had annual sales in excess of $1 million (Malone, 2007: 100). Despite attestations to the promise of technology-based startups, there were only a few persons or organizations willing to invest in new high-risk firms or provide expansion capital to existing firms.

Soon after World War II ended, a few pioneering VC firms were launched. In Boston, American Research and Development (ARD) was formed by civic, corporate, and university leaders including Vannevar Bush, Karl Compton, Ralph Flanders, and General Georges Doriot of the Harvard Business School. ARD raised money through investments from mutual funds (then termed "investment trusts"), insurance firms, and an initial public stock offering. With the proceeds ARD began investing its funds in small firms, a number of which were MIT spinouts (Hsu and Kenney, 2005). Contemporaneously, Laurance Rockefeller for his family, John H. Whitney, and Whitney's sister Joan Whitney Payson established separate professional VC operations in New York. The New York-based family funds were motivated not only by Schumpeterian notions, but also a sense of civic duty, and a conviction that venture investing would be profitable (Reiner, 1989).

The pioneers recognized that a VC firm would need to provide financial and managerial advice and other assistance to their portfolio firms. Operationally, they meant to professionalize the role of the informal investor. It was easier to conceptualize than to actually bring to commercial success an organization aiming to formalize a previously informal investment function, particularly one that had always had affective and charitable dimensions and high loss rates. Consider the problems: How should the VC firm raise capital? What should be the source of support for routine operations while waiting for investment returns? What types of investments should be made—startups and/or established firms seeking expansion capital? Which fields, technology, retail, manufacturing, real estate, etc., might generate returns commensurate with the risks? How should investments be chosen? Also, there were many operational issues, including the best organizational structure for the VC firm, the best backgrounds for the VC professional, how to manage interaction with portfolio firms, how to compensate the individual venture capitalists, to name only a few. Some of the solutions these pioneering firms fashioned persisted, others were ephemeral.

The three family funds were organized as partnerships, but the capital was solely from the family members, while ARD raised its capital in the public markets. ARD was interesting, in another way, as among its initial investors were mutual funds, university endowments, and insurance companies, that is institutional investors—organizations that much later would be joined by pension funds and become the

investors in the privately managed VC limited partnerships that would come to dominate the industry. Payson and Trask, in particular, as well as J. H. Whitney, were reticent to invest in technology-based firms. ARD invested in a wide variety of firms, most, but not all, of which had some technological advantage (Hsu and Kenney, 2005). In a 1947 memorandum, the Rockefeller organization not only expressed its intention to continue investing in aviation, housing, and electronics, but also had the intention of examining investment opportunities in an oddly diverse set of sectors including radioactive isotopes, Mexican industries, new processes using wood or plastics, and industrial applications of nuclear power. Moreover, investments showing "promise of contributing materially to general human welfare should be preferred" (RBI, 1947: 3). As was the case with ARD, the Rockefeller organization recognized the opportunities in technology, particularly in electronics, but had an eclectic set of interests.

From 1946 through approximately 1957, these four pioneering firms, joined intermittently by other investors, practiced VC investing with some success, but no other entrants were attracted to the market. This was unsurprising since three were private and did not disclose their results and ARD had only had a few minor successes. In 1956, an observer would have been entirely justified in concluding that the US NSI was centered upon the large established firms, such as AT&T, DuPont, General Motors, and IBM, and their giant research laboratories, and that this would continue unchallenged. VC was not even a footnote, though there were numerous very small technology-driven firms sprouting around the country.

## 6. The late 1950s through 1970: industry emergence

From the mid-1950s onwards, a series of separate technological, political, and financial events, some interconnected and others unconnected, changed the environment of venture investing and operated to attract new VC entrants. Some events changed the context to make VC investing more attractive, others directly affected the viability of venture investing, and finally the actions of VC investors themselves improved the context for investing.

One dramatic event helping to shape the context was the October 1957 USSR Sputnik launch that ignited a Space Race. This fueled an enormous increase in demand for lightweight components, such as transistors, computers, and various scientific instruments. In response, in 1958 the Department of Defense established the Defense Advanced Research Projects Administration (DARPA, aka ARPA) to fund defense-related research especially in engineering and particularly, aerospace and electrical engineering and computer science. While the Department of Defense had already funded university and corporate research, DARPA opened the funding floodgates. Sputnik-driven spending was important for the VC industry in two ways. First, it greatly expanded the market for extremely high value-added, cutting-edge

electronics and other components; many of which were first produced in newly formed specialist firms founded and staffed by skilled engineers and scientists. Second, there was a massive increase of research funding for university electrical engineering departments and then, at many universities, free-standing computer science departments were formed in the 1960s. This resulted in new inventions/technologies and provided support for large numbers of graduate students that upon graduation entered the expanding electronics industry and firms as researchers, executives, and firm founders.

Linked to this increase in purchasing and funding was the technological trajectory in electronics, especially computers, components, and software that proved to be vitally important, because increasingly it was advances in this field that entrepreneurs exploited to create new firms capable of extraordinarily rapid growth (Dosi, 1984). The most important of these trajectories would be silicon-based semiconductors that would experience a price-constant doubling of processing power approximately every two years (aka Gordon Moore's Law). This was accompanied by a similar dynamic in magnetic data storage and, still later, data communications systems throughput. It was the technological improvement trajectory creating ever more capable components in terms of memory and processing power that made possible ever powerful, smaller, and less expensive computers. The increasing modularity of computing hardware and software that began in this period also enabled entrepreneurship (Baldwin and Clark, 2000). Modularity created customers for new component firms, and at the systems-level allowed entrepreneurs to build new computers with off-the-shelf parts—it lowered entry barriers at both levels (Langlois and Robertson, 1995). Clayton Christensen's (1997) study of the hard disk drive industry illustrates this phenomenon, as new classes of computers, pioneered by new firms, permitted the entry of *de novo* hard disk drive makers; both of which were funded by venture capitalists.

Though not ultimately profitable, the 1955 VC-like investment by Arnold Beckman, the founder of the Los Angeles-area firm Beckman Instruments, in the Palo Alto startup Shockley Semiconductor proved to be of enormous significance to the development of Silicon Valley. Due to disagreements with Shockley, eight of his engineers established their own firm. They contacted an East Coast investment banking firm that agreed to seek private investors for them. It convinced Sherman Fairchild, a scion of the IBM fortune, to invest $3 million in the new firm, which was named Fairchild Semiconductor. Fairchild Semiconductor was immediately successful and grew rapidly. Fairchild's critical role in Silicon Valley was two-fold. First, it pioneered the use of silicon for semiconductors (Braun and McDonald, 1982; Lecuyer, 2005). Second, it was the source of yet more entrepreneurs and supercharged the entrepreneurial fervor in the region (Klepper, 2001; Lecuyer, 2005). Not only did Fairchild alumni establish new firms, but also their funding was organized by the budding young VCs. The successes created significant capital gains shared by entrepreneurs and investors alike.

Fairchild was important in another way, namely its West Coast employees were not given stock options commensurate with what they believed their contribution to the firm was (Lecuyer, 2005: 257–258). In reaction, it would be in the Silicon Valley semiconductor industry where the organizational innovation of spreading stock options to all employees was utilized as a motivational mechanism. As Lecuyer (2005: 294) demonstrates, by the mid-1960s the entrepreneurial "Fairchildren" were building firms "as vectors for personal enrichment and technological innovation." Stock options aligned employee interests with that of the entrepreneurs and venture capitalists—namely generating capital gains. The prospects of a large pay-off at a liquidity event attracted many of the very best engineers and executives and motivated them to work incredibly long hours. Stock options in fledgling firms had a "jack pot" character and became a key part of the VC-fueled new economy business model (Lazonick, 2009).

Successful or, better put, spectacular investment returns from certain VC investments were crucial to its expansion. The first visible success was the 1958 RBI investment in the firm Itek, which produced a top-secret information processing system for satellite photo images. In 1958, RBI purchased Itek shares for $2 per share and by May 1961 the shares were sold in the over-the-counter market for $60 per share (Lewis, 2002: 190). But, the standout firm was Digital Equipment Corporation, an MIT Lincoln Laboratory spinout. In 1957, ARD invested $70,000 in exchange for 70% of the equity in the startup. At the time of the DEC IPO in 1966, the value of ARD's stake in DEC was $38.5 million—a 100% compound annual growth rate. It was this success that validated venture investing, and planted the seeds of destruction for the ARD organizational form. In contrast to many of the other firms such as Itek, which soon collapsed into bankruptcy, DEC continued to grow and in 1970 was worth $350 million. DEC validated the claim that venture capitalists could discover firms capable of becoming new industrial giants. The galvanizing effect of ARD's investment in DEC for VC was best expressed at a 1970 meeting of venture capitalists in Boston where Peter Danforth of Gunwyn Ventures exclaimed, "Would we all be here today if Digital Equipment had not happened?" (New Enterprise Systems, Inc., 1970: 29).

Much attention on the formation of Silicon Valley (and the Route 128 area) and VC has been given to the role of defense R&D funding and particularly purchasing in explaining the growth of technology-based startups (Leslie, 2000), and this is undoubtedly correct for the firms formed in 1950s and the early-1960s, but by the mid-1960s the importance of defense purchasing began to wane (university R&D funding continued to be very important). Increasing growth in the commercial market for computing innovations meant that military purchasing became an ever smaller portion of the market. For example, in the 1950s, the military market for semiconductors was between 20% and 30% of the market, but by 1978, total government consumption had dropped to 13% and increasingly military electronics was superseded by the commercial market (Braun and MacDonald, 1982: 144). Also, in

the 1960s Secretary of Defense Robert McNamara ended cost-plus contracting, which meant that defense industry startups were no longer so attractive to VCs (Lecuyer, 2005: 171–172). The defense industry market became unattractive, both for startups and VC investors, though this shift only became apparent in the 1970s.[8]

The quickening pace of technical advance in electronics created a remarkable coincidence of events in the late 1950s, setting the stage for the rise of ICT entrepreneurship by providing a price-insensitive market, an expanding high-technology labor force, and a booming stock market with great demand for high-technology firms. This would be reinforced by federal legislation creating the Small Business Investment Corporations (SBICs), which will be discussed next.

### *6.1 The small business investment corporations*

Congressional desire to assist small business continued unabated from prior to World War II. In 1953, the Republicans took control of Congress and the Executive Branch, and to secure sufficient support for the closure of the Great Depression-era Reconstruction Finance Corporation, the Republicans agreed to create the Small Business Administration (Zeigler, 1961; Blackford, 1991; Bean, 1996). The Democrats on the Congressional Small Business Committees continually attacked the Eisenhower Administration for not supporting small business. In April 1958, a widely read Federal Reserve Board study concluded that the crux of the small business financing problem was in manufacturing and found that, "the unsatisfied demands [for capital] that appear to have greatest economic justification are mostly those of new firms or concerns with new lines or processes" (Federal Reserve Board, 1958: 13). This ratified a subtle shift in thinking about small business, whereas the Democrats wanted loans for all small businesses, the report recommended helping new firms or firm expansions.

With the US economy sinking into a recession and with midterm elections approaching, Republicans were worried. At the beginning of the 1958 Legislative session, Senate Majority Leader Lyndon Johnson declared that a program to provide financial support for the credit needs of small business was "must" legislation (Sparkman, 1958: 14). Though the Administration was unenthusiastic, it introduced its own bill. To secure Republican support, a new financial intermediary, the Small Business Investment Corporation (SBIC), was created. SBICs were established with a federal loan guarantee to private investors, the SBIC operators, rather than providing direct Federal loans to small business (Stults, 2000). In the Senate debate, Lyndon Johnson justified the SBIC Program by describing the bill as doing "no violence to free enterprise, [as it] does not raise the specter of Federal control of, and compete with private business" (US House of Representatives, 1959: 34). The government would provide incentives and oversight, but there would be no involvement in deciding who would receive assistance.

[8]This also had a geographic impact as VC investment shifted from the defense-driven startup culture of Los Angeles to the Silicon Valley.

To receive a license from the SBA, an SBIC promoter had to have at least $150,000 in paid-in capital. With this they could receive a maximum of 200% leverage in the form of a combination of 15-year loans and 20-year subordinated debentures with a favorable 5% interest rate. Leverage decreased on a sliding scale for starting capital greater than $150,000. This favored small SBICs. In addition, there were a variety of tax incentives.

The initial legislation required portfolio firms to buy stock in the funding SBIC, though this was soon dropped as it made little sense for a small firm to rebate the funds it received to its investor. With the aim of protecting the investment recipient from the investors, initially SBICs were forbidden from owning >20% of the recipient. With insufficient equity, SBICs were limited in their ability to influence or replace management. Also, in cases in which the portfolio firms required further funding, SBICs were often unable to follow-on if it meant breaching this rule. In other words, the vital VC monitoring and control function was handicapped.

The most significant feature of the legislation was the authorization of three different types of SBICs. First, there were individually operated SBICs, which became the most numerous and eclectic in their investment targets and practices. Their chosen investment fields ranged from real estate and retail outlets to technology firms. These SBICs were often established on the basis of the minimum amount of capital. Second, there were SBICs raising their capital through public stock offerings. These public SBICs, though small in number, accounted for two-thirds of all SBIC capital (Hayes and Woods, 1963: 7). Third, there were the SBICs formed by financial institutions. These were the result of the SBIC Act allowing banks to circumvent the Glass-Steagall Act's prohibition on commercial bank investing in industrial firms.

Advocates of more VC investing welcomed the SBIC Program; but quite soon the organizational architecture of each type was shown to be problematic. The greatest problem for the SBIC Program was that the minimum capitalization of $450,000 ($150,000 of paid-in capital plus leverage of two times) encouraged the creation of SBICs that were too small to make a sufficient number of investments to ensure an adequate probability of success. For the smallest SBICs, it was impossible to hire a professional staff as even a single full-time employee was a significant draw upon its capital. Moreover, their limited capital made it difficult to provide follow-on investments as a small firm grew. The small size was not an oversight, Congress wanted to facilitate entry into the SBIC Program to spread the benefits broadly.

Implementation of the law creating these entirely new financial intermediaries was not simple and Congress provided little guidance. Recruiting investors to establish an SBIC was not trivial, as licensees had to invest capital. For potential managers, it was not immediately obvious that such a career choice was prudent, as the SBIC was an untried form and, at this time, the returns from VC firms such as ARD were either unimpressive or, in the case of the Rockefellers and Whitneys, unknown.

**Table 1** SBIC program statistics, 1959–1978

| 12 months ended 3/31 | SBICs established | Number of licensed SBICs | SBICs liquidated | Number of SBIC financings | Total invested ($M) |
|---|---|---|---|---|---|
| 1959 | 62 | NA | NA | NA | NA |
| 1960 | 113 | 62 | NA | 196 | 9.9 |
| 1961 | 273 | 171 | NA | 1376 | 69.5 |
| 1962 | 216 | 442 | NA | 3056 | 154.3 |
| 1963 | 65 | 643 | NA | 3034 | 153.2 |
| 1964 | 49 | 710 | NA | 5638 | 220.0 |
| 1965 | 8 | 713 | NA | 4763 | 186.8 |
| 1966 | 8 | 700 | NA | 4960 | 221.1 |
| 1967 | 11 | 669 | 60 | 3728 | 164.2 |
| 1968 | 7 | 542 | 73 | 2816 | 143.2 |
| 1969 | 8 | 487 | 11 | 3090 | 182.4 |
| 1970 | 6 | 451 | 6 | 2920 | 187.0 |
| 1971 | 6 | 442 | 58 | 2536 | 156.0 |
| 1972 | 8 | 436 | 5 | 2733 | 168.2 |
| 1973 | 9 | 434 | 3 | 2405 | 175.2 |
| 1974 | 16 | 474 | 7 | 2000 | 197.6 |
| 1975 | 16 | 379 | 9 | 1516 | 125.4 |
| 1976 | 19 | NA | 6 | 1708 | 120.1 |
| 1977 | 25 | NA | 10 | 1801 | 143.9 |
| 1978 | 43 | NA | 9 | 2106 | 214.0 |

*Source*: Wilmeth, John. SBIC Program Statistical Package (January 2002).

NA, not available.

Despite the drawbacks, the SBIC's leverage was attractive and the perceived risk was low. In part, attracted by the vision of easy capital gains in the then hot stock market for technology-based firms, from 1960 to 1962, there was a veritable wave of new SBIC formations (Table 1). In 1961, the prospects for the SBIC Program looked bright. SBICs were investing in a wide variety of fields with some notable successes. Due to the rapid success of SBICs investing in electronics, it appeared that the SBIC Program was going to become an important factor in the VC industry. According to data collected by the *Venture Capital Journal* (1983: 9), from 1959 to 1963 SBICs provided three times more VC than did the private VC firms. Later in the 1960s this investment gap would narrow considerably.

The ebullient stock market conditions permitting SBICs to issue stock to the public and list their portfolio firms did not last. In 1962, the stock market reversed

course, and the stock price for some publicly owned SBICs soon plummeted to as little as 50% of their book value (*SBIC Evaluation Service,* 1963a: 1). As soon as the stock market bubble burst, the SBICs suffered problems. Even though the main aim of the SBIC Program was to support manufacturing investment, a 1962 Harvard Business School survey reported in Hayes and Woods (1963: 188) found that the most popular investment fields in rank order were real estate, retail outlets, electronics, consulting, and personal services. Electronics, which became the core investment field for VC, was only the third most popular. More significant for the fate of the program, real estate and retail investments had high failure rates.

Quite quickly, many of the SBICs experienced difficulties. Plummeting value led the public SBICs to exit the SBIC Program voluntarily or through liquidation. By 1972, 36 of the 50 publicly held SBICs had liquidated, merged, or converted into operating companies (*SBIC/Venture Capital,* 1972: 4). In the 1980s, the remainder left the program. The bank-affiliated SBICs, though professionally run, also were troubled. A Harvard survey found that the bank-affiliated SBICs were disappointed because their bank connections provided few deals. Bank respondents found SBICs difficult to administer because the skills necessary for finding and making a good loan were quite different from finding and evaluating an equity investment in a small business. There was considerable disenchantment as 27% of the bank-backed SBIC respondents (as opposed to 15% of all SBICs) said they would not have formed an SBIC had they known the difficulties (Hayes and Woods, 1963: 15). The small private SBICs were the most troubled. With inadequate capital, inexperienced management, and a lack of connections able to produce a high-quality deal flow, many soon experienced difficulties.

As with any government program with guaranteed monies, a vague mandate, and intense pressure to disburse funds quickly, problems appeared as both the serious and the craven flocked to benefit from the government-guaranteed capital. By 1963, it was apparent that the SBIC program had attracted some unscrupulous individuals. In September 1963, the SBA filed fraud charges against an Illinois SBIC for self-dealing, kickbacks, and fund diversion (*SBIC Evaluation Service,* 1963b: 2). These problems created regulatory headaches and also threatened the SBIC Program's legitimacy. Newspapers, particularly the *Wall Street Journal*, reported these cases, creating bad publicity—a significant handicap for a new organizational form. The private SBICs specializing in real estate had a particular penchant for self-dealing (*Wall Street Journal*, 1963: 16).

In 1964, the SBA instituted a 90-day licensing hiatus and reoriented the program to stress "venture capital investing as opposed to real estate and secured lending" (*SBIC Evaluation Service,* 1964: 1). In those 90 days, investigators visited each SBIC and found that "nine out of 10 SBICs had violated agency regulations and dozens of companies had committed criminal acts" (Bean, 2001). Most of the problems were procedural, but serious violations were found. By 1965, there was increasing pressure on the SBIC Program from Congress and others to eliminate what the *SBIC*

*Evaluation Service* (1965: 3) termed the "unscrupulous, self-serving, or inept." As a response, the SBA tightened rules and regulations and encouraged real estate investors to leave the program.

In 1966, Congress conducted hostile hearings on the SBIC Program. Initial estimates were that the government would lose about $18 million of the total $275 million invested. Upon further investigation it was found that the losses were far greater and loss reserves were increased to $54 million in March 1967 (Parris, 1968: 162–63). In 1967, the SBA Administrator was quoted in the *Wall Street Journal* (Schorrs, 1967: 28) as saying, "We're going to get down to a hard core of good companies . . . I'll be happy if we wind up with 250 survivors" of the total 680 SBICs in existence. Congress gave the SBA enforcement authority to investigate conflicts of interest; to fix legal responsibility on officers, directors, and agents of unlawfully operated SBICs; and to levy stiff penalties and fines. The SBA changed its emphasis to having the SBICs take equity stakes in "innovative" manufacturing and research firms (Schorrs, 1967: 28).

As a side effect of the increased regulatory effort, the SBIC Program became increasingly bureaucratic and constraining. The increasing number of regulations and reporting requirements prompted the more successful SBIC operators to contemplate leaving the program (*SBIC Evaluation Service,* 1966: 5). At the December 1967 National Association of Small Business Investment Corporations (NASBIC) annual meeting, the outgoing NASBIC president warned that key SBICs would leave the program due to excessive regulation (*SBIC Evaluation Service,* 1967: 2). Though data on the early days of the SBIC Program is scarce, Table 1 shows the burst of entrants in the early 1960s, then an increasing number of withdrawals, and after 1969 few new entrants.

The SBIC Program also came under institutional attack. In 1964, the Ford Foundation funded the establishment of the Small Business and Venture Capital Associates (SBVCA) to develop a strategy to encourage the expansion of VC. In 1965, the SBVCA initiated a study of VC. In 1967, the SBVCA (1967: 8) released a report entitled *Encouraging Venture Capital for Small Business.* The report strongly supported VC, but attacked the SBIC Program as marred by incompetence, concluding that excessive federal regulation was primarily responsible, and recommending termination. Though federal support continued, the report reinforced the determination of the remaining venture capitalists to abandon the SBIC Program. At the 1968 NASBIC Annual Conference, Stanley Rubel, the chronicler of the SBIC Program nearly from its inception, announced that he was renaming his trade journal from *SBIC Evaluation Service* to *SBIC-Venture Capital Service.* He posited and answered the question:

> Has the SBIC industry become a viable institution at this point? I think we pretty clearly answered the question that it hasn't. It is just too small. The amount of money that it has is declining if anything, and it certainly isn't keeping up with

> the rest of the venture capital industry. The SBICs [*sic*] is a drop in the bucket compared to the portfolios of insurance companies like Prudential and a few others maintain for small companies. American Research and Development has about $250 million in assets [Digital Equipment Corporation stock was the bulk of this, not raised capital] compared to $700 million in total assets of the SBIC industry . . . I don't think there is any way that you can conclude that the SBIC industry is an established institution at the present time. It is just too small and too insignificant and isn't growing adequately (Rubel, 1968: 98).

The role of the SBICs in the VC industry was drawing to a close both for reasons internal to the Program and the success of VC partnership that was proving to be an organizational form better suited to the practice of VC.

In retrospect, the SBIC program had some positive impacts. It attracted some individuals that may not have entered the VC business otherwise, thereby serving as a recruitment mechanism. For some informal venture investors, it provided them with more capital allowing them to leverage their successes and use their record to raise capital from institutions. This was most pronounced in the San Francisco Bay Area, but there are a few important limited partnerships in other parts of the nation that began as SBICs. Their success meant that they exited the SBIC Program and paradoxically this weakened the SBIC as an organizational form. Whether these benefits would have accrued without the SBIC Program is a difficult question to answer, as is the question of whether the waste that the Program engendered was sufficiently compensated by the few but important successes.

### *6.2 New organizational forms emerge*

At the end of the 1950s, the four pioneering VC firms continued to operate and the SBIC Program was just being launched, but there was another organizational experiment being launched—the VC limited partnership. In 1959 in Palo Alto, California, the first VC limited partnership for investing non-familial money, Draper, Gaither, and Anderson (DGA), was organized.[9] DGA's founders were prominent in national political and economic circles.[10] In a remarkable parallel to ARD's close connection

[9]For DGA, there is another possible source of inspiration; namely Rockefeller Brothers Inc., an investor in DGA, was organized as a limited partnership. The nonfamilial model differed from the familial model in significant ways. In the family funds the professionals were employees or junior partners. Often they had the right to invest alongside the partnership, but the investment decisions were made by the family. The professionals did not receive a "carried interest" (Walkowicz and Woodward, 1959).

[10]William H. Draper, Jr. had been a prominent investment banker at Dillon Reed prior to World War Two, and then served as the Economic Advisor for the High Commissioner in Germany. In 1948, he became the Under Secretary for the Army in Washington, and prior to returning to Palo Alto, chairman of Mexican Power and Light. General Frederick L. Anderson had been the commanding officer of the Eighth Bomber command based in England. After retirement,

with MIT and Harvard, DGA's first office was on Stanford University's campus.[11] The source of the idea for organizing VC investment practices into limited partnerships is uncertain. Julian Stern (2002), who was practicing tax law at the time and provided the legal assistance for organizing the second Silicon Valley limited partnership, Davis and Rock, remembers that he took the model from the wildcat oil industry.

At DGA, after the limited partners' initial investment was returned, general partners were entitled to a 40% carried interest while the limited partners received the remaining 60% (Gaither, 1959). Each general partner also received a $25,000 per year salary as a management fee. The duration of the DGA partnership was 5 years and could be continued only if the limited partners agreed. DGA paid-out all returns. There would be no reinvestment. Instead, the general partners would raise another fund. This contrasted with the familial partnerships that were "evergreen," in the sense that they retained and reinvested their gains. Though DGA had a life of 5 years, the later partnership "funds" would have a life of between 7 and 10 years and new partnerships would be organized at the will of the general partners.

The three principals at DGA had previously made a number of private placement investments with considerable success. These successes and the opportunities they saw prompted them to attempt raising a larger investment fund with the express purpose of investing in the Western states, primarily California. Their reasoning for the need for a West Coast VC organization was the following:

> There is, so far as we know, no important private investment banking group which systematically offers these facilities [venture capital]. The formation of one would be welcomed and supported by industry and business, commercial banks and underwriting firms (Gaither, 1959).

Using their considerable connections, they raised $6 million. The investors were the wealthy Bay Area angel venture investor, Edward H. Heller ($1.5 million); the powerful investment bank Lazard Freres ($1.5 million);[12] Rockefeller Brothers, Inc. ($1.2 million); and the Gadran Corporation, a private corporation created by a

Anderson returned to California and began making private investments. H. Rowan Gaither, Jr. was a prominent San Francisco attorney who had been the legal counsel for the establishment of the RAND Corporation and the first chairman of the board for MITRE Corporation. The final DGA partner was Lawrence Duerig who was a San Francisco area investment counselor. The first three were members of the highest levels of the U.S. business and policy elite.

[11]William H. Draper, III (2000) remembered the connections to Stanford as very important, even though DGA invested in only a small number of Stanford spin-outs. According to Draper, Frederick Terman, though critical for encouraging entrepreneurship and attracting R&D facilities to the region, had no direct involvement in the formation of DGA.

[12]Lazard Freres at this time was headed by the famous deal-maker and investor, Andre Meyer.

partner in a New York investment firm ($1.2 million). The remaining $600,000 was invested by the principals (Draper *et al.*, 1960: 2).

After it was formed, DGA soon experienced personnel difficulties as Gaither contracted cancer. According to an internal memorandum from a Rockefeller Brothers executive, he was the "glue" binding the group together (Woodward, 1960). By November 1960, the RBI professionals began questioning their DGA investment. In an internal memorandum dated November 2, 1960, three RBI investment professionals critiqued DGA for having no staff members with a technical background. Though not explicitly stated as a reason, dissatisfaction apparently prompted the Rockefellers to withdraw from the partnership.[13] In 1961, the RBI organization and Lazard Freres sold their interest to the other limited and general partners. As a private partnership, there is little publicly available information on the firm's investments. However, the report to the investors shows that by 1960 DGA had invested in 23 firms; only 12 of which could be considered technology-related (Draper *et al.*, 1960). In 1967 DGA was liquidated.

In 1961, another limited partnership, Davis & Rock (D&R), was formed by Arthur Rock and Thomas Davis. Their initial capital was raised from various successful entrepreneurs, most of whom had previous ties with Rock. The $3.5 million of paid-in capital was provided by successful entrepreneurs from Teledyne, General Transistor, and Fairchild for which Rock had previously organized funding. As compensation, the general partners received 20% of the capital gains (Davis, 1986). Davis and Rock focused on technology firms, and their investment of $257,000 into the computer firm Scientific Data Systems was the most successful as Xerox purchased the firm in 1969 for $1 billion. D&R was liquidated in 1970 after disbursing $94.5 million to its investors for an approximately 60% compound annual rate of return (*SBIC Evaluation Service*, 1970: 2; New Enterprise Systems, 1970: 87). This annual rate of return demonstrated just how great the capital gains could be for a successful VC firm.

The success of Davis and Rock, when coupled with other successes such as the ARD DEC investment, had an electric effect on potential investors and encouraged others to enter venture investing in the San Francisco Bay Area and nationally. While DEC demonstrated that ARD professionals could not receive compensation commensurate with the gains received by the investors, D&R validated the limited partnership as a workable organizational form for VC investing by providing ample rewards to investors and the venture capitalists. Less noticed but also significant was the fact that D&R investors were technical entrepreneurs from previous successes. Though neither Davis nor Rock was technically trained, they were the first VC

[13]Peter Crisp (1999) of the Rockefeller organization did not recall conflicts. However, Lucas (1999) and Draper (2000) recalled that disagreements arose between DGA and the Rockefeller Brothers organization.

firm that was entirely devoted to technology venturing and included technologists as their investors.

The first Boston limited partnership was formed in 1965, when William Elfers left ARD to establish Greylock, and raised money from wealthy East Coast families.[14] Contemporaneously, Sutter Hill Ventures, in the Bay Area, was formed in 1964 by two ex-SBIC operators. In 1970, New Enterprise Systems (1970: 36) estimated that several hundred new partnerships formed after 1965. Not only were many new VC operations forming, but they also were becoming larger. Nearly all of these partnerships raised funds from wealthy individuals that, though willing to invest, were a limited source of funds.

### *6.3 The first mega-funds*

Nearly all of the early private VC investment operations were small, managing less than $10 million, while a few of the public and bank SBICs had $20 million under management. The torrid new issues market, particularly in the late 1960s, allowed a number of VC investors to amass impressive investment successes such as DEC, Itek, and Scientific Data Systems. This prompted stock market demand for similar firms. The VCs "producing" these firms for the public market were rewarded with huge capital gains. In 1969, at the height of the boom, two new organizations, the Heizer Corporation and New Court Private Equity Fund, raised $81 million and $69 million respectively, making them significantly larger than any previous VC operations–these were the first mega-funds. These two mega-funds pioneered a significant innovation. In contrast to the pioneer limited partnerships that raised capital from individuals and families, and the SBICs dependent upon the Federal government, the mega-funds attracted conservative institutional investors having longer time horizons and searching for improved returns. The willingness to commit large sums of capital made the mega-funds possible. Parenthetically, by attracting these institutional investors they validated ARD's vision of VC being contributed by institutions.

The leading mega-fund was the Chicago-based Heizer Corporation established by Edward F. Heizer. Heizer entered the VC industry by managing Allstate Insurance's private placements program, which had been started a few years earlier. The objective of the program was to make VC-like investments. This was a bold step for Heizer and Allstate Insurance, as it committed to what was seen as risky investment. There was substantial internal resistance to investing in fledgling firms, but Heizer's investments had excellent returns due to investments in Memorex, Scientific Data Systems, and Teledyne. To illustrate, a $200,000 investment in the Silicon Valley firm Memorex was sold a few years later for $8 million (Bylinsky, 1976: 30). Heizer (2007) recalled

[14]To secure investments from the Watsons of IBM, the first Greylock fund promised not to invest in "directly competitive data companies" (Elfers, 1995). This may have been the reason that the first Greylock fund had lackluster returns.

that while investing only 4% of Allstate's capital, his team generated nearly 50% of Allstate's total profits. During the seven years (1962–1969) at Allstate, Heizer's investments had a 43% compound annual rate of return and eventually the "venture capital activities had grown to be the largest single pool of capital within Allstate" (New Enterprise Systems, 1970: 87).[15]

As has been typical in corporate venturing, there were internal obstacles at Allstate. The greatest obstacle was one that has been endemic to corporate venturing and also plagued ARD, namely retaining professionals due to compensation issues. Conflict of interest concerns exacerbated this problem because Allstate prohibited investment managers from co-investing. Heizer (2007) described the problem:

> [Compensation issues] created increasing tensions between my boss and me. I was very fond of him and I think he was very fond of me, but he got very mad at me over why I insisted on our people having percentage interest in the companies we financed. I responded that the salary structure of Allstate and the way it is run may be attractive to people in the insurance business, but it is not attractive at all to people in our business. So we hire individuals when nobody knows their talent. We teach them and bring them along and they become very good and then everybody [competitors] starts wanting them. We were running a training school and I didn't like that. I didn't mind running a training school but for people we kept not those we lost.

Eventually, Heizer gave Allstate an ultimatum regarding compensation issues, but it was impossible to restructure Allstate's compensation programs solely for this small, though very profitable, ancillary operation.

With Allstate unable or unwilling to act, Heizer (2007) decided to establish his own firm. Though Heizer's goal was to raise $50 million, due to his excellent track record he raised $81 million. The institutional investors were diverse and included twelve insurance firms (but not Allstate), six commercial banks, two investment banks, and the American Museum of Natural History, the Art Institute of Chicago, Stanford University, State of Wisconsin Investment Board, University of California, University of Chicago, and the University of Rochester endowments (Heizer Corporation circa, 1974a).[16] A far greater number of endowments participated in the funding of Heizer Corporation than had done so at ARD, and since, at that time, Heizer Corporation was not traded on the stock market, their investments were illiquid. The Wisconsin Investment Board was a public employee's pension fund—presaging the investment of public pension fund monies that would become a mainstay source of capital for VC limited partnerships. Most importantly,

[15]Heizer (2007) confirmed that the return was between 41–46% depending upon the accounting methodology.

[16]Two decades earlier, a few insurance companies, MIT, and Rice University had invested in ARD common stock.

these investors included organizations guided by the "prudent man" rule requiring trustees to not take untoward investment risks.

The Heizer Corporation was organized as a business development corporation, not as a limited partnership. It had a corporate hierarchy, a board of directors, and various specialized investment teams (Heizer Corporation, circa 1974b). This provided risk-averse institutional investors with an organizational form that they understood. By 1977, Heizer had invested in 32 firms. The following six of which went public: Amdahl, Commodore Corporation, Data 100 Corporation, Fotomat, Material Sciences Corporation, and SpectraPhysics. Heizer Corporation's investments in these five firms alone were worth $121 million (Venture Capital, 1977: 17). At that time, the other portfolio firms included Beverly Enterprises; Federal Express; Nortec Electronics, a digital watch company; Precision Instrument; Southwest Airlines; and Vilcor—two of these, Federal Express and Southwest Airlines, would become household names. In the early 1980s, the Heizer Corporation itself went public and then in 1986 was divided into a number of public and private companies. In addition to successful investments in a wide variety of firms, Heizer Corporation provided clear proof that institutional investors would commit significant sums of capital to venture investing. Despite the powerful demonstration effect of using the corporate form, it would not become the organizational form VC would adopt.

The other mega fund was the New York-based New Court Private Equity Fund (NCPEF), which raised $51.5 million at the end of 1969. It also had an unusual structure because it was a subsidiary of New Court Securities, which was the US investment vehicle for the European Rothschild family. The investors in the NCPEF were the private pension plans of large corporations such as IBM, AT&T, and RCA. Originally, like Heizer, it was organized as a corporation, largely because its investors felt more comfortable with that form. In 1974 it reorganized as a limited partnership, raised its management fee to 2%, and instituted a 20% carried interest (Lea, 1999). New Court also experienced significant investment success. It was a lead investor in Federal Express and Amgen, one of the most successful biotechnology firms. As co-investors, NCPEF participated in the financing of Cray Research and Tandem Computers. The success of NCPEF was interrupted in 1981 when Mitterand took power in France and the Rothschild family decided to move its operations to the US and take managerial control of New Court and changed the firm's name to Rothschild, Inc. As a result of these changes, Charles Lea and his colleague John Birkelund left New Court and formed their own VC limited partnership (Lea, 1999).

Heizer Corporation and NCPEF were significant because they raised institutional funds—and provided them excellent returns. Accessing institutional funds from endowments and pension funds matched a pool of funds with long time horizons to a type of investing characterized by initial illiquidity and a possibility of large long-term returns. It also solved the problem of VC compensation by providing the investment professionals with a mechanism to share in any capital gains. These first

mega funds and their successes, despite the stock market downturn due to the 1973 Oil Crisis, proved to institutional investors that VC investing could provide excellent returns to compensate for the perceived risk.

### *6.4 Conclusion*

The 1960s was a period of experimentation and by the early 1970s VC was proving itself as a business practice. The semiconductor was transforming the electronics industry as transistors replaced tubes. Minicomputers proliferated and computer time-sharing was growing; new firms commercializing these developments were funded by VCs and conversely the availability of VC allowed these new technologies to be exploited by entrepreneurs. Contemporaneously, the military market was becoming less significant for the firms VCs were funding. Torrid stock markets in both the early and late 1960s welcomed small electronics firms, and lucrative exits were possible. The excellent returns encouraged a greater flow of capital into VC firms.

Due to its attractive features for the VCs and investors, the limited partnership organizational form diffused for these reasons. First, all capital gains flowed directly to investors without being taxed, and, if the investors were tax-exempt, there was no taxation at all. Second, the general partners not only received management fees covering their salaries and expenses, but they also captured a share of the capital gains. This allowed the professional managers to profit enormously in the cases of great success. Third, receiving the management fee from the investors in the partnership eliminated any reason to have portfolio firms pay dividends or fees to the VC firms. The limited partnership business model was able to operate differently from the SBICs or ARD that needed current income to fund operations. Fourth, the limited partners had no ability to interfere with the decisions of the general partners. Fifth, by the end of the period institutional investors were investing in limited partnerships and they were interested in the long-term returns and thus did not pressure the VCs for dividends or interest payments. Sixth, each partnership had a limited life of between 7 and 10 years after which it was liquidated. This self-liquidation facilitated periodic change in both the general and limited partners. Seventh, the funds were invested only once, and all returns were immediately distributed to the investors. If the limited partnership was successful it could raise funds for another partnership. These features facilitated the creation of the "partnership" aspects of the investor–VC–entrepreneur relationship. Finally, the limited partnership life-cycle was aligned with the life-cycle of portfolio firms.

For the VC, the limited partnership form provides powerful incentives. Because of its limited duration of 10 years, the VC partnership is under great pressure to invest the funds in the first 3 to 4 years. They do not want to invest in losers, but missing the home run is disastrous. The risk of loss is mitigated by the large number of investments. Because VCs monitor, advise, and assist their portfolio firms, the

investment is not just a passive "gamble," rather VCs try to positively alter the portfolio firms' chances of success (Florida and Kenney, 1988; Gorman and Sahlman, 1989; Kaplan and Stromberg, 2001; Hellman and Puri, 2002). The VC limited partnership does not charge management or other fees to the portfolio firm for their services, but rather aims to recoup the time expended through the capital gains garnered in a successful exit.

Despite the earlier successes, at the beginning of the 1970s, VC, and the entrepreneurship it supported, was not a significant part of the US NSI. Large firms such as IBM, AT&T, and others, with their central research laboratories, still dominated the world of industrial research. And yet, new firms such as Ampex, Fairchild, DEC, and their brethren startups, were profitable, growing very rapidly, and increasingly competitive with the established information technology giants. Minicomputers had broken IBM's stranglehold on the computer industry, not in mainframes, but in the newly emerging smaller computers. Merchant component manufacturers were finding markets, especially among the new computer manufacturers that were less vertically integrated. Despite these successes, the Chandlerian firm still reigned supreme, and their lavishly funded R&D laboratories were without peer (Chandler, 1990).

## 7. The 1970s: VC becomes a new component of the US NSI

The 1970s began with a continuation of the high-technology boom of the late 1960s; however, the macro political economy became decidedly negative with the Oil Crisis of 1973–1974. The Oil Crisis was accompanied by a bear stock market that took the S&P down 48% from its previous peak. As a result, a number of badly managed pension funds collapsed, prompting Congress to pass legislation, the Employee Retirement Income Security Act (ERISA), meant to protect defined contribution retirement plans through establishing strict standards of conduct for investment professionals. The most important standard was that the fiduciaries should invest prudently, which was interpreted by lawyers to mean that high-risk investments such as those made by VCs were forbidden. Though this was applicable only to pension funds, managers for other institutional investors, such as insurance companies, endowments, etc., took this to mean they personally might be liable for losses on such risky investments. Given the declining stock market and this new legal requirement, the flow of funds into VC abruptly halted. As shown in Figure 1, capital committed to VC limited partnerships collapsed during the early 1970s, though the amount of VC invested in firms was less affected, because existing VC firms continued to invest as did the SBICs.

In the larger US economy, there were also significant changes. Japanese competition graduated from clothing, toys, and other less capital-intensive items, to higher end consumer electronics and consumer durables. This was the beginning of the gradual collapse or shrinkage of a number of US industries (for a discussion, see

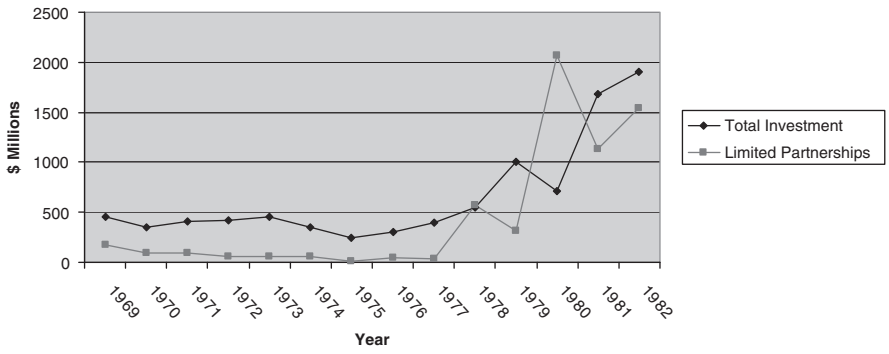


**Figure 1** Total venture capital invested and funds committed to limited partnerships.

Lazonick, 2009) or what some have termed the demise of US Fordism (Aglietta, 1979).[17] In ICT, the control IBM and AT&T exerted noticeably weakened due to government antitrust action, new competitors, and internal difficulties. Two events that would prove of great significance were the 1969 IBM decision to unbundle hardware and software and the legal decision to let a VC-funded startup firm MCI build a long-distance microwave line between Chicago and St Louis, thereby introducing competition to the lucrative long-distance business. So, on one hand, the core of the Fordist economy experienced heightened offshore competition, while, on the other hand, the ICT giants were exposed to greater entrepreneurial competition.

The 1970s were also a decade of dramatic technological change, particularly in electronics. The first and most important of these was the continuing improvement in semiconductors, as ever more processing power could be placed on a single chip. In the early 1970s, engineers developed techniques for placing the formerly separate functions of a computer's central processing unit onto a single chip creating a "microprocessor" (Braun and McDonald, 1982; Lecuyer, 2005). By exponentially increasing processing and storage power in the same physical space, these developments made it possible to dramatically shrink the size of a computer, making "personal" computers possible. The proliferation of computers that began with the minicomputer made inter-computer communication an area of increasing interest. In an entirely different sphere, a technological breakthrough made within research universities made "genetic engineering" possible. These developments allowed small groups of technically savvy entrepreneurs to create new market niches. Some, but not all, of these niches would grow rapidly, becoming the basis of large new industries within which the small firms could expand equally as rapidly. It was precisely these

[17]For an early discussion of the context for the shift to a venture capital-driven economic system and its lack of direct connection to the existing Fordist economy, see Florida and Kenney (1990).

opportunities in which venture capitalists could deploy their funds to turbocharge firm growth and, in return, if their investments were successful, reap enormous capital gains.

For venture investors, liquidating their stakes in their portfolio firms had been difficult. The large and deeply liquid New York and American stock exchanges did not welcome small firms, so generally these firms were listed in the relatively illiquid over-the-counter markets (Ingebretsen, 2002; Weeden, 2002). In 1971, this began to change with the formation of the NASDAQ electronic market. Initially meant to be an alternative electronic trading platform for the existing over-the-counter market, it evolved to be an alternative market accepting listing of fledgling firms unable to qualify in terms of revenues or profits on the two larger stock exchanges. Providentially, Intel was the first firm to undertake an initial public stock offering on the NASDAQ. This set the precedent of VC-financed high-technology firms listing their initial offerings on the NASDAQ. The willingness of the NASDAQ to list smaller firms meant that larger sums could be raised earlier from the public to fuel firm growth and, as a by-product; investors could liquefy their earlier investments. The relationship was symbiotic, as the firms listing on the NASDAQ grew; they validated the NASDAQ as a market with promising firms. In this respect, NASDAQ played an important role in the growth of a VC-financed innovation system (Lazonick, 2009).

And yet, while the new technologies gestated and financial markets became friendlier to entrepreneurial firms, the 1970s proved difficult for the VC industry. In response, even though the flow of capital dramatically decreased, the VC industry had grown so sufficiently large and self-aware that it began organizing. Already during the late 1960s, the NASBIC had tried to recruit the independent VCs; however, it experienced only limited success, in large measure, due to the fact that non-SBIC VCs did not share the same concerns regarding regulatory activity, legislative action, and political maneuvering. The only organized group of VCs, the Western Association of Venture Capitalists, was local in orientation and declined initiatives to evolve into a more active national industry association.[18]

By 1972, venture capitalists and the SBIC operators had formed separate identities. And yet, the venture capitalists did not have an industry association presence in Washington, DC. Morgenthaler (2003), a pioneering venture capitalist and one of the founders of the National Venture Capital Association, recalled that a Congressperson told him during this period, "If you don't have an industry association representative in Washington, you aren't an industry." Rubel (1970: 9), the owner of what had begun as an SBIC newsletter, but had gradually shifted attention

[18]See, for example, Western Association of Venture Capitalists (1972).

to the independent VC industry, observed:

> The VC industry is undoubtedly the most unusual industry in the country. It has no trade association, no lobby in Washington, no official publication other than perhaps *SBIC/Venture Capital*, which is independently published by our organization.

For venture capitalists to create legitimacy and complete their separation from the SBICs, a national industry association appeared necessary.

In April 1973, the National Venture Capital Association (NVCA) was launched in the Heizer Corporation's offices "as a means for venture capital organizations throughout the country to work together on mutual interests and problems. Membership is by invitation and open only to venture capital groups, corporate managers, and individual venture capitalists that are responsible for investing private capital in young companies on a professional basis" (SBIC/Venture Capital, 1973: 3). SBICs were not explicitly excluded, but only the larger ones making venture investments would be invited.

The NVCA's first goal was to loosen the ERISA restrictions to increase the flow of capital to the VC partnerships. Through intensive lobbying over the next 5 years, the VC industry convinced the Department of Labor, which was charged with enforcing ERISA, to reinterpret it to allow investment in professionally managed VC funds. The reinterpretation would have a dramatic effect. According to Venture Economics (1985: 27), in 1978 pension funds committed $32 million to venture investing, which was 15% of the total, but by 1984 this had increased to $1,085 million and 34% of the total committed. As the Venture Economics notes, corporate pension funds were the most active, but public pension fund investing increased even more.[19]

In 1978 Congress lowered the capital gains tax rate from ~50% to 28%, which some argue was the reason for the massive expansion in VC availability in the early 1980s. This claim has been exhaustively examined by economists and debunked by Poterba (1989) who finds that most investors in VC partnerships are tax-exempt organizations such as pension funds and endowments. Moreover, investment by

[19]The leveraged and management buy-out firms, which often call themselves "private equity" firms, use the same limited partnership organization as venture capital. The earliest of these were formed in the mid 1970s, though it should be recognized there is no distinct legal or organizational line between the buy-out and venture capital organizations. Moreover, even the pioneering VC firms invested in existing firms seeking expansion capital. Also, as they raised ever larger funds, a number of the New York City organizations such as Warburg Pincus and Patricof & Company (now APAX) made an ever-larger number of buy-out deals. For example, New York-based Russell Carson (1999), originally of Citicorp Ventures and then founder of Welsh, Carson, Anderson & Stowe(WCAS), said that his firm had to decide between establishing a branch in Silicon Valley or abandoning VC investing and concentrating on buy-outs, which involved far more financial engineering. WCAS decided on the buy-out route. Many of the New York City firms chose the buy-out route, which proved extremely successful. Buy-out firms are omitted in this paper because they are not recognized as having a role in the US NSI.

tax-exempt entities increased more rapidly than that of taxed investors, so any claim that lowering capital gains taxes contributed significantly to the growth of VC is suspicious. Gompers (1994) noted that when capital gains taxes were later raised commitments to VC continued to grow. More likely is that, as Gompers and Lerner (1999) show, the benefit to the VC industry of capital gains tax rate reduction came because it made employees in established firms more willing to establish or join a startup where they would be compensated in equity or stock options (with their concomitant lower tax rates). Though not examined empirically, the fact that the venture capitalist's share of the capital gains, which is between 20% and 30% of the total gains, are treated as capital gains and not taxed as regular income almost certainly was another incentive. In other words, the most recent evidence suggests that changing capital gains taxation likely increased the flow of highly skilled personnel into the startup sector. Still, to paraphrase the research results on this issue, general capital gains tax rate reductions are a blunt instrument for changing the calculus of a small number of individuals to become more willing to join a startup.

A brief excursus into the industrial sectors being created by venture investing during the 1970s, and which would come into fruition in the 1980s, justifies the conclusion that by the end of the 1970s, VC had become a component of the new US innovation system. The first and most important of the new economic spaces might be termed the networked, distributed computing model that was made possible by the advances in semiconductors. This includes both the personal computer (Apple, and then in the 1980s, Osbourne, Compaq, and others) and work stations (Apollo Computers, to be followed in the early 1980s by Sun Microsystems, Silicon Graphics, and many more), components for small computers (Seagate, Shugart Associates, Tandon Corporation, Zilog, and many more), software (Microsoft, to be followed in the early 1980s by Ashton-Tate, Borland, Lotus, to name a few), and even computer retailers such as Computerland. The computer data networking sector also began its explosive growth with firms such as Rolm (founded 1969), Ungermann-Bass, 3Com, and in the 1980s many more. Additionally, there were continuing opportunities in classes of larger computers leading to firms, such as Amdahl, and providing components and software for them, e.g., Oracle. One change for the most successful ICT startups of the 1970s and into the 1980s is that the government market was significant, but no longer critical. Defense spending (with the exception of R&D support) no longer played a key role in the entrepreneurial portion of the NSI. Across the entire ICT industry, the commercial sector drove innovation as the defense sector with its long-cycle times and low volumes was too small and too slow—the electronics industry now moved at a pace set by Moore's law (Stowsky, 2004).

The final field of VC investing that emerged at the end of the 1970s was genetic engineering, which later came to be known as biotechnology (Kenney, 1986a). Though biotechnology was a case of the commercialization of new technology, VCs had a long history of interest in biomedical technologies and scientific

instruments. The rapidity at which VCs funded the building of new firms to exploit the breakthroughs in genetic engineering was remarkable, and arguably would have long-term impacts on the division of labor in the drug discovery market, as established pharmaceutical firms became more dependent upon university inventions that gestated in VC-financed firms (Henderson *et al.*, 1999; Rothaermel and Deeds, 2004). These two technological paradigms and trajectories created a plethora of new funding opportunities.

To review the outlines of this new system: first, two new technological paradigms, networked distributed computing and biotechnology, were ascendant. Second, the pace of technological change in these two paradigms was responsible for a continuing flow of new opportunities. Third, an increasing number of entrepreneurs were creating startups to commercialize promising new technologies. Fourth, government policy changes, particularly the loosening of ERISA, meant that pension funds, with their long-term perspective, were increasingly investing in VC limited partnerships. Fifth, the formation of the NASDAQ market provided an improved source of capital for the rapidly growing firms and an exit for VC investors and entrepreneurs. Sixth, in the San Francisco Bay and Boston areas a community of VCs and, in fact, an entire entrepreneurial support network emerged dedicated to the nurturing of small technology-based firms.[20] Seventh, the role of defense purchasing in fueling the pace of technological change diminished, though DARPA funding for university research in electrical engineering and computer science continued to be important in both generating new ideas and training graduate students. Eighth, capital gains tax changes also likely affected the pool of entrepreneurs and managers willing to join startups.

Despite all of these changes and the outlines of a new component of the US NSI, at the end of the 1970s, large firms, such as IBM, AT&T, and the large aerospace, chemical, and pharmaceutical firms still dominated the US NSI. The 1980s, however, would prove tumultuous for these existing firms and in this tumult VC would mature into the funding agents for a new NSI based on VC-financed startups that would rush in to attempt to exploit any market discontinuities.

## 8. The 1980s: stabilization and routinization

In the 1980s, policy makers and the informed public recognized VC and the firms it funded as a discernable component of the US NSI. The driving force for this recognition was the succession of startling VC-financed firm IPOs in the early 1980s. Among the most prominent was Genentech, which went public in October 1980 raising $35 million, while shares doubled on the opening day. In December 1980, Apple Computer sold its first shares to the public and they soared giving the company an unheard of valuation of $1.7 billion. In March 1981, Cetus, another biotechnology firm, went public and raised $107 million. 3Com went public in 1984.

[20]On entrepreneurial support networks, see Kenney and Patton (2005)

**Table 2** Estimated gross annual return rates for Kleiner and Perkins and successor funds

| Fund Name | Years (where available) | Internal rates of return (% of gross) |
|---|---|---|
| Kleiner & Perkins | 1973–1983 | 39 |
| Kleiner, Perkins, Caufield, and Byers (KPCB) I | 1978–1986 | 83 |
| KPCB II | 1980–1989 | 65 |
| KPCB III | 1982–1988 | 15 |
| KPCB IV | 1986–1996 | 11 |

*Sources*: Rutter 1989: 23; InsiderVC 2003.

Sun Microsystems and Oracle went public in 1986. The stock price appreciation of VC-funded firms validated the model to politicians and public investors alike.

The continuing flow of IPOs and the enormous returns to the early investors attracted ever greater sums of capital (see, e.g. Kleiner Perkins' results in Table 2). The capital gains garnered by successful VCs and their portfolio firms were remarkable. Unfortunately, for the most part, the returns for VC funds are private. According to an article published in a journal dealing with Silicon Valley entrepreneurship, in their first fund in 1974, Eugene Kleiner and Thomas Perkins raised $8 million. Despite having a number of failures, over 10 years it averaged a 39% compound annual return (CAR). The second fund that added two new partners (KPCB I) raised $15 million in 1978 and achieved a CAR of 83% in the first 5 years. The third fund of $55 million raised in 1980 had a CAR of 65% in the first 8 years (Rutter, 1989: 23). The next two funds did not do as well. While Kleiner Perkins and its successor funds performed exceptionally well, other VC partnerships also had very strong CARs. With such returns, ever more capital and highly motivated individuals were attracted. The success of these limited partnerships resulted in it becoming the dominant model for organizing VC investment. To illustrate, Venture Economics (1985: 21) estimated that in 1984 72% of the total organized VC pool of $16.3 billion was managed by independent VC firms; the preponderance of these were limited partnerships.

In the 1980s, the NVCA built significant influence in Washington, DC. VC and the entrepreneurs they funded were becoming a known and understood part of the US political economy and NSI. For example, in 1982 the Congressional Joint Economic Committee held a hearing entitled "The Role of the Venture Capital Industry in the American Economy" and in 1984 issued a report titled "Venture Capital and Innovation." There was a strong consensus in both political parties that VC would be an important component of the US response to the slow deterioration of what Lazonick (2009) termed the "old economy business model."

VC-financed entrepreneurs and VCs themselves were recognized in the popular press. For example, on March 9, 1981, Professor Herbert Boyer, a Genentech

founder, was featured on the cover of *Time*, the ubiquitous weekly news magazine. He would be followed on February 15, 1982, by Apple's Steve Jobs. With the covers were feature stories that wrote glowingly about the VCs that funded these entrepreneurs. On May 30, 1983, *Time*'s feature section was on "The New Economy" and dealt explicitly with technology-based entrepreneurship, and, in particular, successful startups in Boston and the San Francisco Bay Area. However, the crowning recognition was on January 23, 1984, when Arthur Rock, the venture capitalist who had arranged the Fairchild and Intel financings, was featured on *Time*'s cover. VC was now part of the US vocabulary and was increasingly expected to fund the renaissance of the US economy (for a description of this model, see Florida and Kenney, 1990).

The new NSI was correlated with the changing of geographic locus of US innovation in electronics, telecommunications, and biomedicine. Whereas, the most prestigious industrial research laboratories had been located on the East Coast and in the industrial Midwest, the new NSI came to be centered in the San Francisco Bay Area, or, more specifically, what had come to be known as Silicon Valley, which was now the destination for ~30% of all US VC investment. This is depicted in Table 3; however, due to data limitations Northern and Southern California are combined. Boston would account for slightly in excess of 10% of VC investment. What the data does not show is how the concentration of deals in Silicon Valley placed pressure on VC firms operating outside the region. For example, New York-based Russell Carson, originally of Citicorp Ventures and then founder of the buy-out partnership Welsh, Carson, Anderson & Stowe (WCAS), when asked about why Citicorp Ventures established a Silicon Valley branch in 1974, said:

> We concluded that, similarly to the conclusion that we came to 10 years later with WCAS, that it was awfully hard to commute from New York to look after investments on the West Coast. We saw a lot of high-tech investing going on. We were reasonably well plugged into the venture capitalists out there but we recognized that unless we were on their doorstep, it was going to be harder to see the good projects early.

Ultimately, both Citicorp and WCAS abandoned VC investing for buy-outs, rather than make commitments to Silicon Valley operations. Other top-tier VC firms, such as Norwest Venture Partners of Minneapolis and Morgenthaler Ventures of Cleveland, opened branches in Silicon Valley during the 1980s and in the 1990s relocated their VC investing operations to Silicon Valley, while retaining their buyout businesses at home (for empirical proof, see Chen *et al.*, 2009). The VC-financed entrepreneurship model would have a powerful influence on the geography of the US NSI.

The repeated number of enormous successes drove an evolution of the institutional environments for technology-based entrepreneurship, particularly, in Silicon Valley where an entire support network for entrepreneurship arose. During the 1980s, for example, as Suchman (1995) shows, the investment contracts between

**Table 3** Venture capital investment; various years and various states by percentage and total[a]

| | 1968–1975 (percentage of total) | 1980 (percentage of total) | 1985 (percentage of total) | 1987 (percentage of total) |
|---|---|---|---|---|
| California | 26 | 34 | 39 | 39 |
| Massachusetts | 9 | 12 | 14 | 11 |
| New York | 11 | 7 | 5 | 3 |
| Texas | 7 | 11 | 7 | 6 |
| Total ($M) | 747 | 1025 | 2600 | 3900 |

*Source*: Adapted from Florida *et al.* 1991: 105.

[a]Due to data limitations in the early years, the data for California is combined. After the mid-1980s, Southern California accounts for an increasing amount to approximately 10.

entrepreneurs and VCs written by lawyers became increasingly standardized, and interestingly, less specific in terms of binding constraints on both parties. This is a fascinating development because it suggests that entrepreneurs and venture capitalists, through the intermediaries of the local lawyers came to understand the entrepreneurial process (Suchman and Cahill, 1996). In Silicon Valley in particular, but also Boston, and later San Diego, a new innovation system based on technological entrepreneurship and financed by VC had become institutionalized.

## 9. Discussion and conclusion

Tracing the evolution of the VC industry provides insight into how NSIs evolve and new institutions are created and selected. Establishing VC as an institution was a motivation for a number of the early pioneers, but desire was insufficient. VCs also had to demonstrate the requisite financial success to legitimate their activities as a business practice, as socially desirable, and as worthy of support from other economic and political actors. In the process of legitimating VC there were a number of experimental organizational forms that were tried but failed prior to reaching a stable dominant design (Utterback and Abernathy, 1975; Utterback and Suarez, 1993).

A coevolutionary perspective provides a vehicle for elucidating the interlinkages between institutional actors, political and social events, and different economic levels.[21] The development of VC in the US is the result of a complicated multi-actor

[21]Avnimelech and Teubal (2006) argue that the development of venture capital and high-technology business is a co-evolutionary process. Obviously, the perspective adopted in this paper owes much to this conception.

skein within which exogenous events combine with endogenous and conscious actions to contribute to institution creation. While some attribute only positive effects to government action, our history recognizes positive impacts such as the response of the federal government to Sputnik by catalyzing purchasing and electronics R&D investment and negative impacts such as ERISA. In the first event, the VCs were passive beneficiaries, while the second event catalyzed the formation of the NVCA that went on to prove its mettle lobbying in Washington, DC. At the level of the individual investor, during the period from 1946 to the early 1980s, VCs were learning by doing. Their trial-and-error experimentation resulted in a vibrant regional system of innovation in a few locations that now is optimized for technology-based entrepreneurship funded by VC.

Certain of the target industries for VC investment developed socio-technical trajectories that structured them in ways so as to be conducive for entrepreneurial venturing. Though not discussed in detail in this paper, there have been a number of industries and industry sub sectors that were, at one time, attractive to VC, but later lost their attractiveness. For example, in the period roughly from 1976 through 1983 personal computers attracted significant investment. As the industrial branch became routinized, investment tapered off and other computer industry-related branches attracted VC investing. Often there are moments in an industry's life cycle within which there is significant VC investment, after which the economic spaces in that particular sector close for new firms, but during the last six decades in the ICT industries invariably other spaces have opened.

It is impossible to definitively answer the question of whether all industrial sectors experiencing technological or business model change could be configured to encourage VC investing. Though an important component for the US NSI, the historical record suggests VC has significant limitations in terms of the types of innovatory activity that it can support. VC has found deals intermittently in a variety of industries, but during the last 50 years investments have been concentrated in only two industrial fields, ICT and biomedicine. Large systems innovations, such as new generations of transportation equipment, appear to be too capital intensive for VC investment, though recently VCs have invested in the development of all-electric vehicles. Also, many incremental innovations for existing products may not offer sufficiently great returns to attract VC funding for entrepreneurs. This suggests that VC cannot replace other innovation funding sources. However, in the early twenty-first century US political economy, VC financing is an important component of an entire ecosystem built upon funding entrepreneurs who commercialize knowledge developed in existing firms and universities. In industrial branches, such as data communications equipment, VC-financed firms such as Cisco have overwhelmed the incumbents. In these sectors, VC-financed firms that are now incumbents use the VC-funded ecosystem as a laboratory where they can find and acquire other VC-financed firms developing new products. The foremost practitioner of this is Cisco Systems, which has eschewed a central research laboratory, preferring to use

the ecosystem (Mayer and Kenney, 2004) rather than a central R&D laboratory, but Google, Intel, and others are not far behind.

In the biotechnology industry, VC has discovered a different niche, namely the commercialization of university research results (Kenney, 1986a). In effect, VC is funding the transfer and privatization of certain types of knowledge as it makes its way from the publicly funded university research laboratory to a candidate drug. Only a very few of these VC-funded firms actually become full-fledged pharmaceutical firms, the remainder continue as research operations or, if they have a promising product, are acquired by incumbent pharmaceutical firms. VCs fund a division of labor between existing pharmaceutical firms with strong marketing and manufacturing operations and startups conducting risky R&D to prove the potential value of a university laboratory discovery. When successful, the VCs are compensated for their risk.

The high-risk, high-reward nature of VC investing has a self-limiting dimension with respect to its significance in any NSI. Put differently, the failure rate, which Timmons (1990) estimated to be up to 40% and which in nearly all cases was near total as most of the firms have little in the way of salvageable assets in cases of liquidation with losses of 80% (Venture Economics, 1988; Gompers, 1995) constrain VCs to investing in opportunities having prospects of high rates of return (40–50% per annum) through achieving liquidity (for the logic of this statement see the footnote).[22] Investments with such high hurdle rates of return are a small portion of any society's total pool of innovatory opportunities, and *ipso facto* VC can only fund a small portion of any large nation's investment in innovation. Moreover, VC investment has been and continues to be concentrated in only a few regions (Florida and Kenney, 1988; Sorenson and Stuart, 2001; Chen *et al.*, 2009). For this reason, VC might arguably be better understood in the context of regional systems of innovation

[22]Remarkably little research has been done on the returns to venture capital investing. A rule of thumb in the venture capital world is 1/3 liquidations, 1/3 marginal performance, and another 1/3 returning five times or more the investment. In 2007, Fred Wilson (2007) of Union Square Ventures wrote in his blog that his returns were: 5x or greater – 11 deals – average 10.2x; 1x to 5x – 7 deals – average 2.6x; Failures – 5 deals; and Unrealized – 9 deals. This was considerably better than the common expectation. Of course, ultimately the failure rate itself is not important, what is important is the total compound annual rate of return. To illustrate, say Investor #1 makes five investments of $10, all of which triple in five years and so achieve an annual return of nearly 25%. However, it is entirely unrealistic to believe that none of the five new firms will fail. If we allow one to fail and another to simply break even, then the annual return drops to approximately 15%. Investor #2 also makes five investments, but has three fail, one returns its investment, but one returns 20 times the investment. Number 2 thus achieves an annual return of 33%. The necessity of high returns is made even more necessary because the venture capitalist takes 20% of all of the capital gains, meaning that the returns to Investor #1's investors drops to less than 15%, while, after compensating the venture capitalist, Investor #2's investors experience a nearly 29% rate. Since VC investing is considered risky by pension funds, rates of return under 15% are not considered sufficiently elevated to justify placing funds with the venture firm.

(Cooke, 2001; Asheim and Isaksen, 2002; Malmberg and Maskell, 2002), though their investment successes have had national and even global impact. And yet, regional systems of innovation are located in nation states that determine many of the operational parameters such as R&D appropriations, securities regulation, taxation, immigration, and a myriad of other policies that condition the environment within which VCs operate.

In terms of the international diffusion of VC, the US case is interesting because as the pioneer, its evolution was organic and unplanned. The path from conceptualization and advocacy in the late 1930s to its routinization in the 1980s took nearly 50 years. It was an evolutionary process that included far-sighted visionaries such as the founders of ARD and certain members of Congress, but much of the experimentation was local with many failures of individual firms, business models, organizational forms, and business practices.

## Acknowledgements

I thank Robert Strom of the Kauffman Foundation for supporting my research on the history of the US VC industry. The assistance and support of the curators at the Rockefeller Archives is also gratefully acknowledged. The comments by the anonymous reviewers were greatly appreciated. My colleague Richard Florida, with whom I started this work many years ago, deserves great thanks. Jorge Niosi, Donald Patton, and the anonymous reviewers provided many helpful suggestions that improved the article. The many venture capitalists who have taken time to talk with me deserve special thanks.

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