CAPITAL AND CREATIVE DESTRUCTION:
Venture Capital, Technological Change, and Economic Development

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INTRODUCTION

Ever since the transition from feudalism to capitalism, and perhaps even before, the rise of new technologies, new ways of producing goods, and of whole new industries has required capital and credit, or what is more commonly referred to as venture capital. Throughout this industrial history, it has been more common than not for such capital to be mobilized by new providers rather than established institutions of finance. The role of these new institutions of venture finance has been to overcome the risks and other barriers associated with more traditional financial institutions and make the required investments in those new innovations and business opportunities which are the engines of technological change and economic growth. While at times traditional financial institutions have supplied the ultimate source of capital for these opportunities, the role of these new financiers of innovation has been to mobilize capital from these and other sources and to provide it to those entrepreneurs and risk-takers that have provided much of the impetus for technological progress and economic development.

The classical economists from Adam Smith to Karl Marx outlined the broad relationship between capital and industrial development. But, perhaps the clearest statement of capital’s role in the processes of innovation and economic development was provided in Schumpeter’s classic work, The Theory of Economic Development.¹ In Schumpeter’s view, capitalism is an inherently dynamic economic and social system; the source of such dynamism lies in the process of innovation. Powering the process of economic development is the phenomenon Schumpeter referred to as creative destruction, which “incessantly

revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one."² The linchpin of this process, Schumpeter observed, was the entrepreneur, whose function is to "carry out new combinations" of products, markets, supplies, raw materials, and business organizations required for technological innovation and economic growth. Schumpeter further noted that new financial forms at times emerge to assume the risk and uncertainty associated with technological innovations and the rise of new entrepreneurial firms and industries. He emphasized the role of new financiers in supporting entrepreneurs in their quest to carry out these new combinations in the process of creative destruction.³ For Schumpeter, the provision of capital and credit to entrepreneurs is a vital element of a dynamic capitalist economy, indeed, "important enough to serve as its differentia specifica."⁴


³ Schumpeter, Theory of Economic Development passim.

⁴ Schumpeter, Capitalism, Socialism, and Democracy 69.

imperfection, or what Lance Davis has referred to as the "immobility of capital." 6

Economic geographers too see finance as characterized by market imperfections and geographic differences which constrain and orient capital flows to particular places. 7

In our view, new forms of venture finance are typically required to finance the birth of new technologies and business organizations, and the more general process of

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technological and industrial development. Thus, the rise of new forms of finance, or venture capital, correspond to the rise of new industries, e.g., textiles, primary metals, semiconductors, and biotechnology. We focus here on the role played by venture capital in the processes of technological innovation, new business formation, and economic development.

We develop our argument by elucidating the rise of new forms of finance, or venture capital, alongside major economic transformations in U.S. industry. Before proceeding a definitional point is in order. Venture finance differs from more traditional financial intermediaries in two rather fundamental respects. One, venture capitalists exchange equity for an ownership stake instead of providing more traditional forms of debt or loan finance.

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9 We suggest that finance, capital formation, and industrialization are not the product of abstract economic theories; rather they are informed by historical events and social institutions. Following Alexander Gershenkron and James Kurth on the comparative institutional structures of finance in the process of national economic development, we suggest that there are no single or optimal mechanisms for providing finance. The relationship between the political structure and the industrial sector essentially plays itself out in the various stages of product cycle development. Who performs the financial functions varies from country to country and even within some countries. Banks, the state, industrial corporations, and even decentralized financial systems composed of complex multiple sub-systems all provide capital. Simply put, there are multiple forms, or functional alternatives, which are formed by the actual process of historical and institutional development. In formal terms, the relationship between capital formation and industrial development is "path-dependent"—that is, informed by the particular historical path taken. See, James Kurth, "The Political Consequences of the Product Cycle: Industrial History and Political Outcomes," International Organization 33, 1 (Winter 1979): 1-34. See, Paul David, Technical Choice, Innovation, and Economic Growth (New York: Cambridge University Press, 1975). See also W. Brian Arthur, "Urban Systems and Historical Path Dependence," in J. Ausubel and R. Herman, eds., Cities and Their Vital Systems (Washington, DC: National Academy Press, 1988): 85-97.
which require collateral and a regular repayment schedule. Two, venture capitalists are actively involved in the strategic development and management of the enterprises in which they invest. Clearly, the field of business and economic history has provided a deep and thorough understanding of the role of new enterprise formations and technological change in American economic history. However, there is surprisingly little systematic research on role and relationship of financial institutions to technological innovation, and economic growth.\textsuperscript{10}

In developing our argument, we follow William Lazonick and others who characterize American economic history as comprising three relatively distinct periods: (1) the rise of proprietary capitalism alongside simple Taylorist production; (2) the rise of the managerial capitalism alongside the vertically integrated corporation and Fordist mass production; (3) and the rise of the new high-technology industries, knowledge-based production, and/or collective capitalism.\textsuperscript{11} We focus explicitly on the role of new forms of venture finance in the various economic transformations in American economic history.


We organize our discussion around the intersection of venture finance and industrial development in particular industrial regions. Our discussion of finance and the textile industry revolves the growth and development of the textile complex in and around Boston. Our investigation of financial mechanisms and the mass-production industries focuses on Pittsburgh, specifically the role of the Mellon family in organizing and financing technology-based industries. Our exploration of venture capital and high-technology industries centers upon the innovation complexes of Silicon Valley and Route 128.

Given this broad conceptual framework, the contours of our argument can be summarized as follows. First, the development of textile production in and around Boston gave rise to a series of new financial mechanisms that economic historians such as Lance Davis, Robert Dalzell, and Naomi Lamoreaux have referred to as relationship banking or equity-financed "insider lending." Second, new forms of venture capital similarly arose to finance the technology-based, vertically integrated corporations of managerial capitalist epoch of the late 19th and early 20th century, as a new system of securities and investment banking emerged as a vehicle for technological change and industrial development. Third, the rise of new high-technology industries such as semiconductors, computers, and biotechnology in the mid-to-late twentieth century required yet another new form of venture finance.

Beginning in the late 1950s and early 1960s—and continuing throughout the 1970s and 1980s—

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-a new formal system of venture capital emerged alongside the new high-technology industries clustered in regions like California's Silicon Valley and the Route 128 corridor around Boston. Part capitalist, part manager, and part entrepreneur, these modern-day venture capitalists exchange capital for an equity or ownership stake, participate actively in the development and management of the enterprises in which they invest, and invest in informally organized syndicates. Furthermore, this modern brand of venture capital has organized into a formal industry with its own associations (e.g. the National Association of Venture Capitalists), its own research organizations (e.g. Venture Economics and

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13 An increasing number of scholars have argued that the United States and international economies are in the midst of a third major period of technological, economic, and institutional restructuring. This has been variously termed flexible production, post-Fordism, lean production, and/or collective capitalism. See, Lazonick, Business Organization; and, Competitive Advantage on the Shop Floor Michael Piore and Charles Sabel, The Second Industrial Divide: Possibilities for Prosperity. (New York: Basic Books, 1983); Generally speaking, the contours of this new production system are: shifts in the main source of value creation from physical skill to intellectual capability, increasing importance of collective knowledge, accelerated innovation cycles, and greater reliance on continuous improvement on the shop floor which serves to blur the lines of distinction between R&D and the factory. See also Peter F. Drucker, Postcapitalist Society. (New York: Harper Business, 1993). As management theorist Peter Drucker has argued, the foundation of capitalism is experiencing a fundamental restructuring, which will have significant effects on economic and social organization. Also see, Richard Florida and Martin Kenney, The Breakthrough Illusion. (New York: Basic Books, 1991).

FINANCING THE FIRST INDUSTRIAL REVOLUTION:

Boston Capital and the Rise of New England Textiles

The textile industry, as many have noted, propelled the process of American industrialization. Centered around Boston and Lowell this industry provided the foundation for subsequent industrial growth and economic development, and according to Hindle and Lubar, "set the style of American mechanization, industrialization, and work."16 The factory system accelerated the shift from piece-work to mechanized production transforming the workplace in fundamental ways. Beyond this, the growth of textiles elicited changes in the structure of industrial financing. With innovative developments in machinery, factory organization, and production, the textile industry required massive amounts of capital; but where would that capital come from? As many scholars of the New England industrial experience have pointed out, the cotton textile industry was one of the first industries organized with the aid of external capital, garnered in large part from the newly formed Boston Stock Exchange in the early 1820s. Merchants and banking institutions supplied the initial source of financing for the rise of textile industry’s factory system, and as the requirements for more capital outstripped the ability of banks and merchants to supply it,


many merchant houses reinvented themselves as manufacturing capitalists, with ties to their established trading networks, the new stock exchange, banks, and their own sources of private capital. Out of this melange of financing mechanisms emerged a credit market for Boston's burgeoning manufacturing enterprises.

A primary reason for Boston's rise to manufacturing excellence between 1815 and 1860 was the inventiveness of Francis Cabot Lowell, founder of the Boston Manufacturing Company--a pioneer in the textile industry of New England. The company represented the first successful implementation of the British proprietary technology known as power looms, implementing it on a scale unheard of in existing British or American mills. This required not only innovative approaches to management and organization; it also taxed the conventional methods of entrepreneurialism.

Such a high level of capitalization was, according to Lowell, required to adequately equip the factory and provide a safe margin to cover operating expenses. Although capitalized at nearly ten times the amount of competing mills, Lowell and his associates at the Boston Manufacturing Co. kept tight reins on the management of the enterprise. In fact, only seven stockholders controlled the entire capital stock of the company. This was

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rather significant, particularly as increasing scale tended to require new forms of organizational management and control. The Boston Manufacturing Company obtained its capital through an enormous subscription to the company's capital stock by a small group of local investors. The company authorized $400,000 of capital stock, which was issued in three subscriptions. The price was $1,000 per share, which most investors paid in installments over five years.\textsuperscript{19} Boston Manufacturing Co. became a model for the finance manufacturing concerns. Furthermore, it enabled traditional mercantile capitalists to invest in new industrial opportunities promising previously unparalleled rates of return.\textsuperscript{20}

Naomi Lamoreaux has argued that relationship banking or what she refers to as "insider lending" played a fundamental role in the industrial development of Boston and the New England region more broadly. According to Lamoreaux, as banks formed in towns and communities throughout the region, they provided rather basic savings and loan functions. These early nineteenth century banks only vaguely resembled their modern counterparts, having no branches, very few employees, and a handful of directors who in most cases were the stockholders. While they took deposits, most lending took the form of bank-issued notes and bank capital stock.\textsuperscript{21} The most important type of early loan for commercial purposes

\textsuperscript{19} Dalzell, \textit{Enterprising Elite}: 26-28.


\textsuperscript{21} Naomi Lamoreaux, \textit{Insider Lending: Banks, Personal Connections, and Economic Development in Industrial New England, 1784-1912} (1992): 3-5. See also Alfred Chandler, "Entrepreneurial Opportunity in Nineteenth-Century America," \textit{Explorations in Entrepreneurial History} 1 (Fall 1963): 106-124. Chandler traces the flow of capital financing from Broad street in Philadelphia in the 1830s to State Street of Boston in the 1840s to Wall Street in Manhattan for the period thereafter. In both shifts the precipitous agent had been an economic downturn. In 1841 it was the collapse of the Second Bank of the United States of Pennsylvania, operated
was the accommodation loan. Under this arrangement, a borrower would request a loan from a bank, having guaranteed endorsers to sign the note. Nearly every bank portfolio had hundreds of accommodation loans on their balance sheets. As these transactions became more popular, some banks repeatedly renewed the notes effectively converting short term notes into long term debt.

In those years, banks played a role somewhat similar to that of venture capitalists, lending funds to their directors who in turn funneled those funds into manufacturing enterprises. This process of insider lending overcame constraints in the financial markets, providing a much-needed spur to entrepreneurial enterprise. As Lamoreaux points out, "whenever banks maintain an arms-length relationship with their customers, they tend to avoid the risks involved in financing entrepreneurial ventures."22 The rise of New England's textile industry benefited from this close association between bankers and industrialists which enabled capital to be channelled to nascent enterprises.

Rigidities nonetheless began to emerge in this new system of industrial finance. Before 1860, internally-generated capital or equity was the most important source of capital for industrial expansion.23 As Cochran notes, "Problems regarding the entrepreneur in

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capital formation do not differ greatly from those in general economic growth....In the early phase of industrialization most initial financing was of local origin and there was an intimate relation between entrepreneurs and investors. Expansion of the business was usually financed by reinvesting profits". 24 However, the relative importance of equity waned over time. Lance Davis--perhaps the foremost economic historian of capital formation in American industry--argues that American economic and industrial development was punctuated by periods of capital shortage and inflexibility, or what he terms "capital immobility." Davis suggests that capital immobility became acute in the post-bellum decades because capitalist firms required external finance (or access to greater resources) as a result of industry's westward migration, and technological innovations in manufacturing ushered in by mass production. While New England's textile industry gave rise to the most advanced capital markets in the nation, little of that capital moved to the South despite the South's intricate involvement in the existence of a textile industry in Boston. Impeded by communications and transportation systems ill-equipped to handle continental transactions, New England lenders could not efficiently tap into potential frontier markets, although they actively attempted to establish financial ties to the frontier. 25 Southern and Western


industry experienced a widespread shortage of capital, and local pooling of capital was necessary to help these industries finance their expansion. The inflexibility of financial markets comprised a major obstacle to industrial expansion for much of the later 19th century.\textsuperscript{26}

The mobilization of capital through more organized investment and financial markets provided the alternative to self-financed growth and the kind of insider lending Lamoreaux identifies. By the late 19th century, new stock and bond markets were beginning to develop outside of traditional financial centers, and during the 1890s long-term sources of capital from banks, trust companies, and life insurance companies began to channel funds into industrial investment markets.\textsuperscript{27} Gradually, more modern forms of finance began to replace the older, more personal mechanisms. Still in some newly industrializing regions, local pooling and eventually the development of new regional capital markets became an essential strategy for generating capital. Industrialists, or what Thomas Hughes refers to as the “systems builders” of the late-nineteenth and early-twentieth centuries, were able to devise strategies that could overcome the inflexibility of capital markets and at times to create new

\textbf{Western Railroads} (Cambridge, 1967).

\textsuperscript{26} In addition, public trust in the banking system evaporated in the wake of the bank panic of 1857. The National Currency Act of 1863, which assured a national currency of private bank notes backed by treasury bonds, restored a modicum of public confidence and bank participation in financing enterprises through collateral notes increased significantly.

financial mechanisms of their own design. Their strategies compensated for the inability of traditional capital markets to provide capital and credit for the development of new technologies and new industries.

FINANCING THE SECOND INDUSTRIAL REVOLUTION:

Andrew Mellon and the Pittsburgh Technology Complex

The new form of industrial organization which most clearly reflected the need for new financial mechanisms was the modern mass-production enterprise. Although eastern capitalists located in colonial centers of merchant finance like New York, Boston, and Philadelphia, were by and large the dominant source of new venture capital, the emerging industrial complexes of Western Pennsylvania and the Great Lakes region gave rise to their own financial centers. The growth of the modern, M-form corporation and the broader economy that it helped to shape and which in turn supported the corporation, are now fairly well understood. Chandler has termed this the managerial revolution and has highlighted the importance of communications and new markets. The modern corporation became a propulsive force in the American economy.

Less well understood, however, is the symbiosis between new forms of finance that

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29 See, Chandler, The Visible Hand.
emerged to organize this nascent and dynamic industrial system. The second industrial revolution, like the first, required the development of a series of new financial forms and mechanisms to provide the capital and credit required for technological innovation and industrial expansion. Older, more traditional financial forms were in most cases far too risk averse to undertake the required investments. Indeed, impeding the emergence of this new technology-intensive industrial system were a series of rigidities or temporary failures in the financial markets.\textsuperscript{30} Throughout the nineteenth century, capital remained a major obstacle to industrial development, as the pace and demand for investment outstripped the ability of lenders to provide it.\textsuperscript{31}

One of the most important new sources of capital came from the explosive growth in investment banking activity. As Vincent Carosso’s landmark study \textit{Investment Banking in America} outlines, the direct personal ties of the early to mid 19th century became increasingly institutionalized. The railroads best exemplified the growing popularity of securities and bond offerings during the 1870s and 1880s as a form of finance. As Carosso


\textsuperscript{31} See Davis, Easterlin, et al, \textit{American Economic Growth}, for a discussion of the many ways industrialists sought to obtain capital to finance expansion. For an important account of the capital flow into and out of a nineteenth century industrial city see William Cronon’s \textit{Nature’s Metropolis: Chicago and the Great West} (New York: Norton, 1991). Cronon gives an intricate account of the flow of capital between Chicago and the eastern financial centers. Significantly, Pittsburgh was an important creditor in the expansion of the Chicago manufacturing community. See also Charles K. Hyde, “From ‘Subterranean Lotteries’ to Orderly Investment: Michigan Copper and Eastern Dollars, 1841-1865,” \textit{Mid-America} 66, 1 (January 1984): 3-20 presents the argument that places like Pittsburgh speculated in the mining commodities of frontier regions.
notes, "Bank representation on railroad directorates...was an institutionalization of the close personal ties that commonly had existed between bankers and railroad officials."\textsuperscript{32} The structure that emerged to serve the capital needs of the railroad industry provided a model for industrial firms to follow. The new investment banking syndicates emerged because the immense size of industrial capitalization prevented any one firm from bearing the burden of underwriting corporate financing.\textsuperscript{33}

The role of new forms of finance in the rise of heavy, mass-production industry can be clearly seen in Pittsburgh's rise to industrial prominence during the late 19th century. A common practice at that time was for entrepreneurs to approach established industrial enterprises who had built up vast equity which could become a source of lending capital. Andrew Carnegie's venture into steelmaking, for example, was funded through equity gained in partnerships with established iron producing families of Phipps, Kloman, and Shinn. Similarly, George Westinghouse's air brake concern received financial backing from Robert


\textsuperscript{33} Vincent Carossa, Investment Banking in America 108-109. Sophistication on the part of investment bankers was necessary to accommodate the investment needs of these new firms, thus existing brokerage firms diversified and new niche markets developed in the financial services industry. See Also Barry Supple "A Business Elite: German-Jewish Financiers in Nineteenth-Century New York," Business History Review 31 (Spring 1957): 143-178, for a discussion of the importance of foreign investment, which even more heavily depended on personal relationships and close-knit groups. Foreign capital became a widespread option for cash starved manufacturers in the mid-nineteenth century and remained so into the twentieth. Participation by financiers such as Cornelius Vanderbilt, John Jacob Astor, or John Murray Forbes was a sufficient guarantee to attract foreign investors. This bred familiarity of the older established European financial institutions like the Rothschilds and Lloyds with American financiers such as J.P. Morgan, William Vanderbilt, Henry Villard, and Nathaniel Thayer. In addition, enclaves of immigrant groups in Boston, New York, and Philadelphia maintained close ties with their home countries in Europe gaining access to capital in the old country.
Pitcairn, a Pennsylvania Railroad Vice President, and brother of John Pitcairn who later teamed with John Ford to launch the Pittsburgh Plate Glass Company. Initial backing for H. J. Heinz was provided by L. Noble, a successful brick manufacturer, and the company was launched as Heinz & Noble Co. in 1869. That same year, Henry Frick obtained start-up capital from the A.O. Overholt Co. distillery.

The financial activities of Andrew Mellon and his associates best captures the role of new forms of venture finance capitalism in rise of Pittsburgh’s heavy industrial complex. As with American industry more broadly, Pittsburgh industry faced difficulty mobilizing capital during the mid-to-late 19th century. However, by the turn of the century, Pittsburgh was home to—and indeed an important incubator--of a new series of new financial intermediaries which fuelled the development of the region’s increasingly diversified manufacturing complex. Indeed, the Mellon family functioned to a great extent like a contemporary venture capital fund providing both financial resources and management assistance in helping to organize and incubate new industrial enterprises and an entire regional complex of industrial enterprises.

Andrew Mellon’s first foray into venture finance involved underwriting Henry Clay Frick’s coke business in 1871, while an assistant at his father’s bank T. Mellon & Sons. Frick promptly repaid the $10,000 investment, which impressed Judge Thomas Mellon. Over the next three years, Mellon and Frick became close friends, and the bank increased its investment in the coke company. In 1874, despite a severe depression in Pittsburgh, T. Mellon & Sons provided H.C. Frick Coal & Coke Co. with a $15,000 loan, a $25,000 line
of credit, and assumed a $76,000 mortgage on some coal property. The first of Mellon’s venture investments, Frick’s company was anomalous: It was the only investment in which Mellon did not stipulate significant equity participation and managerial control.

The financing of the aluminum industry in Pittsburgh clearly illustrates Mellon-style venture capital. Discouraged by the cool reception his aluminum reduction process received while at the Cowles Electric Smelting & Aluminum Co., in July 1888 Charles Martin Hall came to Pittsburgh to demonstrate his patented electrolytic process for reducing pure aluminum by dissolving alumina in molten cryolite. A company was organized on August 8th of that year by Captain Alfred Hunt and George Clapp of the Pittsburgh Testing Laboratories, and a small shop was established at 32nd and Smallman Streets in Pittsburgh’s Strip District. Captain Hunt and Charles Martin Hall approached Andrew Mellon for $20,000 expansion loan. What Mellon offered instead was a $1,000,000 capital inflow in


35 See, Junius Edwards, A Captain in Industry (New York, 1957) 40-41. Hall was unable to attract investors because the expense for generating enough electric current to produce merely a pound of commercially viable aluminum was too high. Thus in small-scale demonstrations Hall could not achieve the reduction he needed.

36 Four other men also were part of the original company. Two were from Carbon Steel Company, one was from Carnegie Steel Company, and one from the Pittsburgh Testing Laboratories. Hunt and Clapp both worked for the Park Brothers Black Diamond Steel Works as metallurgical engineers. In 1882, Black Diamond hired two college graduate engineers, William Kent and William Zimmerman, who formed a department in the company known as the Pittsburgh Testing Laboratory for the Testing of Materials and Engineering Inspections. Hunt and Clapp worked in that division of Black Diamond. In 1886, Hunt and Clapp spun-off the company, gained full title to it, and renamed it the Pittsburgh Testing Laboratory.
exchange for a 40 percent equity participation in the new firm.\textsuperscript{37} Mellon also insisted upon naming his own general manager, Arthur Vining Davis, in return for the investment.

In late 1891, Mellon was approached by George Westinghouse for $500,000 to finance his new air brake plant outside. Westinghouse offered his property and company’s goodwill as collateral. Mellon in turn demanded a high level of equity in his air brake and electrical equipment divisions, as well as latitude to name his own general manager. Westinghouse found this untenable and turned toward the New York financial community for help.\textsuperscript{38} Mellons tactics backfired and he would have to wait until the Westinghouse companies reeled under the financial panic of 1907 before another opportunity to gain financial leverage presented itself. Mellon’s investment practices were uncommon among turn-of-the-century industrialists and mirror the techniques used by Silicon Valley and Route 128 venture capitalists a century later.

These episodes convinced Mellon that he needed a formal organization to effectively make venture investments. The vehicle he devised was the Union Trust Company, which he organized in 1889 with $250,000 in capital.\textsuperscript{39} Between its founding in 1889 and 1895, Union Trust barely registered a profit. But, in 1895, with commercial banking activity now


\textsuperscript{38} Burton Hersh, The Mellon Family: A Fortune in History. (New York: William Morrow & Company, 1978). Westinghouse came away from the deal empty handed, and with a bitter distaste for the baronial Mellons and the whole Pittsburgh capital financing scene. Westinghouse had been given a similar ultimatum in 1869 by Robert Pitcairn when he sought to start up the air brake company. Andrew Mellon vowed never to allow a Pittsburgh manufacturing firm slip away from his financial control, and to one day control the Westinghouse company.
part of its repertoire, Union Trust posted a $31,000 profit, initiating a long tradition of increasing profitability. Over the next two decades, Mellon amassed an impressive array of manufacturing investments, ranging from oil exploration and aluminum production to structural steel manufacturing and railroad car companies. Nearly a dozen new enterprises, mergers and acquisitions were orchestrated by Union Trust Co. which underwrote and marketed corporate securities such as stocks and first mortgage bonds, including: McClintic Marshall (1899), Mon River Coal & Coke Co. (1899), Pittsburgh Coal Co. (1899), Union Steel Co. (1899), Standard Steel Car Co. (1902), Carborundum Co. (1895), Crucible Steel Co. of America (1900), Pittsburgh Steel Co. (1901), and Gulf Refining Co. (1903). Additionally, Mellon reorganized the T. Mellon & Sons bank, acquiring the City Deposit Bank, Pittsburgh National Bank of Commerce, and the Citizens National Bank and rolling them up into one colossal institution, the Mellon National Bank,

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Although Union Trust proved to be lucrative beyond anyone’s imagination, Andrew’s initial wealth was built up from his father’s real estate and banking activities, and his brothers’ construction and lumber company. David E. Koskoff, The Mellons: The Chronicle of America’s Richest Family (New York: Thomas E. Crowell Publishers, 1978). It seems the Judge had a reputation for being a prudent and difficult lender who rarely dirtied his hands with disreputable businessmen. The fact that Judge Mellon ensured that “investments covered almost every phase of commercial activity” was not lost on the Andrew and Richard during their forty year reign over investment capitalism in Pittsburgh. See also William Larrimer Mellon and Boyden Sparkes, Judge Mellon’s Sons (privately printed, 1948). When Andrew Mellon assumed the Secretary of the Treasury in 1919, his longtime friend and legal advisor Philader Knox advised him to relinquish all formal ties to his financial and industrial empire. As a result he resigned from the boards of more than fifty national corporations, including Gulf Oil, Mellon Bank, Alcoa, Standard Steel Car, American Locomotive Co., and the Crucible Steel Company of America. His brother Richard B. Mellon remained at the helm of the Mellon empire. Eventually there were Congressional hearings in 1925 to determine what if any undue influence Andrew Mellon had over his former investments. For an account of these hearings see the muckraking story by Harvey O’Connor in Mellon’s Millions: The Life and Times of Andrew W. Mellon (New York: John Day, 1932).
N.A. in 1902.

Mellon jumped at the chance to bring the by-product coking industry of the Heinrich Koppers Company to Pittsburgh. Lured from Joliet, Illinois, where Koppers had first ventured into the American market from his native Germany, Mellon quickly acted to invest in Koppers' by-product coking methods. In 1915, the Koppers Company became another part of the Mellon family of firms, and enjoyed extensive interlocks with other giant enterprises like McClintic-Marshall Construction Co. and Crucible Steel Co. Two years later, after American involvement in the war became inevitable, the Alien Property Act was applied to Heinrich Koppers' investments in the company. His shares were sold at auction in the Mellon-controlled Pittsburgh Stock Exchange on September 13, 1918. Andrew Mellon paid $300,000 for Koppers' 3000 shares, which represented their 1914 value plus interest. On the day he gained title, the market value of the stock exceeded $3,000,000. Andrew W. Mellon not only pulled off a managerial coup in gaining nearly complete voting control of the Koppers Company, but realized a phenomenal profit as well.

Mellon also made considerable forays into the steel industry. In a matter of three years, Mellon organized these three conglomerates to compete directly in markets that Carnegie's steel empire dominated. McClintic-Marshall set its sights on the lucrative Ambridge unit of Carnegie Steel, Union Steel competed directly with finished steel products such as those manufactured by American Steel and Wire, and Standard Steel Car competed with Pressed Steel Car after Carnegie forced Henry Oliver and Charles T. Schoen

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41 Union Steel began threatening American Steel & Wire in 1902 after it and Carnegie Steel Co. became a part of the United States Steel Company.
out of that company in 1901.\textsuperscript{42} The Crucible Steel Co. endeavor and the organization of Union and Donner Steel to produce wire and finished steel products at Donora, PA radically altered the empires of Pittsburgh’s informal syndicates. Crucible Steel pulled together the loosely held alliance of independent steel producers. The Union Steel Company recruited Henry C. Frick, just ousted from Carnegie Steel.\textsuperscript{43} Through his flurry of corporate takeovers and reorganizations, Mellon effected the convergence of the Carnegie--later Morgan--empire with the Crucible Steel empire under formal interlocked corporate directorships. The icing on the cake was the sale of Union Steel--in which Mellon had personally invested $100,000--to the U.S. Steel Corporation in 1903 for nearly 300 times that amount.\textsuperscript{44} One of the pivotal players involved behind the scenes was attorney James Reed, of the Reed, Smith, Shaw, and Beal law firm. Reed represented both the U.S. Steel Company and the Union Steel Company.

In his quest to build an integrated complex of finance, manufacturing, and cutting-

\textsuperscript{42} Standard Steel Car Company was a coup. With the aid of Henry Oliver--who was recruited by Henry Frick in his acrimonious divorce from Carnegie--Frick, Mellon, and Charles T. Schoen (a close friend of Oliver and another of Carnegie’s disaffected partners) orchestrated the Standard Steel Car venture as a frontal assault on Carnegie’s control over the Pressed Steel Car Company.


\textsuperscript{44} Harvey O’Connor, \textit{Mellon’s Millions} 62. Capital of the company had been increased from $1,000,000 to $45,000,000 after Mellon negotiated to purchase the Sharon Steel Corporation and announced plans to build a new mill at Donora on the Monongahela River. Rather than compete head on with Union Steel, which would have “disturbed industrial conditions which the Steel Corporation sought to establish” the directors of U.S. Steel authorized the purchase of Union Steel from Mellon.
edge innovation, Mellon sought to create a central source of technological innovation from which his various industrial holdings could draw. In 1909, he read an account of an Applied Chemistry laboratory at the University of Kansas. He spent the next two years convincing the founder, Robert Kennedy Duncan, to relocate in Pittsburgh. Duncan’s book, *The Chemistry of Commerce*, outlined the financial rewards that could be realized by marrying scientific research and development and commercial manufacturing. In 1913, the Mellon Institute of Industrial Research was established as a center for metallurgical and chemical research done in collaboration with Mellon’s local industrial holdings.

The investment activities by Andrew Mellon, the Union Trust Company, and his syndicate of financiers exemplifies the concomitant rise of new forms of finance and new industrial enterprises. In most cases, Mellon style of venture investing involved a combination of innovative forms of finance and direct managerial control. When it was to their advantage, as with the financing of Pittsburgh Coal, the organization of Crucible Steel Company, and Standard Steel Car Co., the Mellons turned to the securities markets for capital. In other cases, as with Union Steel in 1899 and Guffey Petroleum in 1901, they held back, preferring to keep financial control within their close-knit syndicate rather than cater to a large contingent of stockholders. Furthermore. Mellon’s strategy for venture investing reflected a keen sense of the advantages of industrial concentration, or what geographers have come to call industrial agglomeration, and the propulsive effect of an

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45 Pittsburgh Coal required the financial backing of Judge William Moore and William “bet a million” Gates from Chicago. All three of these initial public offerings flooded the stock markets of New York and Pittsburgh.
The case of Pittsburgh provides an important window into the relationship between venture capital and industrial development in the late 19th and early 20th centuries. During this period, the financial markets took on new scope and functions, as new forms of investments banks and trusts developed as increasingly institutionalized vehicles for providing venture finance. As Thomas Navin and Marian Sears contend, the depression of 1893-1897 was a turning point for the fortune of industrial securities. And by the 1890s, long-term loan capital from credit intermediaries such as banks, trust companies, and life insurance companies increased the opportunities for new business formation, business expansion, and industrial development. Trusts stimulated the rise of marketable industrial

46 Despite all their dealings outside of the metalworking sectors of Pittsburgh's industry, Mellon's eventual investments in the Crucible Steel Company of America, McClintic-Marshall Construction Company, and the Standard Steel Car Company indicate his attempt to benefit from the agglomerative advantages of steel production in Pittsburgh. Mellon came to control McClintic-Marshall in a manner similar to his ownership of the Pittsburgh Reduction Company. In 1899 two engineer-inventors, Howard McClintic and Charles Marshall, approached the Mellons looking for a loan to start a new business. Both gained experience in structural steelmaking and bridge construction at the region's leading bridge firms (Ambridge, Fort Pitt Bridge Works, and Keystone Bridge). Interestingly, the Ambridge and Keystone Bridge firms were part of the Carnegie Steel empire. Aware of the skyscraper building boom, and recognizing the potential to compete with industry leaders, Mellon offered his financial resources in exchange for equity participation and management control. He (and three other partners) retained ownership of the company until 1932 when it was sold to the Bethlehem Steel Company.

47 and attractive option among investors who previously looked to railroads and mining companies for perennially sound investments, leading to the proliferation of regional stock markets like the one in Pittsburgh. Without the creation of a market for industrial securities there would have been a much slower movement toward big industrial concerns. See, Thomas Navin and Marian Sears, "The Rise of a Market for Industrial Securities, 1887-1902," Business History Review 29 (June, 1955): 103-138.

securities, providing a vehicle for enormous amounts of capital, usually in the form of convertible securities, to be commingled and leveraged against future investments. Mergers aided the growing acceptance of industrial securities by creating enormous publicity around industrial concerns to the delight of investment bankers bent upon getting public offers for newly generated stock.⁴⁹

Still, the unbridled growth of industrial investment throughout the first decades of the twentieth century was not without its limits. In the aftermath of the merger frenzy, many large corporations were saddled with huge debt. At the same time, expanding corporate bureaucracy dampened the entrepreneurial spirit of many leading enterprises. A new round of capital market rigidity set in.

VENTURE CAPITAL AND THE NEW INDUSTRIAL REVOLUTION:

Financing High-Technology in Silicon Valley and Route 128

The Great Depression put the brakes on manufacturing investment. Financial intermediaries linked to the stock market toppled like dominoes, and the national banking system endured a massive panic. Banking reform was necessary.⁵⁰ The thrust of so-called

⁴⁹ See, Larry Neal, "Trust Formation."

⁵⁰ See, Benjamin Friedman, (ed), Corporate Capital Structures in the United States (Chicago: University of Chicago Press, 1985). According to the data compiled by Friedman, the trend of U.S. manufacturing corporations’ D/A ratios moved from .26 in 1937 to .55 in 1979. The type of debt financing has shifted more towards short term as opposed to long term. This combined with the secular development of the financial intermediaries has had an effect on long-run corporate finance patterns. The increase of debt financing of physical capital formation translated into a corollary decrease of cash and marketable securities on hand on the asset side of the corporate balance sheet. In other words, the available corporate capital for risk investment has declined while the amount of debt companies have been saddled with has
reform legislation like the Glass-Steagall Act was to draw strict lines between commercial and investment banking activity. Investment banks were no longer allowed to accept deposits and commercial banks were “required to divest themselves of their security affiliates, and their underwriting activities were restricted to general obligation bonds of federal, state, and municipal authorities.” Prestigious firms like J.P. Morgan & Co. and Brown Brothers Harriman gave up their securities businesses to retain the their respected position as private bankers to the largest corporations in America. By the middle 1930s, investment banking rebounded as new specialized institutions emerged in the wake of regulatory reform and investment stagnation. On the down side, local investment bankers lost out disproportionately due to new banking rules and the high concentration of investment banking in large private firms like Morgan Stanley and First Boston.

increased. Rather than reinvest their profits on expected future gains, companies borrow more against the hope that they will one day realize those gains.


53 See, Martha Louise Reiner, “The Transformation of Venture Capital: A History of Venture Capital Organizations in the United States,” (University of California, Berkeley: Ph.D. Diss., 1989): 161. Also, see John Wilson, The New Venturers (Reading, Massachusetts: Addison-Wesley Publishing, 1985): 44-59. Neither firm stayed away from the investment banking business. Nine partners from J.P. Morgan left to form the Morgan Stanley Co. and the lead partner in Brown Brothers Harriman Co. left to form Harriman Ripley & Co. Both of these new firms were investment banking houses engaged in managing syndicates and wholesaling securities to dealers and other investment houses. Both also shared directors with their private banking cousins. In the Mellon constellation of financial stars---Union Trust and Mellon Bank---a return to the core business of trusteeship and commercial banking accompanied the formation of two new institutions to fill in the withdrawal of Union and Mellon from investment banking and savings & deposit functions in 1934. Mellbank became the umbrella under which local savings banks operated, and Mellon Securities continued the Mellon family’s involvement in the investment banking business.
Behind the more immediate economic and financial implications of the Great Crash stood deeper institutional problems in the financial system. The financial system had become quite specialized and segmented before the Crash and focused almost exclusively on the needs of large, established industry. Indeed, smaller, start-up enterprises found the investment community rather unresponsive to their needs, in part because debt replaced equity financing and also as formal institutional procedures replaced more personalized forms of finance.  

Yet, despite these problems, the 1930s saw the origin of a proto-venture capital industry organized by a small group of financial elites such as Jock Whitney and Laurence Rockefeller who created small risk-capital funds. Whitney’s own contribution was nearly $10 million, and Rockefeller’s venture capital partnership placed roughly $9 million in new ventures. In fact, the phrase "venture capital" was coined at the 1939 convention of the Investment Bankers Association of America, where in his presidential address, Jean Witter, highlighted the need for new forms of venture capital to spur economic growth and revitalization.

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55 Wilson devotes considerable attention to some of the new industries financed by J.H. Whitney & Co. and other new venture capital syndicates that emerged in the 1930s and took off after the Second World War. See, Wilson, The New Venturers, 19-29.
An important impetus for the rise of modern venture capital came from a group of influential bankers and industrialists who began to sketch out plans for a new government agency devoted to the problems of small business and small business finance. To lend legitimacy to their designs, they organized their efforts through the influential Committee for Economic Development (CED), a group concerned with the post-war planning and reconversion effort. Many of these elites were concerned with the increasingly conservative outlook of large corporations, and what Schumpeter referred to in his influential book of the period, *Capitalism, Socialism, and Democracy*, as the increasing bureaucratization of the innovation process. Many also believed that new mechanisms would be required to re-create the entrepreneurial impulse in the American economy—to nurture and support inventive new enterprises. While the push to develop new sources of capital for entrepreneurial endeavors proceeded on many fronts, the first and perhaps foremost of these efforts involved establishing a new federal program to support small business and provide small business finance. In 1945, Ralph Flanders published an influential manifesto on the subject, "The Problem of Development Capital," which made the case for the creation of new institutional structures to provide capital for innovative, entrepreneurial enterprises.\(^5^6\) In 1947, a CED study outlined the need for policy initiatives to address the problem of adequate capital for the small business community.\(^5^7\) Five years later, in 1952, *Dun's Review* asked "Can Small Businesses Get the Capital They Need?," concluding that capital markets were failing to


provide required capital to entrepreneurial enterprises. Furthermore, the study showed that small businesses faced interrelated managerial and capital crises, and that both must be addressed.

By the early 1950s, business and financial leaders were beginning to make the case for some sort of government program to bolster small business start-ups. The efforts of bankers and industrialists and the Committee for Economic Development led to the establishment of a new federal agency for small business development, the Small Business Administration. The CED’s position was outlined in a series of studies and reports that provided much of the background for the establishment of the Small Business Administration. And, by the close of that decade, they succeeded in getting the federal government to initiate a new program to create and to subsidize a new set of institutions, small business investment companies or SBICs, designed to provide finance capital to startup companies. In 1958, the Small Business Administration was authorized to establish Small Business Investment Corporations (SBICs), which were private investment companies whose capital was leveraged against asset sources in the federal government. Many of the first venture capital funds actually emerged as SBICs. SBICs also benefited from mandated tax breaks and other investment incentives, which eventually enabled them to become an import source of venture capital, especially in new growth regions such as California and


Massachusetts.

Both the federally sponsored SBICs and private investors saw a connection between the new emphasis on scientific research and commercial viability in the marketplace and sought to capitalize on it. Part of the solution was to forge closer links between entrepreneurship and scientific research and development. Vannevar Bush and others had effectively made the case for the importance of basic research in the war effort, and proposed to tap into the university as a source of new and potentially lucrative technologies. MIT led the way in the commercialization of academic research. 60 Led by Vannevar Bush, Karl Compton, and Horace Ford, MIT envisioned turning the greater Boston region into an incubator of technology-based economic development. Ironically, they looked to the example of the Mellon Institute in Pittsburgh, sponsored by Andrew Mellon for his industrial investments, as the model of a regional focal point for industrially sponsored research and development projects. To realize this vision, Compton joined forces with a private development agency, the New England Council, to address the decline of New England industries, such as machine tools by providing capital and managerial support. 61

Immediately after the war, this group of Boston industrialists and bankers established up a formal venture capital vehicle devoted to financing high technology enterprise—

60 This should come as little surprise given its historical commitment to industrial-academic partnerships, dating back to the vision of MIT benefactor, William Barton Rogers. During the 1930s, MIT began to look into direct industrial partnerships with companies like Raytheon.

American Research and Development (ARD), the nation’s first institutional venture capital firm. They selected Georges Doriot, a Professor of Business at Harvard and former army general, to head their new institution. Although ARD failed to meet its initial subscription goal of $5 million, it played a critical role in the emergence of the region’s high-technology complex, providing the initial capital for Digital Equipment Corporation.

The structures of the modern venture capital industry came more fully into form with the rise of the new high technology industries of the post-World War II period. Most of the early professional venture capital funds were located in large financial centers such as New York, Chicago, and Boston. These funds were tied to either to wealthy families or later to large banks and financial institutions. The New York venture capital complex emerged during the Great Depression. Its catalysts were venture capital funds linked to family fortunes, most notably the Rockefellers (Venrock), Whitneys (Jock Whitney and Company), and Phipps (Bessemer Securities). The Rockefeller family made important venture investments in McDonnell Douglass and Eastern Airlines during the late 1930s, while J.H. Whitney and Co. provided backing for Minute Maid. The Rockefeller family, for example, transformed its family-run venture interests into a formal venture capital firm, Venrock during the 1960s. It later provided early stage financing for a host of important high technology companies such as Intel and Apple Computer. Other wealthy families did the same. Being close to large financial institutions, venture capital in New York grew very

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rapidly giving rise to some 50 New York funds tied to banks or investment houses and
another 40 or so, linked to financial institutions such as large commercial banks (i.e.,
Citicorp, Bankers Trust and Irving Trust), or investment banks (i.e., Merill Lynch; Drexel,
Burnham, Lambert (Lambda); Smith Barney (First Century Partnership); and Donaldson,
Lofkin and Jenrette.\footnote{Our discussion of New York venture capital is based upon oral interviews and back issues of \textit{Venture Capital Journal}.} New York City became home to funds like Rothschild and CMNY, which were affiliated with European investors\footnote{\textit{Venture Capital Journal} June, August, and October 1979.}. During the 1960s and 1970s, New York City was the nation's largest center of venture capital. New York venture capitalists tended to invest their funds on a national basis, funnelling their capital to the burgeoning high-
technology industries of Silicon Valley and the Boston Route 128 area.

Chicago was another important source of venture capital for high technology. Allstate
Insurance was very important to the rise of Chicago venture capital. In 1960, it became one
of the first financial institutions to set up a venture capital fund.\footnote{\textit{Venture Capital Journal} June 1975.} Allstate's director, Ned
Heizer, made very successful investments in young high tech companies such as Control
Data, Memorex, Scientific Data Systems, Teledyne, and others.\footnote{See, Gene Bylinsky, \textit{The Innovation Millionaires} (New York: Charles Scribner's Sons, 1976) 29.} In 1969, Heizer spun off from Allstate and formed what was then the largest venture capital fund in the country,
Heizer Corporation. Heizer Corporation became a training ground for venture capitalists and was in turn responsible for spinning off a number of important venture capital funds.
Chicago banks became active in venture capital during the late 1960s and early 1970s with
the First National Bank of Chicago spawning two venture capital affiliates (First Capital
Corporation of Chicago and the Institutional Venture Capital Fund), and Continental Illinois
also creating two venture capital units: Continental Illinois Equity Corporation and
Continental Illinois Venture Corporation. AMOCO and Sears made significant venture
capital commitments in the 1970s. The Chicago venture capital industry was rounded out by
the important partnership, Golder Thoma, a number of smaller partnerships, and a few
SBICs. Like New York, Chicago venture capitalists tended to export new capital to
established high-technology centers.

The modern institutional system of venture capital emerged during the 1970s and
1980s. During this period, the amount of funds devoted to venture capital skyrocketed from
an average of $3.5 billion to more than $35 billion. There were four basic reasons for
massive expansion in the amount of venture capital and more importantly for the
institutionalization of that segment of the financial markets. First, sharp declines in the
overall rate of profit during the mid-1960s prompted an investment shift from basic industry
toward new industries and more speculative investment opportunities. As a result, some
small portion of the leftover capital from declining investment in old line industries, spilled-
over into venture capital-related activities. Second, by the mid-1970s, it became obvious that
venture capital investments produced huge returns far exceeding those on corporate stocks.


70 Our discussion of Chicago venture capital relies upon John Wilson, The New Ventures,
Gene Bylinsky, The Innovation Millionaires, and the August 1974 and June 1981 issues of
Venture Capital Journal.
and bonds. This exerted a powerful pull on outside capital sources, drawing external capital into venture investments. Third, success itself was reinforcing, encouraging more entrepreneurs to form companies and opening up additional investment opportunities for venture capitalists. Fourth, two major changes in federal government policy—a series of reductions in the capital gains tax rate and the loosening of restrictions governing pension fund investments increased the attractiveness of venture capital and caused a variety of institutions to increase their venture capital investments. Fifth, and most perhaps most significantly, it was only during the 1960s and 1970s that a new form of venture capital institution, the venture capital limited partnership, emerged to finance high technology companies. Under this new form, professional venture capitalists (the general partners of the fund) were able to raise money from limited partners, i.e., banks, corporations, pension funds, and wealthy families. Venture capital funds could now be established right in the heart of emerging technology centers by personnel familiar with the most current technologies and business opportunities. During the period stretching from the mid-1960s through the 1980s, a huge number of limited partnerships were formed, most of them inside technology complexes like California’s Silicon Valley and Boston’s Route 128.

The venture capital industry in Silicon Valley—which represents the largest concentration of venture capital in the U.S.—emerged during the 1960s and 1970s alongside the development of high-technology enterprises in that region.\(^7^1\) Before then, entrepreneurs

\(^7^1\)There is a substantial body of literature which addresses the development and organization of high-technology industry in Silicon Valley, see, Annalee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge: Harvard University Press, 1994); Everett Rogers and Judith Larsen, *Silicon Valley Fever: Growth of a High-Technology Culture* (New York: Basic Books, 1984); Michael Malone, *The Big Score* (New York:
had to rely on industrial corporations or financial firms in more established financial centers for early stage funding. For example, Shockley Transistor Corporation was started with backing from Beckman Industries, while financing for Fairchild Semiconductor was provided by Fairchild Camera. But, in the late 1950s and early 1960s things began to change.\textsuperscript{72} This early period was one of experimentation by a variety of individuals and groups with different institutional forms which might permit them to capture the super-profits of the microelectronics revolution.

The early venture groups in the San Francisco Bay Area took on a variety of forms. The first venture capital firm in California, Draper, Gaither and Anderson, was founded in 1958 as a limited partnership. The following year saw the establishment of two federally leveraged SBICs, Continental Capital Corporation and Small Business Enterprises. Another SBIC, Draper and Johnson, was set up in 1962. The important venture capital firm, Sutter Hill, was founded as the venture capital arm of a successful real estate development firm.

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\textsuperscript{72} Our discussion of the Silicon Valley venture capital industry draws heavily upon interviews by Richard Florida and Martin Kenney with venture capitalists in Silicon Valley and San Francisco. Additional background is taken from back issues of \textit{Venture Capital Journal} which describe venture capital in California, and a poster depicting the history of California venture capital available form Asset Management Associates, Palo Alto, California.
Bank of America and a number of other commercial banks also provided venture financing for expanding businesses. In 1961, New York investment banker, Arthur Rock, formed a model limited partnership with Tommy Davis of Kern County Land Company. Of even greater significance was the revolving syndicate of independent investors centered around John Bryan and Bill Edwards which later came to be known as "the Group". One intermittent partner of "the Group," Reid Dennis, was able to persuade his employer, Firemen's Fund Insurance, to invest in a number of new ventures.

The San Francisco Bay Area venture capital industry thus emerged from a period of active experimentation with different types organizations for providing venture capital. The seminal period, 1956-1963, witnessed the establishment of more than a dozen important venture capital firms in San Francisco and Silicon Valley. Faced with acute difficulties mobilizing funds and the need to share information and expertise, these early venture capitalists gradually evolved into an interactive community trading information and participating together in rudimentary coinvestments.

The late 1960s and early 1970s saw the dramatic growth and reorganization of the Silicon Valley venture complex. Much of this expansion came from the original group of venture capitalists. In 1968, for example, Bryan and Edwards was established and George Quist of Bank America set up Hambrecht and Quist. In 1974, Reid Dennis founded Institutional Venture Associates with Burton McMurtry of Palo Alto Investment. Two years later, Institutional Venture Associates split into two partnerships, McMurtry's Technology Venture Associates and Dennis' Institutional Venture Partners.73 Tommy Davis launched the

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73 See, John Wilson, The New Venturers 54-56.
important Mayfield Fund in 1974. A variety of other actors and institutions entered the
Silicon Valley venture industry during this period. In 1968, Bessemer Securities became the
first East Coast venture capital firm to open a California branch. Citicorp opened a West
Coast office in 1973. Eugene Kleiner of Fairchild Semiconductor was a co-founder of the
important firm Kleiner Perkins in 1974, while Donald Valentine, an alumnus of both
Fairchild and National Semiconductor, established Capital Management Services, Inc. (later
Sequoia Capital) around the same time. A host of new partnerships (i.e., Idanta Partners and
WestVen Management) were formed during this period. Between 1968 and 1975,
approximately 30 new or reconstituted venture capital operations were established in the Bay
Area. This period also saw an increase in outside funds committed to venture capital. One
consequence was the emergence of the limited partnership—with professional venture
capitalists managing capital provided by passive outside investors—as the dominant model for
venture capital. University endowments, financial institutions, and pension funds initially bet
on venture capitalists with proven track records. Over time, a growing group of former
entrepreneurs, past employees of venture firms, and outside personnel were able to attract
financial resources and launch limited partnerships.

The growth of Silicon Valley as an entrepreneurial center resulted in a shift in the
locus of venture capital activity from San Francisco to Silicon Valley. By the 1970s, many
of Silicon Valley's leading venture capital funds clustered in a new office complex at 3000
Sand Hill Road, Menlo Park which became the largest single enclave for venture capital in
the United States, housing more than two dozen venture capital funds. The Bay Area
venture complex witnessed its most recent growth phase during the late 1970s and early
1980s. This period saw an even more dramatic surge in outside funding to the industry. The reduction in the tax rate on capital gains and the liberalization of restrictions on pension fund investments were two reasons for this. The profit squeeze faced by many large corporations and the tremendous success of venture-backed startups such as Intel and Apple Computer also attracted external capital to the industry.\(^\text{74}\) This growing pool of funds encouraged significant spin-off activity from established funds. Citicorp, for example, became a virtual training ground for venture capitalists, as its alumni established a series of important partnerships during this period, notably Arscott, Norton, and Associates (1978), and Doughtery, Jones and Wilder (1981). Similarly, Merrill, Pickard, Anderson, and Eyre was founded by members of Bank of America's venture group.

The early 1980s saw the emergence of venture capital megafunds as established venture capitalists pyramided partnership funds on top of one another. This resulted in a shift toward larger venture commitments and opened up an investment niche for seed funds concentrating on very early stage investments i.e., Alpha Partners, Crosspoint Ventures and Onset Partners (which was capitalized by a consortium of established venture capital funds). Finally, a host of venture capital firms headquartered elsewhere opened California offices, including L.F. Rothschild, J.H. Whitney, TA Associates, and General Electric Venture Capital (GEVENCO). Between 1978 and 1982, more than 50 venture capital funds were established in the San Francisco Bay area.\(^\text{75}\) Silicon Valley's venture capital community


experienced tremendous expansion between 1960 and 1985, displacing the old money centers of New York, Chicago, and Boston as this country's leading venture capital center. The remarkable returns generated by the dozen or so original Silicon Valley venture funds sparked a massive surge of capital, as banks, insurance companies, wealthy individuals, universities, and other institutional investors rushed to invest in Silicon Valley's venture capital partnerships. In contrast to venture capital in financial centers like New York and Chicago, the great bulk of Silicon Valley venture capital is invested in local companies. Furthermore, Silicon Valley's venture capital community grew up right alongside high-technology industry in a mutually-reinforcing and symbiotic way, similar to what occurred in the Boston textile industry or heavy manufacturing around Pittsburgh. Silicon Valley venture capitalists gradually insinuated themselves into developing entrepreneurial networks, bringing important financial resources and business development skills to those networks and hiring successful entrepreneurs.

As we have already seen, Boston was perhaps the nation's original source of venture capital. As early as 1911, the Boston Chamber of Commerce generated a small pool of risk capital and began providing managerial assistance to new enterprises. Later, in the 1930s, Boston retail magnate, Edward Filene and a group of New England businessmen

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launched the New England Industrial Corporation to provide organized assistance to new industries.\textsuperscript{78} Boston was the home of American Research and Development (1946) the nation’s first institutional venture fund which had been created by a prominent group of bankers and industrialists who saw such an entity as a way to more effectively finance technology-oriented enterprise.\textsuperscript{79} In addition, a significant number of early venture capital investments in the Boston area were made by private individuals and wealthy families both from the Boston area and New York City.

By the early 1960s, large Boston financial institutions also became involved in venture capital. In the early 1960s, the major bank in the region, the First National Bank of Boston, "the Bank," established a program for providing loans to high technology businesses. First National Bank of Boston established a program for providing loans to technology oriented businesses and formed an SBIC affiliate. Other large banks established small business investment companies to invest in the technology-oriented businesses that were springing up in the region. Federal Street SBIC was established a consortium of Boston banks.

Both ARD and "the Bank" became important sources of spin-off funds. In 1963, for example, ARD alumnus, Joseph Powell founded Boston Capital Corp. Other ARD alumni went on to launch most of the important Boston funds like Palmer, Greylock, and Morgan Holland. Another important development was the rise of TA Associates, currently the nation's largest venture capital fund with assets of $1 billion plus dollars. In 1968, Peter


\textsuperscript{79} See, Patrick Liles, \textit{Sustaining the Venture Capital Firm} 28-36.
Brooke left his position as director of "the bank’s" high technology loan program to launch TA Associates. And, as TA Associates grew it begot a number of other partnerships such as Burr Egan and Deleage and Claflan Capital Management. Recently, a number of venture capital funds headquartered elsewhere, like the New York fund Bessemer, have opened Boston branches.

Boston, like Silicon Valley, thus witnessed the development of a technology-oriented venture community parallel to the emergence of the Route 128 entrepreneurial complex.\(^{80}\) ARD’s enormously successful investment in Digital Equipment Corporation (DEC) in the late 1950s provided a vital impetus to the climate for high technology entrepreneurship in Boston.\(^{81}\) DEC played a significant role in the evolution of the Route 128 high technology center; it became an incubator for more than 30 spin-offs, most notably Data General.\(^{82}\) ARD similarly became an incubator for venture capital funds. In 1963, Boston Capital Corp. was founded by ARD alumnus, Joseph Powell. By the 1970s, ARD alumni were instrumental in launching a host of top level partnerships including Palmer, Greylock, Charles River

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\(^{82}\) See, Nancy Dorfman, 1983.
Partnership and Morgan Holland. As the technology base of the Boston region developed, a host of partnerships were organized by veteran venture capitalists. The late 1970s and early 1980s also saw the formation of new funds such as Eastech and Zerostage and the movement of branch offices of funds headquartered elsewhere, such as Bessemer Venture Capital, to the Boston area.

The role of Route 128 venture capital community in financing new innovation is similar Silicon Valley, but the evolution of venture capital in the Boston area has been much more closely tied to large local financial institutions and wealthy families. In fact, venture capital in the Route 128 area was largely orchestrated by large business and financial interests, a far cry from the organic model of venture capital that grew up in and around Silicon Valley. Yet, like their counterparts in Silicon Valley, Boston venture capitalists also invest heavily in local high technology, bolstering that region’s capacity to engender important new innovations.

Venture capital in the Silicon Valley and Route 128 evolved gradually alongside the high-technology industrial complexes that grew up there. Venture capital thus became an integral part of the regional technology infrastructure, or what has been elsewhere termed the social structure of innovation—an interactive system comprised of technology intensive enterprises, highly skilled human capital, high caliber universities, substantial public/private R&D expenditures, specialized networks of suppliers, support services such as law firms and consultants, strong entrepreneurial networks, and informal mechanisms for information

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exchange and technology transfer. The synergies among the various elements of this infrastructure created a unique window of opportunity for the emergence of technology-oriented investing apart from traditional financial institutions. The growth of venture finance then proceeded along a learning curve characterized by the gradual accumulation of investment and management skills on the part of venture capitalists and entrepreneurs alike. This in turn facilitated the development of extended entrepreneurial networks that became conduits for sharing information, making deals, and mobilizing resources. As a central component of such networks, venture capital thus played an important role in incubating entrepreneurial activity, attracting entrepreneurs, and accelerating rates of new business formation.

CONCLUSION AND DISCUSSION

The very phrase venture capital calls forth the image of new financiers of innovation who back cutting-edge high-technology concerns. These industrial enterprises are usually linked to some cutting-edge, industry-defining technology—biotechnology, advanced materials, computer software, and the like. Popular conventions aside, we tend to associate venture capitalism with the sweeping technological and economic revolution of the past two or three decades. But, venture capital has a much deeper and richer history than that. Indeed, the rise of new forms of finance to channel capital to new enterprise and new industries is a defining feature of the America’s technological, industrial and economic

development.

We started from the hypothesis that new forms of finance—or more appropriately venture capital—are typically required to finance the birth of new technologies and business organizations, and the more general process of technological and industrial development.\textsuperscript{85} In other words, we suggested that the rise of new forms of finance, or venture capital, correspond to the rise of new industries and technologies. We aimed to essentially draw upon, expand and test Schumpeter's seminal insights on the role of innovation in capitalist development. In Schumpeter's eyes, economic development is a process of discontinuous evolution which is driven by technological change. Major innovations—or clusters of innovations—set in motion strong "gales of creative destruction" which revolutionize industrial production and industrial organization. However, the risks associated with these major innovations are sufficient to deter average firms, so "exceptional entrepreneurs" are required to set such gales in motion. In our view, Schumpeter's risk-taking entrepreneurs require a symmetric counterpart in the financial system.

We believe that the historical record, at least for the American case, lends considerable support for this hypothesis. America's first industrial revolution of textile production in and around Boston both required and reinforced the rise of a new set of financial institutions that economic historians such as Lance Davis, Robert Dalzell, and Naomi Lamoreaux have variously referred to as relationship banking or equity-financed insider lending. New financiers of innovation similarly arose to finance the technology-based

corporations and corporate complexes of the second industrial revolution: the activities of Andrew Mellon in financing Pittsburgh’s industrial complex are illustrative of this process. During this epoch, a new and more complex system for banking and investment thus emerged as a vehicle for technological change and industrial development. The high-technology revolution of the mid-to-late twentieth century required yet another round of financial innovation and a new set of venture capitalists to bring to fruition. These new venture capitalists grew up alongside the high-technology innovation complexes of Silicon Valley and Route 128. By the 1980s, a new and highly institutionalized national system for venture capital had emerged to finance the latest wave of entrepreneurial, technology-based enterprise. Simply put, venture capital is a defining element of the American pattern of technological change and industrial development.

The venture capital system itself evolved alongside American industrialism, becoming increasingly formal and institutional in character over time. The early venture capital or "insider lending" of the New England textile industry was largely a regional system, built upon close personal ties between the region’s financiers and industrialists. The new forms of venture capital that emerged to finance America’s second industrial revolution took shape as more formal institutions, such as Andrew Mellon’s Union Trust Company. The high-technology venture capital of the mid-to-late twentieth century evolved into a more fully-blown institutional system of formal (indeed legal) organizations such as the limited partnership and its own set of trade associations and research organizations. Furthermore, this institutional system of venture capital evolved into a well-articulated national system for mobilizing capital via co-investment syndicates and other mechanisms.
Our historical excursus thus lends considerable support to the view that the processes of finance or capital formation, technological change and industrialization occur in tandem over time. They can be seen as different "faces" of an overall development process which grow up together, influence and shape one another, and are to some degree inseparable. This can be thought of as a cumulative process as industrial growth generates new sources of capital which are in turn invested into subsequent rounds of industrial expansion and growth. With every major technological step forward, corollary shifts in finance occur and new forms of venture finance are created. These new financial forms emerge in response to the of mismatch of capital and industrial needs, as older, more traditional forms of capital remain tied to older paradigms of industrial organization and growth. New mechanisms for providing capital--and new financiers of innovation--are required to support the rise of new technologies, new enterprises and new industries.

Furthermore, our findings suggest that place matters in the co-evolution of finance and industrial development. Here, we simply suggest that Schumpeter's fundamental insights have a considerable spatial or geographic dimension. As we have seen, major technological changes, or shifts in the organization of production tend to occur in specific places and diffuse unevenly across the industrial landscape. The growth and development of local industrial complexes in turns creates the expanding economic base, vibrant investment climate, and new opportunities for capital accumulation. The initial opportunities may well be filled by traditional financiers and investors in established financial centers especially given the well-developed financial structure of contemporary capitalism. Yet over time, the developmental trajectory of the new growth complex creates a momentum of its own, helping
to create and indeed generate new sources of indigenous capital, finance, and investment articulated to the needs of its local industries. The new complex is now able to finance itself and embarks on a period of self-reinforcing growth while, at the same time, retaining connections to outside sources of capital and investment.

Our review of the historical record leads us to conclude that venture capital has played a rather fundamental role in innovation, industrial transformation and economic development. Capital and creative destruction thus go hand in hand in the process of technological change and industrial growth in American economic history.