The Financial Base of the New Technological Enterprise

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ABSTRACT

The article presents an assessment of the capital market for technology-based firms, focusing upon the links between the stages of evolution of a firm and the investment preferences of various capital sources. These factors lead to an expectation that initial capital will be supplied most frequently by the entrepreneurs themselves from their own savings, secondarily by their families and friends and by private investors, all these being sources of capital outside of the formal channels. More substantial but still initial funding from rather unique "wealthy family funds", special "seed" funds and somewhat more conventional venture capital funds are expected to be the primary complements of the informal sources.

Data from studies of technological firms support these expectations, providing evidence of the usual small initial capital base (almost half with less than $10,000) and the dominance of personal savings as the principal source of initial capital (74 percent of the companies). "Outside" sources of capital are responsible for the larger initial investments when they occur. Larger amounts of initial capital are both contributed and raised by larger groups of co-founders, especially when the founders are involved in the companies from the outset on a full-time basis. Specific plans for the company are associated with greater initial capitalization, as well as with raising outside capital, as is also true for the effect of having an initial product. The needs for initial capital vary enormously by amount and intended use as a function of the type of business being started, with consulting firms and software companies requiring far less than hardware developers and producers.

THE FINANCIAL BASE OF THE NEW TECHNOLOGICAL ENTERPRISE

Entrepreneurial people provide the initiative, the energy and the vision for launching a new company. Advanced technology often provides the unique competitive advantage over existing companies or the basis for creating a new market. But money provides "the grease", the wherewithal to make it happen, even for the high technology firm.

In recent years numerous books and articles have been published on how to manage venture capital investing along with even more publications on how to raise capital for the new enterprise. But surprisingly few of these works have been based on careful empirical research (see Dunkelberg and Cooper, 1983, for an exception), and I have found none focused upon the initial funding of technology-based companies. This article establishes a general background for understanding the financing of a technological firm by first discussing the several stages of a company's financial development and the variety of potential financial sources relevant to the firm. This discussion leads to a set of expectations or hypotheses as to the initial sources of capital for the technological enterprise. Empirical studies of several hundred technological firms provide the data for verifying these expectations, indicating the sources and extent of initial capital base of the technical enterprise and the factors affecting this initial financing.

STAGES OF FINANCIAL DEVELOPMENT

The new technology-based firm evolves through a succession of multiple stages of corporate growth and parallel development of its financial needs. The period of time during which a company can be classified in a particular phase varies widely among firms and the dividing line between phases is at best fuzzy. Yet the relative stage of evolution does strongly influence the type and amount both of capital required and especially of capital available. To understand this relationship I shall first examine the general characteristics of the firm at each stage, which in turn imply the nature of its likely financial backers. Empirical research will later be used further to illuminate these financing relationships.

Traditionally the technical firm has been visualized as going through a usually pre-company R&D stage, followed by three phases of corporate

development: (1) start-up, (2) initial growth, and (3) sustained growth. The research and development phase often takes place in the laboratory of some other "source" organization or the basement of a founder's home, often while the founders are still employed "full time" for another organization. It involves experimental verification of product principles and may include attempts to determine commercial applicability. Few resources other than the founders' time are generally employed at this "pre-venture stage". In recent years the financial community has become more involved in this pre-company stage, often with university laboratories or their direct spinoffs, in the long-term funding of ambitious R&D programs with hoped-for commercial outcomes. Sometimes the mechanism of an "R&D Limited Partnership" is employed during this stage, especially in recent years with biotechnology companies, but the R&D stage (especially R !) remains a largely pre-corporate or at least unfunded aspect of most new companies' formation and development. The R&D stage does sometimes overlap with the "zero stage" of start-up firms, as will be discussed below.

Phase 1 -- Start-up

The start-up phase begins with the founding of the company and ends, more-or-less, when the company has experienced significant sales (at least a few hundred thousand dollars per year) and has developed one or more products or services that exhibit growth potential. In recent years the start-up phase has been subdivided conceptually into the "seed stage" or "zero stage" and the "first stage". During the so-called "zero stage", the new company works out its basic technology, formulates its initial strategy, and rounds out the start-up team.

At the outset of its "seed phase" the company often lacks an operating prototype of its intended product and even has little in the way of a formal business plan. Many companies carry what we described above as a "pre-company R&D stage" into this "seed phase", continuing to solve key product development issues and moving toward an operating demonstration prototype of their initial product. Following the seeding activities is the more conventional "first stage", during which the company generally has produced a reasonably well-defined business plan, an emerging organizational structure built up around several key committed personnel, and a product for which at least some level of commercial applicability has been demonstrated.

During the entire start-up phase the new technological firm typically devotes considerable time to product development. It is dealing with only a few customers but is actively seeking new marketing/sales channels. The firm is housed in modest facilities, using barely adequate equipment. It has little or no available financial collateral. Typically few of the people in the company have substantial management experience; a large portion of the founders and their early employees are technical people by education and work experience. The company is able to react quickly when opportunities arise. However, the company is usually losing money.

The financial needs of the firm during the start-up phase are many. It needs capital to finance product development, primarily to support salaries for the technical personnel, despite the fact that many or all of them are being paid lower salaries than in their previous jobs, earning by their financial sacrifice the so-called "sweat equity" ownership in their company. Some capital is also needed for equipment. Working capital may be required if the company is already producing products for sale. Since the company is losing money, the entrepreneur must turn outside the firm for capital.

But what type of investor would be willing to supply initial capital to such a new company? Since the investment is so risky, the potential payoff must be high in order to outweigh the high probability of failure. The capital source must be patient, willing to wait for five to ten years for a return. He, she or it must trust unproven management to develop, produce, and sell a product or service that often does not yet exist. Such an investment is viewed by many as analogous to putting several hundred thousand dollars or more on the Daily Double!

Phase 2 -- Initial Growth

The initial growth phase can be felt to begin when the company has completed the development of a product line and has sufficient sales to justify an expectation of rapid growth. The phase may be regarded to end when the company has lived up to such expectations and demonstrated a capability to operate profitably and grow quickly. During this phase the company matures somewhat. It begins to work on product quality and on lowering unit costs. Although gaining new customers it is also beginning to

face some competition from other small firms and sometimes from large corporations as well, giving the young company strong incentives to develop new products. The company is operating profitably, but the resultant cash flows are typically insufficient to supply the needed growth capital.

The problems which the firm faces are also changing. Plant and equipment are needed. Working capital needs are expanding with the growth in sales. Key management personnel are needed as production, sales and marketing, and research and development become important functional areas. Management and operations control become important to keep the company operating efficiently.

The type of financial backers which the firm attracts tends to change with the company's characteristics. The risk and uncertainty associated with the company decrease. The young company still offers the opportunity for a large payoff, but the probability of failure, though still large, has decreased significantly. The investment need not be locked in for more than two to three years, if the founders are willing and the financial market permits the company to go public or to be sold to a larger firm during these next few years. The company no longer needs a gambler to supply capital, but phase two investors must still be speculators over the long term.

Phase 3 -- Sustained Growth

Having solved its initial start-up and early growth problems, the successful company emerges as a growth business. It has annual sales in the millions of dollars and employment numbers in the hundreds. The enterprise begins to face many of the problems of the large corporation but on a smaller scale. The firm serves many customers with a variety of products and services and is faced with strong competition. Profits and cash flows are sufficient to meet the majority of its capital requirements, but new growth possibilities are continually being presented. Indeed, growth rate of the company may be the source of its most serious challenges, including financing the growth.

The major problems facing the entrepreneur change significantly during phase three; he is now required to think about overall corporate direction, development of multiple product lines, employee morale, communications,

and long range planning. Potential merger or acquisition candidates present themselves; and the company itself is courted by larger corporations. Tax and legal considerations loom increasingly large. The entrepreneur may find himself no longer the central figure of the company and he may wish to sell his interest and retire or start over again. The company has ceased to be a new enterprise and has become a growth business, maybe the IBM of the future!

Despite, indeed perhaps because of, its speculative future prospects, the company has undoubtedly become attractive to the public. If it had not previously issued stock publicly, it can now turn to the public financial markets with some degree of confidence. Long term loans are now also available since the company has sufficient assets to serve as collateral. The technological enterprise, through its ingenuity, efforts, persistence and good luck, has stood the test of time and established itself as a going concern.

FINANCIAL SOURCES

A wide variety of financial sources are potentially available to fund the technology-based company's capital requirements through the successive stages of its growth and development. But embryonic technological enterprises are quite different from most other new firms in their lack of tangible resources. Many research- or technology-based companies start out with little more resources than an oscilloscope and a soldering gun or a magnifying glass. Many begin with only the entrepreneur's intelligence and drive as inventory. With little else for collateral, the entrepreneur's searches for funds from banks and other formal financial institutions are also often fruitless. Alternatively, the term "venture capital" often comes to mind when thinking of the initial financing of new enterprises. And yet, it has long been true [1] (and still is!) that the bulk of financiers known as "venture capitalists" do not support the earliest stage of capital acquisition for the vast majority of technology-based enterprises. As we shall later show, venture capitalists generally prefer later-stage investments in growing enterprises, not early-stage investments in technological start-ups.

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[1] Historical evidence of this is indicated as far back as thirty years ago in Rubenstein, 1958.

But if not the venture capitalist, then to whom does the entrepreneur turn for funds to finance his dreams? Although initial requirements may be low, who is willing to gamble on the start-up's success? And once the future begins to look promising, where can the entrepreneur find several hundred thousand to a few million dollars of growth capital? The many classes of potential financiers for new technical enterprises will be examined here in an effort to determine their resources, attitudes toward risk, selection criteria, preferred investment terms, and post-investment relationships with the young technical firm. I will consider them in the order of their general likelihood of being an initial investor in the new firm.

Personal Savings

Undoubtedly the most available source of capital to the entrepreneur is his personal savings. Indeed, Dunkelberg and Cooper (1983) had found personal savings to be the primary source of financing for 890 owner-started firms in a wide variety of mostly non-technical industries. Tyebjee and Bruno (1982) indicated similar dominance of personal savings in the funding of 185 California technology-oriented companies. However, those savings are typically quite limited and the average individual scientist or engineer in his early 30s would have difficulty in raising more than $25,000 to $50,000 on the strength of his savings account, his signature, and his available collateral. The entrepreneur must realize though that he may be required by other investors to gamble much of his own assets on his company as a sign of good faith. It is especially important that he and his co-founders own the bulk of the company initially, as later dilution of their ownership will necessarily follow from the required acceptance of increasing amounts of outside capital. The entrepreneur should recognize that his potential capital gain is phenomenal if the company proves successful and that he should be risking much of his own "wealth" if the future looks bright.

Personal savings then are the foundation of initial capital. Usually additional funds are not needed for close to a year or more, depending on the scale of initial efforts. The entrepreneur can make many non-monetary forms of investment in the company in the form of patents, developed products, and free labor, previously referred to as "sweat equity". However, the assets of the entrepreneur are all too soon exhausted and he must turn to outsiders for

capital. If the entrepreneur is personally wealthy, from birth or from previous entrepreneurial success, the need for outsider investments may be delayed significantly.

Family and Friends

Next to personal savings the assets of an entrepreneur's relatives and friends are probably most available. Such investments often take the form of short term loans, although the loans may later be changed into "equity" investments at the insistence of subsequent investors. The main advantage of such funds is that they are relatively easy to get. The investors know the entrepreneur and have assessed his capabilities. Often the entrepreneur, unsure of whether his venture will succeed, properly feels reluctant to "take advantage" of such close personal relationships to raise money. The major disadvantage if friends and relatives do invest is that they may feel that the investment gives them the right to advise or actively interfere with management. Therefore, although such "naive" money is relatively easy to obtain, many problems may result from its acceptance.

Private Individual Investors, or "Angels"

The great majority of initial investing through outside investors has traditionally been undertaken by wealthy individuals. Gordon Baty long ago (1964) characterized the traditional private venture capitalist as having a tax bracket favoring capital gains. Furthermore, being "accountable only to himself for his actions, he can afford the inevitable loss and he often has motivations for investing which are not strictly economic". Non-economic motivations include a sense of gambling, participation in an exciting growth company, especially the involvement with young bright people, and sometimes satisfying his sense of social responsibility, perhaps related to his wealth. Unfortunately the current lack of tax differences between regular income and capital gains obviously to at least some extent affects this individual's motives and actions.

The private individual seldom seeks out investments. Instead he learns of opportunities from contacts within the financial community of which he is often a member. Investment bankers, commercial bankers and brokers all refer companies to him. Occasionally the prospective individual investor

participates in local groups like the MIT Enterprise Forum, where early-stage entrepreneurs present their aspirations and problems.

William Wetzel (1983) has carefully analyzed this informal risk capital investor, whom he calls a "business angel". The angel's resources are considerable. Acting alone or through a syndicate of friends and acquaintances he can raise as much as $1,000,000 for a given deal, although he seldom does. A large fraction of the deals are for $50,000 to $200,000, typically involving an angel and one or more of his friends, each putting up $50,000 or less. They usually do not seek a controlling interest or management position in the company, but most prefer to be consulted on major management decisions.

Such investors rely heavily on the advice of their friends and other backers when making investment decisions. Few make a detailed analysis of the situation, evaluating the company primarily on the basis of its management. The investments are usually straight equity. The wealthy individual venture capitalist thus tends to qualify as the type investor needed in the company's initial phase. The entrepreneur need only find the right angel for his company; this is not easy, despite the computerized "matching network" created by Wetzel for informal investors in the New England area and now also replicated elsewhere in the United States.

Wealthy Family Venture Capital Groups

More-or-less next in line, at least historically, in likelihood of investing at the outset of a technological enterprise is the formal private venture capital investment group established by a wealthy family. Shortly after World War II several wealthy families created such organizations to invest family resources in young businesses, especially those based on advanced technologies, in search of capital gains. The largest of these groups, led by such people as Laurance Rockefeller, Jock Whitney, and Payson and Trask, became well-known within the investing community and instrumental in funding numerous technological enterprises. Rather than invest informally and as individuals (as the "angels" above) those families usually funded an autonomous investing organ (corporation or partnership), managed by a staff of full-time employees who analyze incoming investment proposals, make the investment decisions (usually without family

participation in the decision), and work with the investee companies during the post-investment period. Venrock, founded by the Rockefeller family, is perhaps the best known of the current survivors of these organizations.

As these family groups developed they evolved a certain style of operations that became the basis for today's U.S. venture capital industry, with resulting advantages and disadvantages to the entrepreneur who deals with them. The advantages to an entrepreneur who gets funds from such family groups are many. Other investors look more favorably at the new company because these larger family groups have a reputation for choosing only the best companies. This of course makes it easier to obtain additional capital later. Their resources are essentially unlimited, making it possible for the entrepreneur to come back later for more capital. The staffs of such family groups have had top quality reputations, with both business and technical expertise. The final advantage is that they are patient investors, willing to wait five or ten years for their returns, and they do not have to answer to stockholders or outside investors for their performance.

The disadvantages associated with investments by the organized family groups are also numerous. They have been very discriminating in choosing their investments, investing typically in less than 1% of the proposals they receive; the entrepreneur must submit a detailed proposal (called a "business plan") to be considered. The investors will demand one or more positions on the board of directors of the company and detailed ongoing reports of operations. They may insist on placing a staff member in an operating position in the company if growth does not materialize, or even worse from the entrepreneur's perspective,they may step in and replace the founding entrepreneurial head of the company. They are also rather slow in reaching a decision, so the entrepreneur must approach them several months before he needs the money.

In evaluating a young company the aspect that seemed to loom most important to these family groups during their early and formative years was the quality of the management, followed by the market for the product. They also considered the state of product development and the underlying technology. Investments were usually made in the form of convertible debentures, providing some modicum of investor protection in the event of company liquidation. The size of their investments tended to range in their

early years between $300,000 and $500,000 and of course have grown in magnitude over the past forty years, but not by more than about a factor of two. The family venture capitalists often avoided initial financing, but now tend to be willing to put in small sums as early-stage investments, especially in companies headed by entrepreneurs with whom they have had prior experience.

Venture Capital Funds

The family venture capital groups were the models for the formation of specialized closed-end investment companies that focused on venture capital. The first of these was American Research and Development Corporation (ARD), organized in Boston in 1946 in large part through the efforts of the then Chairman of MIT, Karl T. Compton, and a number of prominent alumni and friends of MIT, to move research and technological ideas forward into the market. The heads of MIT's Departments of Chemical Engineering and Aeronautical Engineering acted as advisors, and the Treasurer of MIT served as Treasurer of ARD. ARD was funded initially with $3.4 million in investments from Boston-area insurance companies, but joined as investors by MIT, Harvard, Rice Institute and the University of Rochester. ARD later went public, sold out still later to become a division of Textron Corporation, and finally was sold by Textron to a member of the Mellon family.

Initially and for several years ARD invested in ideas promoted by senior MIT faculty, housing the start-up companies in MIT buildings with a unique cost-sharing arrangement that only today is beginning to be replicated at other universities. This approach led to formation of and ARD investments in such companies as High Voltage Engineering and Ionics. Gradually ARD's approach changed under the guidance of Georges Doriot, a professor at the Harvard Business School who served as president of ARD, and who moved ARD toward imitation of the larger family groups in almost every respect. A full-time staff of professionals annually screened hundreds of incoming proposals, giving careful consideration to perhaps ten percent of them, and eventually investing in two to three percent of the companies. In its early days ARD usually took dominant stock ownership position in a company through an investment of $100,000 to $500,000 in the form of convertible debentures, with $200,000 buying 80 percent of High Voltage in 1946 and $100,000 gaining 75 percent of Ionics in 1948. Its principal success by far

was the $70,000 start-up investment in 1957 that purchased 78 percent of Digital Equipment Corporation, that success dwarfing all other actions ever taken by ARD. ARD's attitudes and policies toward company management were very similar to those of the family investment groups.

Following the lead of pioneers like ARD other professionally-managed venture capital funds were formed, usually raising their money privately from wealthy individuals, banks, pension funds and corporations. Whereas ARD had strong bias toward companies located in the greater Boston area, funds were formed in other parts of the United States with tendencies toward regional biases, such as those managed by Arthur Rock in the Silicon Valley area. Gradually these professional funds proliferated and came to dominate the venture capital sector, becoming far larger in magnitude of total funds managed and invested than the earlier-formed wealthy family funds. Funds such as TA Associates, Hambrecht and Quist, Kleiner Perkins and many others became well-known for technology-oriented investments in particular. In general these funds followed patterns of investment analysis, decision-making and management similar to those practiced first by the family funds and then ARD. Careful screening and selectivity characterized their investments, with aspirations toward high rates of potential return to compensate their investors for the presumably high risks being taken. In recent years this initially U.S. phenomenon has spread globally and venture capital funds interested in investing in technology-based firms now exist throughout western Europe and Asia, albeit sometimes with different operating styles.

Among the hundreds of venture capital funds is a small group of so-called "seed funds", like the Zero Stage Capital Equity Funds with which I am associated, that focus on investments primarily in the initial and early stages of technology-based firms. These "seed" or "zero stage" funds follow in the tradition of the earliest activities of the wealthy families and of ARD in helping to put together the startup enterprises, working very closely with the company founders to round out their team, more sharply define their business objectives, help develop a completed business plan, providing possibly more value in advice and "sleeves rolled up" assistance than in the capital itself. Such funds typically invest from $200,000 to $500,000 at the initial stage of a new company, with perhaps matching funds available for participation in a later second round of financing. The seed funds seldom have

"deep pockets", and seek kindred spirits for sharing the initial investment so as to ease the difficulties that might be experienced later in securing the hopefully much larger requirements of growth financing. One unique seed fund that has helped many Massachusetts startups is the Massachusetts Technology Development Corporation (MTDC), state chartered and funded during a period of low public availability of venture capital. It works very closely and effectively with other Boston-area seed funds to help initiate and enhance early growth of local technical firms.

Small Business Investment Companies (SBICs)

A special form of venture capital fund that was important in the U.S. during the early 1960s was the SBIC, enacted by Congress in the 1958 Small Business Investment Act. Private capital was given tax incentives and low interest leveraged loans from the U.S. government to invest in small business. Several hundred SBICs were chartered with combined assets of nearly $1 billion, but only 50 of them had assets greater than $1 million. The resulting generally small financial organizations invested heavily in real estate and the trade sector, with some of the larger ones investing in new technical companies. About 15 to 20 percent of the SBIC investments were made in early-stage companies that were less than one year old. But probably less than ten percent of the SBIC capital was invested in technologically-oriented companies. Overall, however, the SBICs did have significant impact by the principal fact of their funds availability during a period of time that was otherwise relatively dry of small business investing resources. Most of them are now out of business although some associated with banks, such as Bank of Boston Ventures, today are still active and important participants in investments in early stage technology-based firms.

Non-Financial Corporations

Beginning in the early 1960s and increasing significantly only in the 1980s, major manufacturing firms have become interested in supplying venture capital to young technological companies. Many of them are seeking to supplement their in-house research and development efforts by backing entrepreneurs in hopes of gaining access both to technology and engineering talent. Initially companies such as DuPont, Ford, Texas Instruments and Union Carbide experimented with this approach of direct venture capital investment

in new or early stage companies. Later Exxon, Inco, Lubrizol and Monsanto demonstrated active and effective programs of investment that encouraged widespread participation by many Fortune 500 corporations.

Non-financial corporations differ significantly from the previously discussed venture capitalists in regard to their motivations, selection criteria and attitudes toward the technological enterprise. Their prime consideration is usually technology. Most investing firms choose only a few technical fields in which to invest, sometimes related or complementary to their current lines of business, at other times wholly unrelated, depending upon the corporation's present strategy of concentration or diversification. The quality of the entrepreneurial team is usually the second most important decision criterion. They have tended to avoid providing initial capital, often because they do not see the opportunities soon enough or because they cannot act fast enough, instead preferring somewhat later growth financing. In recent years this tendency has changed somewhat, especially in areas of medical technology and advanced materials, where a number of non-financial corporations have developed close ties to venture capitalists that allow the corporations to see and participate in early stage financings.

The non-financial firms often are willing to provide technical, marketing and managerial assistance to the companies in which they invest, potentially more valuable than the funds themselves if these services can be accessed and utilized effectively by the investee. This assistance, which in earlier writings I have labelled "venture nurturing" (Roberts, 1980), plus very "deep pockets", may be primary advantages provided by the corporate venture capitalist, but combines with some potential disadvantages. The corporation may have a tendency to interfere more in the day-to-day operations of the young firm than the entrepreneurs find desireable. Furthermore, the corporate investor may oppose the firm "going public", preferring to merge it eventually into its own operations. Entrepreneurs often think that going public is the ultimate measure of and route to personal glory and financial success, but the facts are that far more technical companies eventually sell out to larger companies than go public. Thus the entrepreneur frequently is leery of corporate funding at early stages of the firm but becomes less naive and resistant to their funds and help as his company moves forward.

Commercial Banks

In some areas of the U.S. commercial banks have taken an active role in supplying capital to new technical enterprises, even though the bank itself is restricted by regulations in how it can invest its resources. During the early years of a company the more venturesome banks supply short term loans secured by projected accounts receivable based on contracts or orders received by the firm. These sometimes can get converted effectively into intermediate or even long term loans through constant renewals and renegotiation. Banks can also help through long-term lease financing of laboratory or manufacturing equipment. Bank-owned SBICs, discussed above, can of course become direct investors and the SBICs and/or bank commercial lending officers can assist in establishing relationships with conventional venture capital funds.

The bank's motives for its lending, investing and referral activities are future profits to be generated through regular banking business with a growing corporation. By helping to finance the firm when it is young the bank hopes to retain the company's conventional banking business when the company becomes large and successful. Thus the bank's attitudes and patience may well differ from other potential investors.

Public Stock Issues

During several short periods of time since the early 1960s the start-up entrepreneur could turn even initially to the public market in the United States for very early-stage capital, especially for a high-tech or otherwise "glamorous" company. Although few people active today in venture financing will remember, 1969 was the peak year to date (!!) for initial public offerings by early-stage companies. But those speculative times are usually short-lived. In contrast when a more conservative mood prevails, especially in "bear market" conditions, it becomes very difficult, certainly very costly, for even the successful growing new enterprise to raise public funds.

There are many reasons for a young technical company to go public. The entrepreneur and the venture capital backers may wish to realize capital gains; the entrepreneur may want a public market to insure that his holdings will be liquid if he should die; the new enterprise may want the prestige of being listed on the financial pages of the newspaper. Or, specifically relevant

to our current discussion of the financial base of the company, the company may find that the public market will supply the least expensive or otherwise most attractive funds for its further growth and development.

Regardless of the motivations the entrepreneur needs expert advice from the financial community before attempting a public stock issue. The U.S. Securities and Exchange Commission (SEC) has extensive and complex requirements that affect the process of "going public", as do many state regulatory bodies. There are several different ways for a U.S. firm to raise public money, including both underwritten and non-underwritten methods, and in recent years including the possibility of going public in Britain. Underwriters vary greatly in criteria and effectiveness, and need to be carefully evaluated by the entrepreneur. Large investment banking houses, for example, seldom underwrite issues of less than $10,000,000 and then usually only when the firm meets other performance criteria. Thus early-stage entrepreneurs need to deal with the smaller underwriters, with whom greater caution is recommended. Consequently the public markets typically serve the technical firm's growth capital financial needs, and not earlier requirements.

Synopsis

Figure 1 portrays the relationship of the stage of evolution of the technology-based firm to the likely availability of capital from the various investment sources discussed above. As such it constitutes a loose set of testable hypotheses with respect to the sources of initial capital for the technological firm. The diagram is inexact and is meant to convey the average tendencies of each class of investor during the three stages of a company's development. As should be expected the investment behavior of each group contains considerable variance, to be evidenced by the presentation of empirical findings that follows.

INSERT FIGURE 1 ABOUT HERE

This synopsis of initial capital sources has not included any mention of pension funds or insurance companies, both major participants in U.S. capital markets. In fact, with few exceptions neither of these types of institution directly participates in initial or even early round financing of high-tech firms. But both sources have become major investors in the pooled funds

managed by venture capital firms, a fraction of which do directly invest as described above. Corporate pension funds have been major players since 1981 and public employee retirement funds have become active since then. In recent years over 20 states have become involved in venture capital fund investments, often with the combined motives of economic stimulus of their own regions as well as increased returns on their investment portfolios. In addition, both pension funds and insurance companies often invest in the later growth financing of technical companies, with some of the insurance companies aggressively managing their own direct investment portfolios.

SAMPLE SELECTION AND DATA COLLECTION

The data analyzed here in order to test the rough hypotheses presented above are part of a twenty years research program on all aspects of the formation and growth of high-technology new enterprises, including more than 40 separate but related research studies. Elements of the data collected in thirteen of those studies (shown in Table 1) are used in part in this article, covering information from several hundred firms founded by former employees of MIT major laboratories and engineering departments as well as the former employees of a government laboratory, a major non-profit systems engineering organization and two large technological corporations. The four non-MIT organizations were selected from the Greater Boston area for ease of data collection, seeking comparability with the size and nature of work of the MIT "sources". Contrasting information is used occasionally from a study of new non-technical consumer-oriented manufacturing firms, as well as from other studies within the overall research program.

INSERT TABLE 1 ABOUT HERE

Beginning with strong cooperation of senior managers in each source organization, initial lists were developed of suggested names of spin-off entrepreneurs from that organization. Follow-up interviews were used to screen these lists for inappropriate names as well as to generate further suggestions in a "snowball" sample creation process. Rigorous criteria were applied to include only those who had been former full-time employees of the source organizations, who later participated as founders of wholly-new for-profit companies. (As very few female entrepreneurs were found in these samples of technical entrepreneurs, the male pronoun will be used in the

remainder of this article in referring to the entrepreneurs.)

Structured interviews with a detailed questionnaire, lasting typically one to two and one-half hours, were used to gather data from each entrepreneur personally, with telephone interviews used in less than ten percent of the cases and mailed interviews used only as a last resort in less than one percent of the cases. Some interviews stretched to seven or eight hours over two or three sessions! Despite extensive efforts to include all spin-offs from each source organization studied, no doubt some minor bias has crept into the sample of companies studied in that it is likely that any companies not located were less successful than those traced. The bias did not prevent many companies from being found and studied that were clearly failures or not very successful.

Answers to the detailed questionnaires led easily to the quantification of information. Most all of the answers were coded and arranged in computer data files. Incomplete information on some of the companies does not particularly affect the data analysis as relevant codes were given to isolate missing information.

THE INITIAL CAPITAL BASE

Amount and Source

Many entrepreneurs begin their companies with a minimal amount of initial capital and often find their operations hampered by a shortage of capital. Other entrepreneurs, perhaps wiser or just monetarily more fortunate, raise substantial funds before beginning their ventures and have their operations proceed relatively free of financial constraints.

Figure 2 presents the distribution of initial capital of 113 new technology-based companies spun-off from MIT departments and laboratories.

INSERT FIGURE 2 ABOUT HERE

Twenty-three percent of these companies (26) were begun with funds of less than one thousand dollars. Almost half began with less than $10,000. Only twenty-two percent (25) began with funds equal to or in excess of fifty

thousand dollars, of which the vast majority (20 out of 25) began operations on a full-time basis.

A separate sample of new companies, the 38 spin-off firms from a large electronic systems company, had similar initial funding: 18 percent with less than one thousand dollars; 42 percent with less than $10,000; only 18 percent with more than fifty thousand dollars. And twenty three spin-offs from a large technologically diversified corporation had somewhat higher but still small average startup equity of $67,000.

In regard to initial funding the consumer-oriented manufacturing firms we studied also had modest beginnings, over half of them starting with less than $10,000. Rather remarkably, clusters of companies incorporated ten years apart experienced the same distribution of initial capital, with a median of $15,000. The precise amounts of initial capital for 154 companies in our samples ranged from zero dollars for several firms to one company's $900,000. Close to half of these firms started on a part-time basis. Of 52 firms begun on a part-time basis that provided financing data, 58 percent started with less than $10,000 while only 38 percent of the full-time operations began with so little.

As reported in Table 2 personal funds of the founders were the primary sources used to finance the start of over seventy percent of these companies, and family and friends were key contributors to the start of an additional five percent. These percentages were consistent across all subgroups of MIT

INSERT TABLE 2 ABOUT HERE

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spin-off companies, as well as those from a large electronic systems company and from a sample of entrepreneurial firms whose early years were carefully assessed. Similar personal or "close" sources funded 20 out of 23 companies spun-off from a large diversified corporation, as well as 80 percent of the consumer-oriented manufacturers. The other companies were begun through funds obtained primarily from private investors or "angels", venture capital firms or non-financial corporations at which the founders worked, with a few funded by the public stock market. We found these same two sources, the founders themselves and private investors, to be the dominant initial financiers of a sample of 21 companies which were carefully

evaluated for later funding by one venture capital firm we studied.

Those starting on a part-time basis were even more likely to use their own personal funds to finance the early years of the company. (Query, not answerable from the data: Is the direction of causality here really the other way? Did the lack of outside capital support force the entrepreneur to utilize his own limited personal resources and thus restrict him to starting on a part-time basis only?)

As anticipated in the discussion above no equity capital was supplied by commercial banks, but bank credit came early and frequently into these companies. Many of the companies had early sales by contract to government or large industrial organizations, and the banks often granted loans to these firms, attaching the contract payments as security.

In Table 3 the amounts of initial capital and their sources are shown in detail for 110 new enterprises. The specific amounts of money provided by the various categories of investors are obviously incidental to the specific time periods at which these companies were incorporated and to some extent to the specific industries in which they were involved. New biotechnology companies, not included in this sample, would for example typically generate far more initial capital than new software firms, of which several were in this sample. But what is more important and persistent over time and industry in my experience are the relative distributions of which sources are actively involved at the outset of new technical firms, and which ones provide more rather than less amounts of capital.

INSERT TABLE 3 ABOUT HERE

The figures in Table 3 demonstrate empirically what might have been assumed beforehand: In the relatively few cases where money was obtained through "outside" forms of financing (those sources other than the founders or their families or friends), those sources provided far greater average amounts (.000). Of twenty-six firms begun with funds from outside sources, twenty had initial capital equal to or in excess of $50,000. Of eighty-five companies funded by personal or "close" money, only five were begun with comparable amounts. Similar patterns were found in each of our research clusters. For example, among the enterprises being assessed by a venture

capitalist for "step-up" funding, those which had initially been self-financed had started with considerably less initial capital (an average of $90,000) than the companies funded by private individuals (an average initially of $215,000) (p=0.02).

The primary reason for this difference is understandable. The amount of money that the founders and their associates have is limited by the fact that these are personal funds. Indeed some of the founders did have a healthy personal stake from the sale of previous ventures, e.g., 5 of 21 self-funded spin-offs from the MIT Instrumentation Lab, to cite an extreme case. But most entrepreneurs used only accumulated savings from past earnings, not from sales of prior companies. The "outside" financial sources by their nature have a much greater supply of money available for investment in a technological entrepreneurial startup.

The more basic question of why some entrepreneurs sought out and received funds from outside sources and why other entrepreneurs either did not seek or did not receive initial outside capital cannot be answered simply. Some more insight will be provided in analyses of venture capitalist decision-making that will be carried out later using our database. But three possible answers to this question are apparent and all somewhat applicable: (1) The need did not exist. (2) The desire for outside funds did not exist. (3) The entrepreneurs were unable to obtain outside funds.

Analyses below will demonstrate that the need for initial funds varies significantly among new enterprises as a function of their industry and type of business, and indeed size of founding group, among other influences. Clearly, many firms did not need outside financing. At the opposite end of the spectrum, the general interviews and our several specific studies of venture financing did reveal many failed attempts at raising capital by entrepreneurs who ended up using only personal or family and friends funding. Some entrepreneurs did not know how to go about seeking outside funding and used their own monies as a default.

However, other entrepreneurs knew of the more formal sources, might well in our judgment have been successful in gaining outside commitments, but chose not to. Some entrepreneurs want little or no equity financing at the outset because they wish to retain a maximum amount of ownership and

control. They often seek primarily debt from outside sources, resulting usually in relatively small loans because of the founders' limited net worth. Then, in order to cope with the constraints of their limited funds, the entrepreneurs gear their operations to reduce their need for funds, e.g., they render a service instead of producing hardware or they tend to engage in custom-oriented development and production that can be contracted with larger firms or government agencies. The contracts provide advances and/or progress payments that minimize additional financial requirements. One small study provided statistical support for this explanation, demonstrating that the entrepreneurs who initially preferred debt to equity tended to finance the companies themselves (0.015) and had lower initial capitalization (0.11).

But several of the self-financing entrepreneurs seemed rather less rational and more emotional in their emphatic opposition to sharing the profits of their labors and their ideas with others "who did nothing more than provide money"! Not understanding that initial capital for a high-technology company is a very risky investment, such entrepreneurs repeatedly cite venture capitalists as "vultures" who want something for nothing. Underlying this rather naive and often angry opposition, and also involved with many other aspects of financing, are a complexity of motivations that I cannot even attempt to explain.

On occasion, naivete about sources of finance produced unusual problems, as in the case of one firm financed by a group of "bookies" who had funds available due to a temporary crackdown on bookmaking activities. The bookmakers wanted their money back three years later, just when the enterprise really needed the funds to finance expansion. As a result this company literally was forced out of business.

The data analyses reveal that those individuals with the greatest amount of commercial work experience started their companies with more initial phase capital financing (.08). These individuals, by virtue of their more extensive familiarity with the industrial and financial community, were probably more aware of venture capital sources and how to approach them successfully. Their greater experience no doubt also provided some modicum of comfort to the investors. Not necessarily in conflict with this finding is that a significant fraction of entrepreneurs coming out of MIT labs and

departments felt their previous association with MIT had aided their capital seeking efforts.

Initial Capital and the Number of Founders

The number of founders can influence the amount of initial capital both directly and indirectly. As the number of founders increases more personal funds are available from which to draw money. This has a direct effect in that over seventy percent of the companies we studied were financed initially by personal funds. Indirectly, the more founders there are, the greater possibility that one of them knows a receptive "outside" source. Furthermore, multiple founders are likely to reflect a more substantial intended undertaking, e.g. product development and manufacture rather than just research or consulting. This implied need for greater funds both generates and justifies its supply. And the larger team is itself likely to be more impressive to outside sources, partly explaining our research finding that outside sources are more willing to invest in multi-founder companies.

Table 4 presents the initial capital amounts associated with the number of founders of 109 companies. The largest proportion of companies which began with less than $10,000 (62.5%) was in the group of one-founder companies. In general the larger the number of founders, the less the occurrence of financing under $10,000 and the greater the occurrence of funding in excess of $50,000.

INSERT TABLE 4 ABOUT HERE

We carried out separate analyses of the companies begun primarily with the entrepreneurs' own funds and those started with others' funds. Nearly half of the firms founded by a single individual using his own money began with less than $1000. In the founder-funded firms greater amounts of initial capital were provided as the number of founders increased. (Tau=0.19, p=.03) (Indeed, when Jack Pugh and I co-founded our consulting firm, Pugh-Roberts Associates, Inc., we each invested $1000!) Looking across the entire sample of companies, at each size of founding group the average amount of funds supplied by others was greater than the average supplied by the founders themselves. All but six of twenty-six companies which obtained funds primarily from others were started by multi-founder teams. And for

outsider-funded firms, the same finding holds that the number of founders and the amount of initial capital received are positively related. (Tau=0.23, p=.08)

Initial Capital and Specific Plans

Not all the entrepreneurs had specific plans for their companies when they decided to start them. Twenty-four of fifty-three entrepreneurs (45%) who responded to questioning indicated that they had neither specific short term nor long term plans at the beginning of their companies. With no specific plan considerable investment is not necessary. The Alice in Wonderland adage applies here: If you don't care where you are going, any path will get you there. Nor is an investment likely to be attracted from an outside professionally managed financial source when the nature of the future work is so uncertain.

In Table 5 the amounts of initial capital for twenty-nine firms started with specific plans are compared with the amounts for twenty-three firms started without specific plans. Seventy-four percent of those without

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INSERT TABLE 5 ABOUT HERE

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specific plans started with less than $10,000 whereas only 24 percent of the companies with specific plans were formed with so little funding. Furthermore, 38 percent of the companies begun by founders with specific plans received funding in excess of $50,000 while only 9 percent of the companies lacking specific plans had so much initial capital. Clearly entrepreneurs with specific plans raised more initial capital than those without plans. (.001)

As might be expected from the discussion thusfar the more institutional sources of financing are much more inclined to support ventures which have a specifically planned future. Table 6 shows that ten of twelve companies which received other than personal or "close" funding had specific operational

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plans at the start. Clearly investors see firms with plans as better bets. In

addition the entrepreneurs who prepared detailed plans no doubt foresaw needs for greater capital and went out to get it.

The two companies in this cluster that received outside funds despite lack of specific plans are special exceptions. One was founded by several MIT employees who had been left without work when MIT abandoned its atomic energy research. These founders along with nearly ninety other MIT employees engaged in the same work formed a company without specific goals, but backed strongly by private investors, an investment that is easily understood. The other situation involved a new company formed from the division of a larger corporation, spun-off in its entirety due to rising costs. The venture was backed by a public stock issue generated by the parent company. Excluding these two unique cases only companies with specific plans obtained money from the more sophisticated sources of financing.

Initial Capital and Product Initially

Information gathered from 110 firms indicated that forty-seven (43 %) of them were based on specific products that had already been developed or which the entrepreneurs planned to develop immediately. A firm dependent upon a product needs capital, whether for product development or production facilities or market launch. Such a firm would have difficulties getting operations underway without substantial capital. Since the sixty-three other firms in this grouping did not have a product or immediate product objectives, they needed considerably less initial capital to get going.

Table 7 displays the amount of initial capital for forty-three companies that had a product or specific product plans initially and for fifty-nine companies that did not. The group with initial products were initially

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INSERT TABLE 7 ABOUT HERE

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financed to a greater extent. (.02) This situation is driven statistically by the fact that twenty-one of these firms without product began with less than $1000, while only three companies with products had similarly small initial funding.

A product-oriented company's capital requirements do vary according to

the nature of the product, its stage of development, development requirements, its production process, as well as the demand for the product. Among 21 firms in one of our samples those with a "proprietary" product (the combination perhaps of "specific plans" and a product orientation!) had significantly higher initial capitalization ($200,000 on average) than those without a proprietary product ($129,000) (.07). But it is doubtful that capital required would ever be much less than $1000. Indeed each of the three product-oriented firms listed in Table 7 that had begun with less than $1000 was in the process of developing its first product, making its meager funding slightly more understandable.

The distribution of initial capital within the group of spin-offs that began without a product is readily explainable. Many of these companies were initially engaged in activities such as technical consulting or computer programming. Little or no financing was needed to start them. Others were involved with work such as systems design and development, which required capital primarily to support technical personnel and equipment. Here capital needs varied, depending on the size of work to be done. There is a bit of the chicken-versus-egg issue here. In some of these cases companies that had problems in raising initial outside capital had already abandoned their earlier intentions and started to do things that were not capital-intensive. Thus lack of available initial capital often influenced the apparent lack of "initial" product orientation!

No significant differences were observable in the sources of capital for both groups. Thirty companies (70 percent) formed around a product were financed by founders or close associates, while thirteen generated other funds. Fifty-one companies (82 percent, slightly more than the above group) without an initial product focus were funded by founders or family or friends, while eleven received funds elsewhere.

Amount by Needs and Type of Business

Table 8 presents responses from 107 entrepreneurs who ranked their needs for capital. They contain wide variances that reflect the types of business entered. In hardware production capital is first needed for product development, then for production facilities and working capital. Software companies need working capital for their technical personnel payroll and to

finance their accounts receivable (A/R), but they also need funds for computer equipment and for product development work. Firms performing contract research and development (R&D) exhibit needs for lab equipment, product development, working capital and production facilities. Even individual consultants need funds for lab equipment and to fund development work.

INSERT TABLE 8 ABOUT HERE

None of the groups found that either marketing expenses or production and clerical workers placed a stress on their capital needs. The technological enterprise unfortunately displays typically little emphasis on marketing. Also the Boston area labor market, relevant to most of the firms studied, has been especially efficient until recently in terms of a new company's ability to find both skilled and semiskilled hourly workers.

Given the differences in specific needs how do the capital requirements vary in amount by type of business? The consultants and the software houses required the least capital; nearly 80 percent of them were capitalized initially at less than $10,000. Indeed, one software entrepreneur started his company on $700 he received from selling his automobile. At the opposite extreme were the hardware production firms, but even here 84 percent were capitalized at under $50,000. This relatively modest figure is explained in part by the fact that sixty percent of those companies were started on a part-time basis. Most of the companies found that their initial funds were insufficient to support their growth during their early years. Sixty percent of the companies sought capital a second time and nearly half sought funds a third time, but this will be discussed in more detail in later writings.

SUMMARY

This article has presented an assessment of the capital market for technology-based firms, focusing upon the links between the stages of evolution of a firm and the investment preferences of various capital sources. The review of these factors led to an expectation that initial capital will be supplied most frequently by the entrepreneurs themselves from their own savings, secondarily by their families and friends and by private investors, all these being sources of capital outside of the formal channels. More

substantial but still initial funding from rather unique "wealthy family funds", special "seed" funds and somewhat more conventional venture capital funds were expected to be the primary complements of the informal sources.

The data from our studies of technological firms support these expectations, while also providing evidence of the usual small initial capital base (almost half with less than $10,000) and the dominance of personal savings as the principal source of initial capital (74 percent of the companies). "Outside" sources of capital are responsible for the larger initial investments when they occur. As listed in Table 9 larger amounts of initial

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INSERT TABLE 9 ABOUT HERE

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capital are both contributed and raised by the larger groups of co-founders, especially when the founders are involved in the companies from the outset on a full-time basis. Specific plans for the company are associated with greater initial capitalization, as well as with raising outside capital, as is also true for the effect of having an initial product. The needs for initial capital vary enormously by amount and intended use as a function of the type of business being started, with consulting firms and software companies requiring far less than hardware developers and producers.

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Figure 1. Investment Timing Preferences of Capital Sources

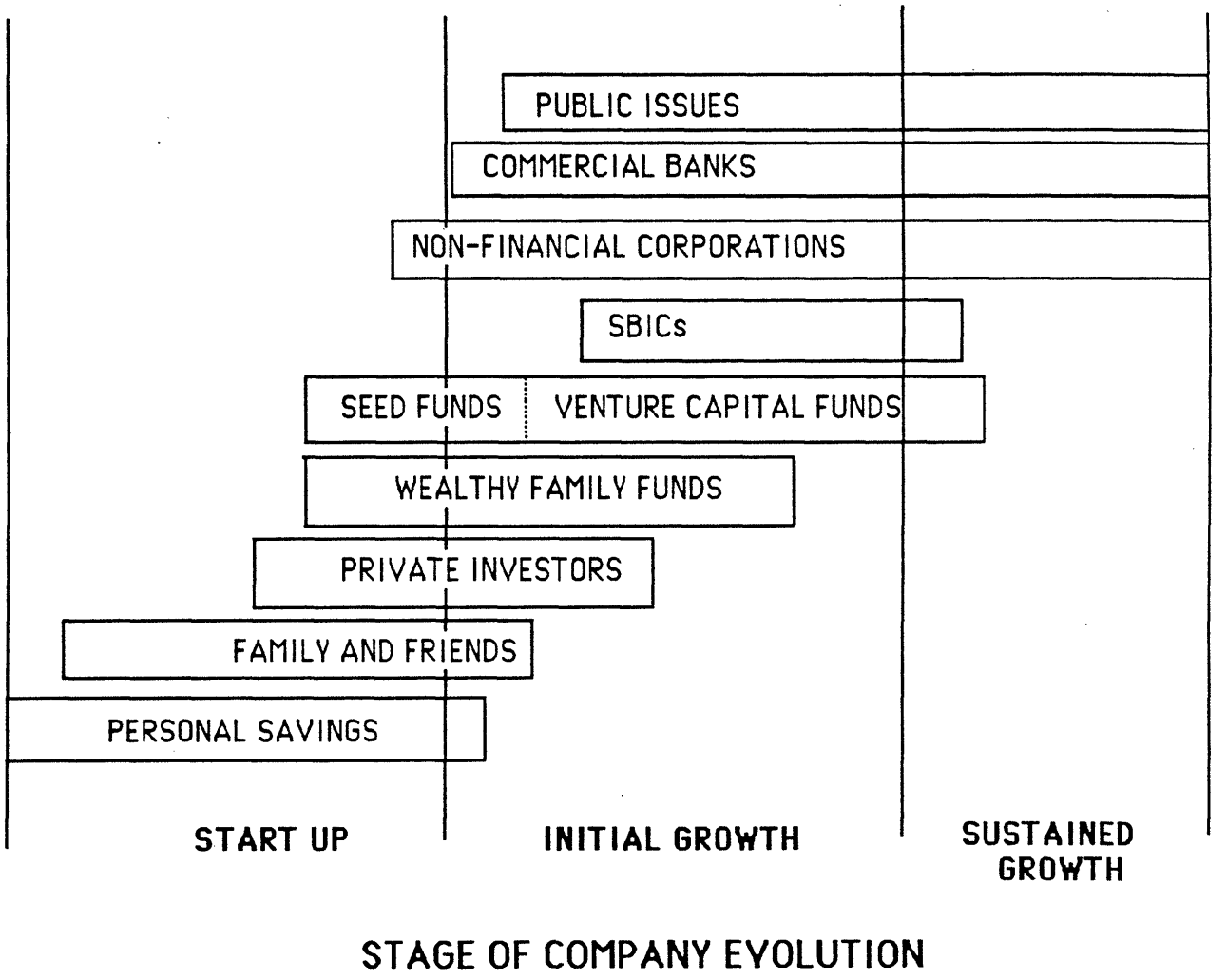

Figure 2. Amount of Initial Capital (113 MIT Spin-off Companies)

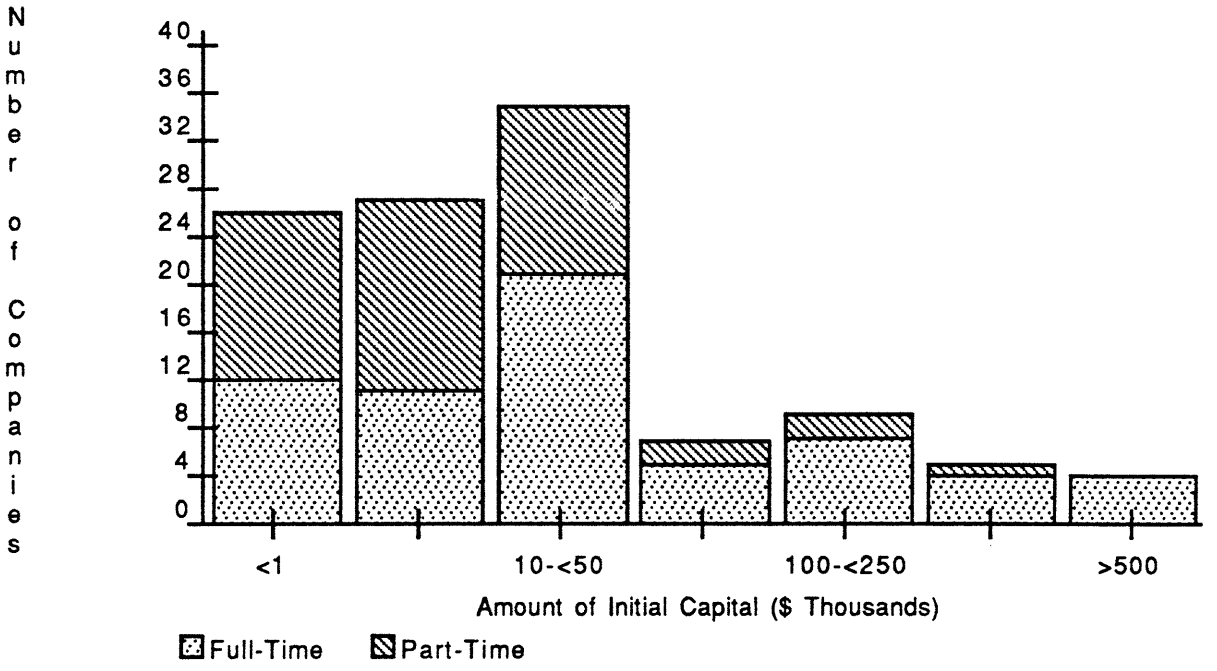

Table 1. Data Sources for Financing Study of New Technological Enterprises*

Sources of New Enterprises	New Companies Identified	Participants in Research Study
MIT major laboratories (4 studies)	107	96
MIT academic departments (5 studies)	74	60
Air Force Cambridge Research Laboratory	16	15
MITRE Corporation	5	5
Electronic systems company	45	39
Diversified technological company	58	23
Totals	305	238

* Among my former research assistants and thesis students who contributed importantly to this phase of research were E.K. Bender, E.F. Briskman, F.L. Buddenhagen, H.A. Cohen, D.A. Forseth, J. Goldstein, D.R. Hall, M.W. Klahr, D.H. Peters, J.C. Ruth, C.L. Taylor and P.V. Teplitz, as well as my former research associate Herbert A. Wainer.

Table 2. Primary Source of Initial Capital (154 companies)

Source	Number of Companies	%
Personal Savings	114	74
Family and Friends	8	5
Private Individual Investors	11	7
Venture Capital Funds	8	5
Non-Financial Corporations	9	6
Commercial Banks	0	0
Public Stock Issues	4	3
Totals	154	100

Table 3. Amount of Initial Capital by Source (110 companies)

	Amount of Initial Capital ($ thousands)							
Source	<1	1-<10	10-<50	50-<100	100-<250	250-<500	≥500	Total
Personal Savings	22	27	27	1	3	0	0	80
Family and Friends	1	0	3	1	0	0	0	5
Private Investors	0	0	2	2	3	1	0	8
Venture Capital Fnds.	0	0	0	2	2	3	1	8
Non-Financial Corps.	1	0	2	1	1	1	2	8
Commercial Banks	0	0	0	0	0	0	0	0
Public Stock Issues	0	0	0	0	0	0	1	1

Table 4. Amount of Initial Capital by Number of Founders (109 companies)

Number of Founders *	Amount of Initial Capital ($ thousands) *						
	<1	1-<10	10-<50	50-<100	100-<250	250-<500	≥500
1	17	8	11	1	3	-	-
2	2	10	9	2	1	2	-
3	3	5	10	-	1	1	2
4	1	4	1	1	1	-	-
5	1	-	2	1	1	1	-
6	2	-	-	1	-	1	-
7	-	-	-	-	1	-	1
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	1

* Kendall Tau= 0.25, p= 0.01

Table 5. Specific Plans for the Company and Amount of Initial Capital
(52 companies)

Initial Capital ($ thousands)	Specific Plans Yes *	No *
< 1	4	7
1 -< 10	3	10
10 -< 50	11	4
50 -< 100	2	0
100 -< 250	3	2
250 -< 500	3	0
≥ 500	3	0

* Mann-Whitney U, p=0.001

Table 6. Specific Plans for the Company and Source of Initial Capital
(49 companies)

Source	Specific Plans Yes	Specific Plans No
Personal Savings	15	19
Family and Friends	2	1
Private Investors	3	1
Venture Capital Funds	3	0
Non-Financial Corporations	3	0
Commercial Banks	0	0
Public Stock Issues	1	1

Table 7. Product Initially and Amount of Initial Capital (102 companies)

Initial Capital ($ thousands)	Product Initially Yes *	No *
< 1	3	21
1 -< 10	12	13
10 -< 50	15	15
50 -< 100	2	5
100 -< 250	5	3
250 -< 500	4	0
≥ 500	2	2
Totals	43	59

* Mann-Whitney U, p=0.02

Table 8. Ranked Needs for Initial Capital (107 companies)

Type of Business	Aggregate	Hardware	Software	Contract R&D	Consulting
#	107	33	10	22	20
Rank					
1	Product dev.	Product dev.	Other	Lab equip.	Tech. personnel
2	Lab equip.	Prod. facilities	Tech. personnel	Product dev.	Lab equip.
3	Tech. personnel	Inventory	Lab equip.	A/R	A/R
4	A/R	Other	A/R	Prod. facilities	Development
5	Prod. facilities	A/R	Development	Tech. personnel	Inventory

Table 9. Initial Capital for the Technological Enterprise

Primary Sources of Capital:

Personal savings

Family and friends

Private individual investors

Larger Initial Capital Associated with:

Full-time, rather than part-time, commitment

Larger co-founding team

"Outside" initial investors

Specific plans for business development

Initial product available or targeted

Hardware focus, rather than software or consulting