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FINANCIAL CHARACTERISTICS OF NEW TECHNOLOGY-BASED FIRMS

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by

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BACKGROUND

This study of the financial characteristics of new technology-based enterprise was conducted as part of the Research Program in Entrepreneurship, cosponsored by the Bureau of Business Research of the Graduate School of Business Administration and the Industrial Development Division of the Institute of Science and Technology of the University of Michigan. The report was taken from a doctoral dissertation proposal, "Financial Characteristics of New Technology-Based Firms" and is the first in a series of reports focusing on the financial needs and sources of new technology-based enterprise. The series is designed to promote regional economic development through an understanding of small business formation and development. Additional working papers will follow and the dissertation will be published as a book by the Institute of Science and Technology.

ABSTRACT

The aim of this study was to investigate the financial needs and sources of new technology-based enterprise in the Detroit-Ann Arbor and Boston areas. For this purpose a model was developed to facilitate the description of the firms' financial characteristics, needs, and capital suppliers, and to permit explanations of differences in the financial support of these firms in the two areas. The literature was examined to develop support for the hypothesized relationships. In the continuing research, data will be gathered by means of official financial records, mail questionnaires, and personal interviews, and the hypothesized relationships will be tested empirically.

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I

INTRODUCTION

The economic potential of venture firms which exploit new technologies has been of considerable interest to the state of Michigan for some time. In 1959 the Industrial Development Division of the Institute of Science and Technology was formed to "strengthen the scientific and technical resources within the state in order to advance the growth of Michigan's economy."[1/]

The success of new technology-oriented firms in the Palo Alto, California and Boston, Massachusetts areas has been especially notable to those concerned with economic development in Michigan, and there has been some work done to quantify the spin-off phenomena in these areas. Edward B. Roberts of the Alfred P. Sloan School of Management at Massachusetts Institute of Technology has identified 218 spin-off firms in the Boston area, and of these 158 were directly traceable to MIT laboratories and academic departments. Estimates vary as to the number of spin-offs in the Palo Alto area, but one source estimates that 200 firms are doing $1 billion of

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[1/] Joseph J. Martin, Preface, in Technology Transfer, Innovation, and Marketing in Science-Oriented Spin-Off Firms, by Lawrence M. Lamont (Ann Arbor: Industrial Development Division, Institute of Science and Technology, University of Michigan, 1971).

business within a 50-mile radius of Stanford University.[2] Other areas where new technology-oriented business complexes have developed are Minneapolis-St. Paul and Los Angeles.

Although most of these complexes have developed in metropolitan areas where there are research-oriented universities nearby, the proximity of a university seems to be only one of many ingredients necessary to the success of these new firms. A Stanford Research Institute team studied six research and development centers (Boston, Los Angeles, Minneapolis-St. Paul, Denver, Tuscon, and Orlando, Florida). From these six, it identified four common factors that promote university spin-offs: "encouragement of key university officials, credibility of the enterprise, communication or access to information, and availability of financing."[3]

Similarly, the Denver Research Institute has suggested seven requirements that are necessary for the development of a scientific complex based on the spin-off process:

1. Individuals forming the spin-off firms must have knowledge of market opportunities.
2. Key men are needed to attract a sizable amount of research dollars.
3. Research performance must provide a wedge into newly emerging or growing areas of science and technology.
4. Adequate financing must be available for the new, inexperienced firm.

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[2] Edward B. Roberts, "Entrepreneurship and Technology" (unpublished draft of paper, 1966).

[3] Victor J. Danilov, "The Spinoff Phenomenon," Industrial Research (May 1969), pp. 56-57.

5. Low-cost incubator space (such as older buildings) must be available.
6. Research contracts must provide the initial income for most new firms.
7. An environment must be present which encourages small firms.[4/]

Despite the seemingly wide range of information about spin-off firms, very little is known about the financial needs of new technology-oriented venture firms formed during the last ten years in Michigan. Most of the recent research in the venture capital field has been concerned with either the personal characteristics of individuals who become entrepreneurs, the mechanism of technology transfer, or the preferences and investment activities of venture capital suppliers. No major systematic research on the supply-demand relationship for venture capital in technology-oriented venture firms has focused on venture firms themselves. It is not known whether technology-oriented venture firms in Michigan have venture capital support that is as extensive as that of firms in the geographic areas where the venture capital phenomenon has been notably successful. A more thorough understanding of the financial needs of technology-oriented venture firms and of their capital support will better enable Michigan public agencies and private capital sources to allocate their support to these firms. A comparison of the venture capital support for Ann Arbor-Detroit firms and that for particularly successful technology-oriented firms, e.g., those firms in the Boston area, will be made.

[4/] Ibid., p. 57.

This comparison will determine who provides support and under what conditions and should help show how venture capital support for Ann Arbor-Detroit firms can be changed to facilitate their growth more effectively.

II

PURPOSE AND OBJECTIVES OF THE RESEARCH

The purpose of the research that is being undertaken is to examine the capital needs and sources of technology-oriented venture firms to determine what their needs have been, who meets their needs, and under what conditions their needs are met. Then these findings will be compared for firms in the Ann Arbor-Detroit and Boston areas.

In line with the purposes of the research, there are four specific objectives:

1. Examine and compare the financial support characteristics for Boston and Ann Arbor-Detroit technology-oriented firms to show who provides support and under what conditions this support is given.
2. Describe the capital needs of Boston and Ann Arbor-Detroit technology-oriented venture firms to provide answers to the following questions:
   a. When in their lives do these firms need financial support?
   b. For what reasons do these firms need support?

c. How much financial support do these firms need?

3. Identify the reasons for differences between the capital needs and sources of firms in Ann Arbor-Detroit and Boston.

4. Examine how financial needs vary over the formative years of the new technology-oriented firms in Ann Arbor-Detroit and Boston.

III

RESEARCH DESIGN

The Model of Supply and Demand for Capital

The approach of the proposed research is to examine the actual sources of capital that have been used by venture firms and to determine the preferences of the venture capital suppliers on the basis of the characteristics of their past support of venture firms.

The research is directed toward the construction and testing of a model of the supply-demand relationship for venture capital of new technology-oriented firms in the Ann Arbor-Detroit and Boston areas (see Figure 1). The purpose of the model is to provide a structure to describe the parameters of the technology-oriented firms' characteristics, financial needs, and the investment preferences of the venture capital suppliers.

The model of the supply and demand for capital illustrates the variables that constitute the environment of a prospective

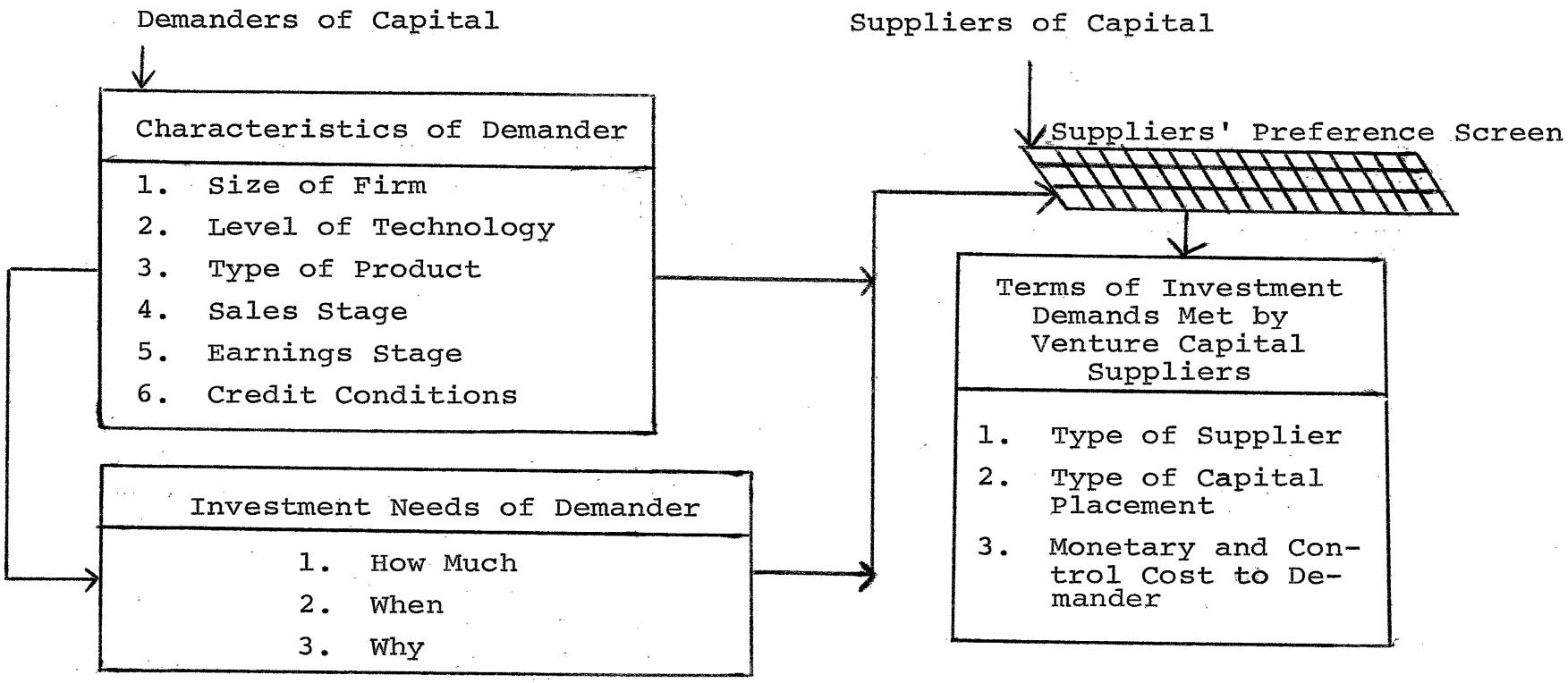

Fig. 1. Model of supply and demand for capital.

investment situation. The characteristics of demand are:

1. The credit conditions that exist at the time of the investment
2. The type of product of the firm
3. The newness of the technology embodied in the firm's products
4. The financial size of the firm
5. The stage in the firm's product development and sales history
6. The stage in the firm's earnings history.

It is hypothesized that these variables, which describe the demander in the supply-demand relationship, are related to the demander's investment needs: (1) how much capital is needed? (2) when is it needed in the firm's life? (3) for what purposes is it needed? These three need variables can be thought of as the parameters of the stage of financing, i.e., first, second, and third stage financings can be defined in terms of these three variables. The relationships between the six variables that describe demand characteristics and the three variables that characterize the venture firms' capital needs are an important part of this study.

Potential suppliers of capital have preferences for particular types of investments. They prefer investments in firms with particular characteristics, e.g., firms with positive earnings, and meeting particular investment needs, such as a certain size or range of investment sizes. Each venture capital source has a screening process (implicit or explicit)

by which he reviews investment proposals. An important objective of the proposed model is to determine whether the characteristics of the firms and their investment needs (as stated in the model) are relevant parameters of venture capitalists' investment screens. The investment demands that are met by capital suppliers are described by the type of capital supplier (personal sources, wealthy individuals, leasing, etc.), the monetary and control cost to the technology-oriented venture firms, and by the type of capital placement (equity, short-term debt, long-term debt, and combinations of these).

The model of supply and demand for venture capital describes the parameters of a venture capital investment decision. The research will entail the testing of hypotheses regarding the relationships between the variables of the model. There are four sets of hypotheses to be tested. The first set deals with the relationships between the variables that describe the firms' characteristics and the variables that describe the terms of investment demands that are met by capital suppliers. The second set examines the existence and direction of the relationships between the variables which describe the characteristics of the firms needing venture capital, such as product type, and the variables that describe the financial needs of the firms, i.e., those that define the stage of financing. The model also hypothesizes relationships between the variables describing the financial needs of venture firms and the terms of the investment demands that are met by capital suppliers. The fourth set of hypotheses concerns differences between venture

capital support of technology-oriented firms in the Ann Arbor-Detroit and Boston areas. For example, I expect to find greater institutional support (bank and insurance companies) earlier in the lives of Boston firms and for firms with a more varied range of investment characteristics than for Ann Arbor-Detroit firms.

The hypothesized relationships and the empirical support for each hypothesis found in the literature are discussed. Throughout this section the direction of the relationships between the variables that characterize the demanders of capital and the variables that describe the terms of investment demands that are met by venture capital suppliers (first set of hypotheses) will be shown diagrammatically and then discussed. The relationships between the characteristics of the demanders of capital and the parameters of their capital needs (second set of hypotheses) are not as readily illustrated but will be discussed in the text.

Characteristics of demand

The characteristics of demand describe the venture firm itself and the conditions of the capital market at the time it seeks capital. In the model each characteristic helps determine the parameters of the venture firm's capital needs and the type of capital supplier that meets the need, as well as the cost to the firm of the capital and the type of capital placement.

Credit conditions. The credit conditions that exist at the time of the capital need affect the availability of capital for venture firms. The relationships between credit conditions and terms of investment demands met by venture capital suppliers are shown diagrammatically in Figure 2.

Investment in new venture firms involves considerably more risk than investment in an ongoing firm. New venture firms face a greater risk of business failure, they have fewer marketable assets to provide as security in case of failure, and investments in new venture firms are less liquid, especially when failure threatens. When credit conditions are tight, interest rates are high, and credit is scarce, institutional support (commercial banks and insurance companies) for venture firms is very scarce. Public and private venture capital firms find their own credit scarce and find it necessary to channel what little additional funds they have to firms in their existing portfolios. The stock market offers good bargains in the public stock of existing venture firms and, as Mel Mandel has suggested, venture capitalists have been less supportive of new ventures during periods of tight credit such as existed in 1969 and 1970.[5/] When support from financial institutions and organized venture firms becomes scarce, venture firms, particularly new ones, are forced to rely more on personal sources, i.e., friends and relatives, and on wealthy individuals who are interested in speculative investments. When the general

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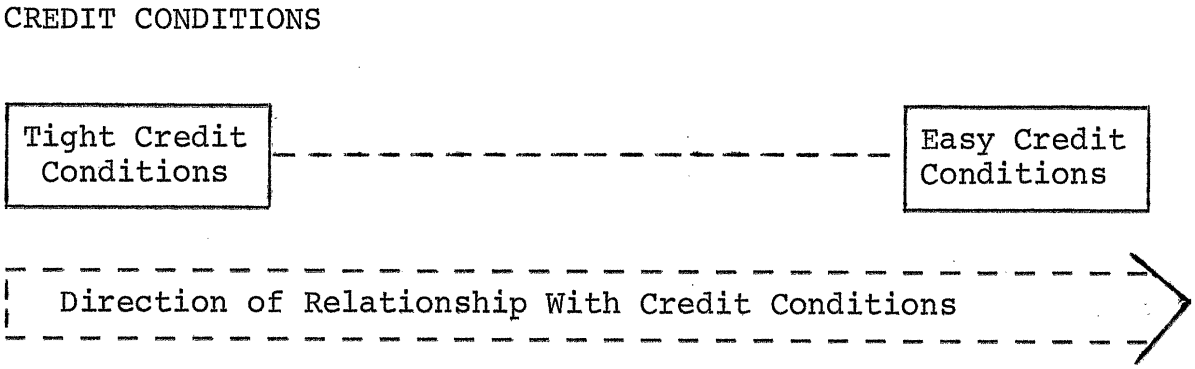
[5/] Mel Mandel, "When Venture Capital Dries Up," Innovation, XIX (March 1971), 16.



Terms of Investment Demands Met By Venture Capital Suppliers

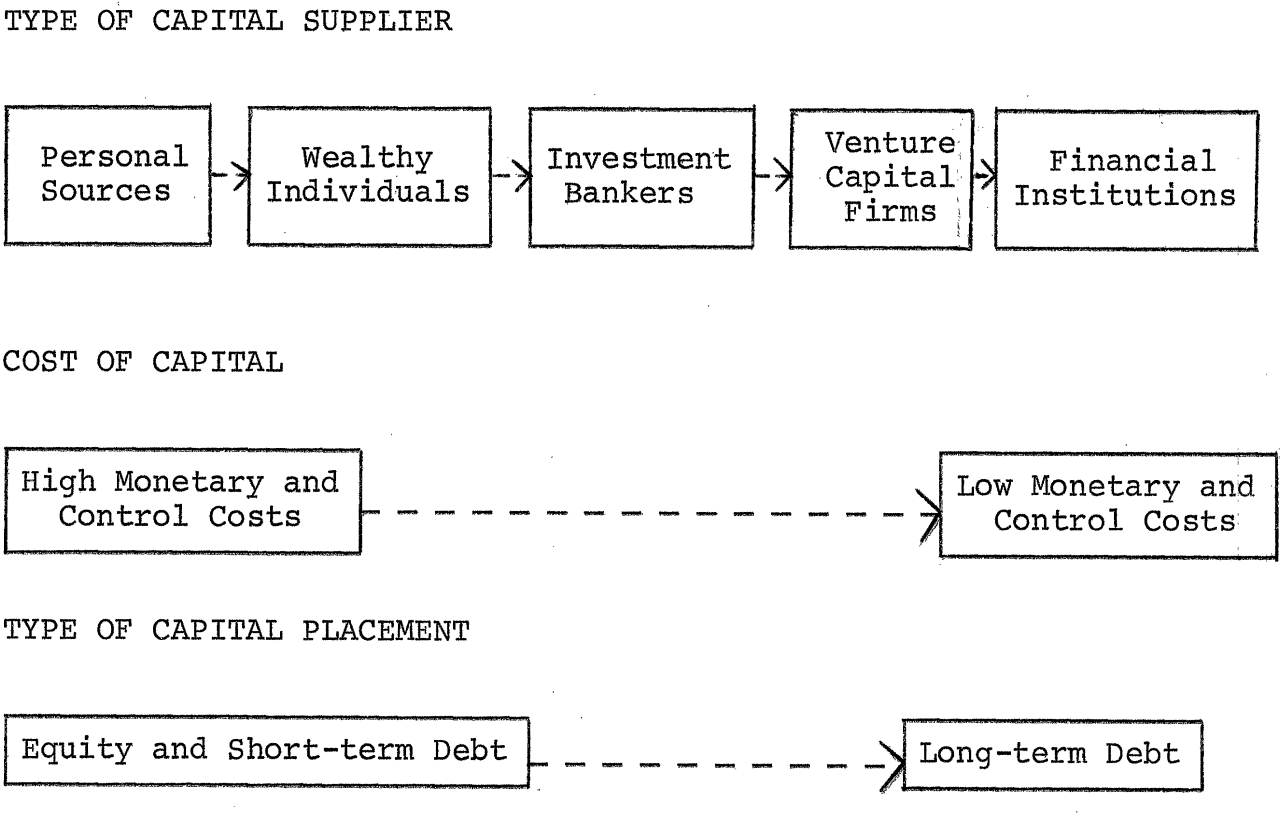


Fig. 2. Relationships between credit conditions and terms of investment demands met by venture capital suppliers.

interest rates are higher, the interest rate cost to venture firms can be expected to be higher. As venture firms turn to equity financing and to suppliers of capital that are more interested in equity than in debt, the bargaining positions of the firms deteriorate and they have to relinquish more financial control.

The model also hypothesizes relationships between credit conditions and the variables that describe the venture firms' financial needs at the time of the capital search. In the continuing research I expect to find that the financial needs of new technology-oriented firms are higher during periods of tight credit than during periods of easy credit because of the greater likelihood that they will experience working capital shortages. It also seems likely that unmet needs will be greater in periods of tight credit and that firms will seek short-term capital as opposed to long-term capital during these periods. Leasing as an alternative to purchasing plants and equipment is likely to be more common when credit is tight because of the scarcity of capital and its higher cost.

The relationship between the age of the venture firm at the time it seeks funds and the credit conditions that exist at that time will be particularly interesting. Much of the recent literature about financing of venture firms has touched on the problems that new "start-up" firms have had during the credit squeeze of 1969. Generally, it has been found that venture capital becomes very hard to obtain during periods of tight credit.

While numerous measures of credit conditions have been suggested, and each is more or less useful for different purposes, one of the most accepted measures of general credit conditions is the annual rate of change of the money stock. Using analyses of the annual rate of the money stock along with data for bank reserves and discounts, and the three-month treasury bill rate, I have designated the following as periods of either tight credit or easy credit.[6/]

Period	Credit Conditions
Jan. 1965 - Mar. 1966	Easy
Apr. 1966 - Jan. 1967	Tight
Feb. 1967 - Jan. 1969	Easy
Feb. 1969 - Feb. 1970	Tight
Mar. 1970 - July 1971	Easy
Aug. 1971 - Dec. 1971	Tight

Some of these periods were more tight or more easy than others, and the impact of the fluctuating credit conditions on different financial sectors varied. Nevertheless, I think that the above designations of relative ease or tightness of credit would generally be agreed upon by economists.

The characteristics and financial needs of venture firms and the terms of their capital supplies will be compared for the tight and easy credit periods. The same variables will be compared for the above periods lagged one to six months to

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[6/] Norman Bowsher, "How Fast is Money Growing," Federal Reserve Bank of St. Louis Review, LIII (June 1971), 4.

determine how the relationships hold for periods in which credit conditions for venture firms may lag behind the generally accepted periods of credit tightness or ease.

Product type. Three types of products are being considered--standard products, custom products, and R & D testing and consulting. Research has been conducted on the financial needs and support of venture firms that sell different product types. Chastain and DeVries found that new firms substituted leasing for long-term borrowing. R & D firms leased most of their land--72.8 per cent--and virtually all of their buildings and plants--95.2 per cent--while established manufacturing firms leased only 1 per cent of their buildings and plants and 2.4 per cent of their land. Of the nonleased capital that R & D firms had raised, 46.8 per cent was used to meet working capital needs. For new manufacturing and established manufacturing firms the percentages were 24.0 and 10.4, respectively.[7/] The advantages of leasing over borrowing and purchase were a faster rate of deduction for tax purposes, more capital budgeting flexibility, and freed working capital for other uses.

Chastain and Devries also found that new Michigan R & D and manufacturing firms received very little financial support from banks or insurance companies, and that new R & D firms were financed very heavily by equity capital held by personal sources and investment bankers.[8/]

[7/] Clark E. Chastain and Marvin G. DeVries, Financing in Michigan (Ann Arbor: Institute of Science and Technology, University of Michigan, 1966), p. 14.

[8/] Ibid., p. 6.

Lamont examined the technology transfer process and the marketing needs of Michigan technology-oriented firms and classified the firms as to product type in the same manner that will be employed in this model. He found that there was usually an evolutionary process whereby R & D firms tended to develop their products to custom products and later to standard products.[9/]

In a recent unpublished paper, Lamont and Melicher found that firms engaging in contract business (R & D and custom products) had a higher turnover of current and total assets than firms with proprietary products, and that contract firms did not seem to need as many fixed assets and as much inventory as did firms with proprietary products.[10/] Their conclusions are interpreted to lend support to the hypothesis that the type of the firm's product is related to the amount of its financial need.

On the basis of these results, I expect to find that the type of product is related to: (1) the type of financial supplier, (2) the monetary and control costs of capital, and (3) the type of capital placement. R & D firms rely more on personal equity, short-term loans, leasing of plant and equipment, and individuals interested in venture capital. Standard product firms rely more on long-term debt from institutional sources for the purchase of plant and equipment. The monetary and control costs of capital of the R & D firms are expected

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[9/] Lawrence Lamont, Technology Transfer, Innovation, and Marketing in Science-Oriented Spin-Off Firms (Ann Arbor: Institute of Science and Technology, University of Michigan, 1971), p. 50.

[10/] Lawrence M. Lamont and R. W. Melicher, "The Life Cycle and Financing Requirements of Small Technology-Based Firms" (unpublished paper, University of Colorado, 1970).

to be higher than the costs of capital of the standard product firms because of the greater risks that R & D firms entail. The hypothesized relationships between product type and terms of investment demands met by venture capital suppliers are shown in Figure 3.

I also expect to find that:

1. The type of the new technology-oriented firm's product is related to the reason for the financial need. Working capital becomes more important for R & D firms, and plant and equipment needs become more important for standard product firms.
2. The type of product of firms is related to the size of the firms' financial needs. R & D firms have smaller needs than custom product firms, which in turn have smaller needs than standard product firms.
3. The type of product is related to when the firm goes to the capital market; firms that are developing rapidly from R & D products to standard products are more likely to seek capital earlier in their lives than firms that are developing more slowly.

Newness of technology. All of the venture firms to be studied in the continuing research will be firms whose products are technological in nature. Real estate and mineral development firms will not be included. Of the firms selected for the study, some will produce products that embody newer technology than others. I suspect that the newness of the technology is

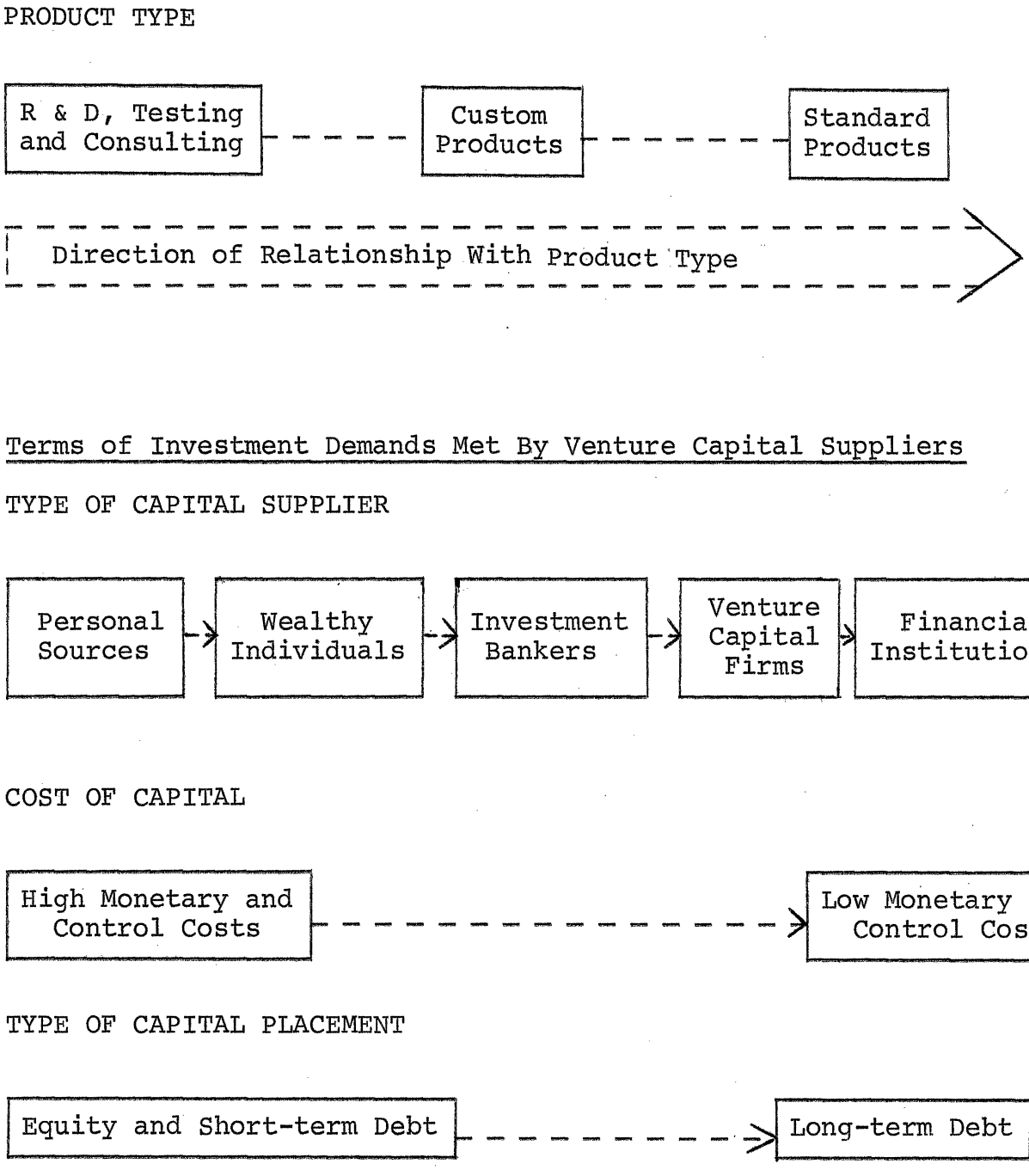


Fig. 3. Relationships between product type and terms of investment demands met by venture capital suppliers.

related to the level of perceived risk by the venture capitalists, and that newness of technology will therefore be related to the suppliers of capital of the technology-oriented venture firms. Firms attempting to exploit new technology may entail higher risks to investors since their technology has not been proven, nor is there likely to be a developed market for their products. Financial institutions are likely to be more averse to these risks than other potential venture capital suppliers. Commercial banks are not able to take equity positions in the firms, and thus are unable to participate in the firms' large profit potentials. Wealthy individuals in higher tax brackets may be more willing to accept the higher perceived downside risks of equity investments in newer technologies because any personal loss incurred is tax deductible and is therefore often limited to as little as 30 per cent of the actual loss. Potential personal suppliers of capital are often in a better position to evaluate the new technology, e.g., professional colleagues of the founder, than any of the other sources. The hypothesized relationships between newness of technology and terms of investment demands met by venture capital are diagrammed in Figure 4.

There is little in the literature that deals with the effects of the newness of the firm's technology on the firm's financial needs, and it is not clear, a priori, how the newness of the technology is related to the variables that describe the parameters of the venture firm's financial needs. I suspect that newer technology firms go to the capital market

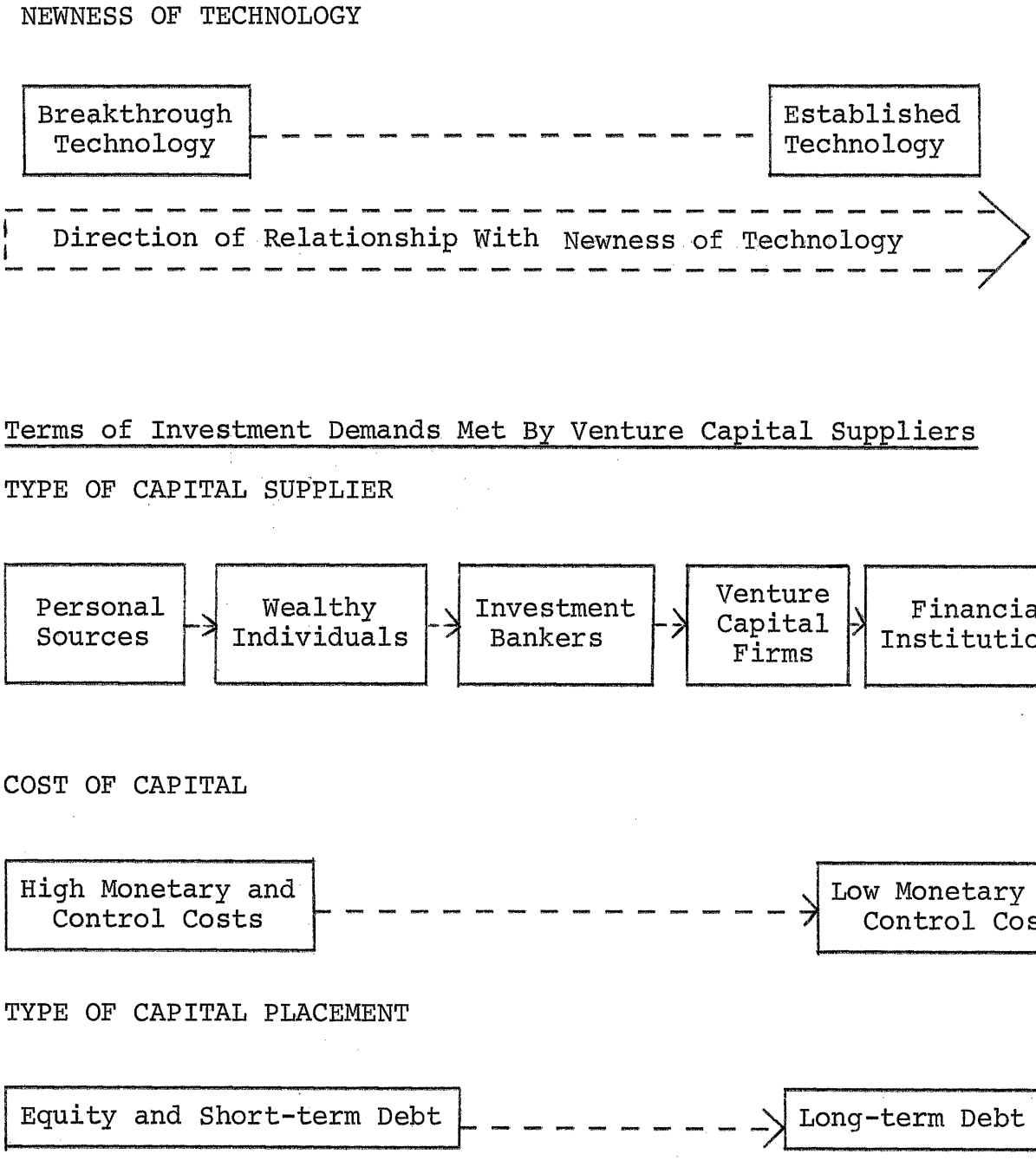
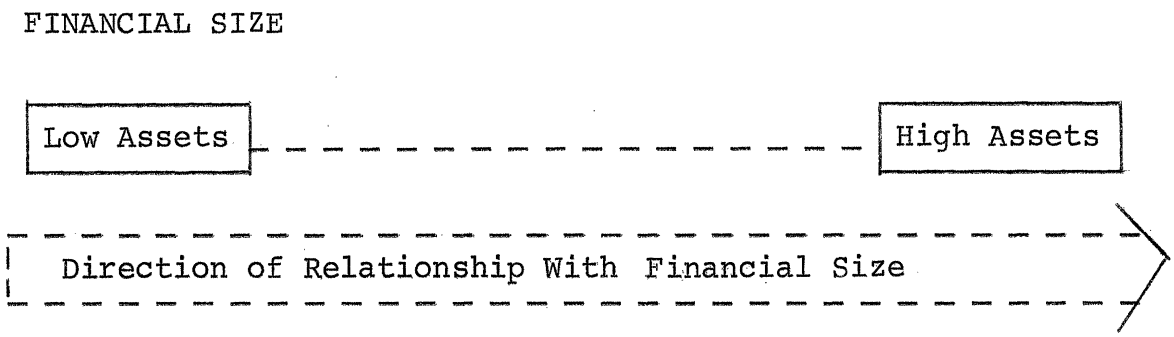


Fig. 4. Relationships between newness of technology and terms of investment demands met by venture capital.

for smaller amounts and at later times in their lives, but this may be more a function of their relative sizes and their different growth patterns. The relationships between the newness of the firms' technologies and their growth in size, sales, and earnings need to be further examined. The firms in the study will be categorized by industry, and the relationships between the firm's industry and its financial needs and the variables describing the terms of its financial supply will be examined in the continuing research.

Financial size of the firm. I expect to find that the size of the venture firm is related to its type of financial suppliers, to its cost of capital, and to the type of capital it receives. The size of the firm will probably affect the risk perceived by venture capital suppliers; the institutional suppliers are more likely to be risk averse and less likely to provide capital to the smaller venture firms. Personal sources, private individuals, private venture captial firms, and investment banks are more likely to provide this support on an equity and short-term debt basis. The hypothesized relationships between financial size and terms of investment demands met by venture capital suppliers are shown diagrammatically in Figure 5.

The relationships between the size of the firm and the parameters of its financial needs seem readily apparent. The larger the financial size of the venture firm, the larger will be its financial needs when it goes to the capital market. This may be explained by the larger actual needs of the larger firms, the fact that these firms are able to raise more money



Terms of Investment Demands Met By Venture Capital Suppliers

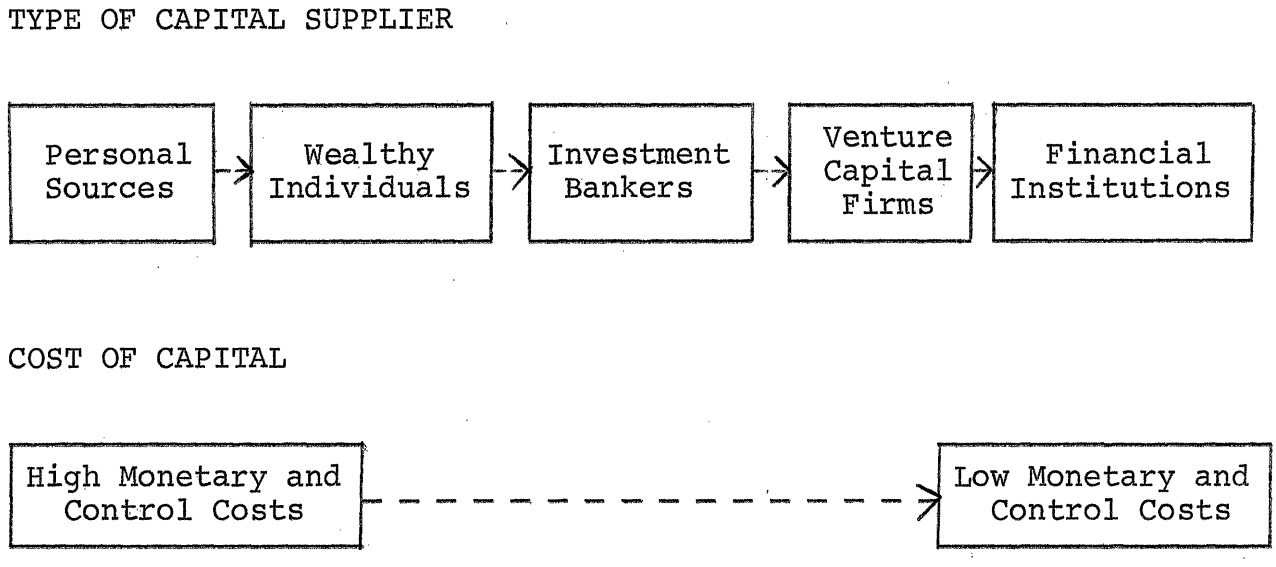


Fig. 5. Relationships between financial size and terms of investment demands met by venture capital suppliers.

in the capital market, or more likely a combination of the two. The unmet needs of venture firms of different sizes will be examined closely to determine what the actual differential needs of various-sized firms are. The differential frequency with which firms of varying sizes go to the capital market will also be closely examined to determine whether the differential needs are exhibited by more frequent trips to the capital market for smaller amounts, or by less frequent trips for larger amounts.

Sales and earnings stages. One of the most prevalent idiomatic expressions in venture capital literature is "track record." Venture capital suppliers appear to have a strong preference for firms that have shown accomplishment. Sales and earnings are the variables used in this model to represent accomplishment.

Lamont and Melicher divided their 37-firm sample into three age groups--one to two years, three to six years, and seven to twelve years--and computed the mean and median sales for each group. They found that venture firms' sales behave over time in a pattern similar to that found by Mahar and Coddington (see Figure 6).[11/] They concluded that it was during the third to sixth year that venture firms' sales begin to grow rapidly, and that the first few years of a firm's life were devoted primarily to product development. Lamont and Melicher calculated three sets of financial ratios which measured the firms' liquidities,

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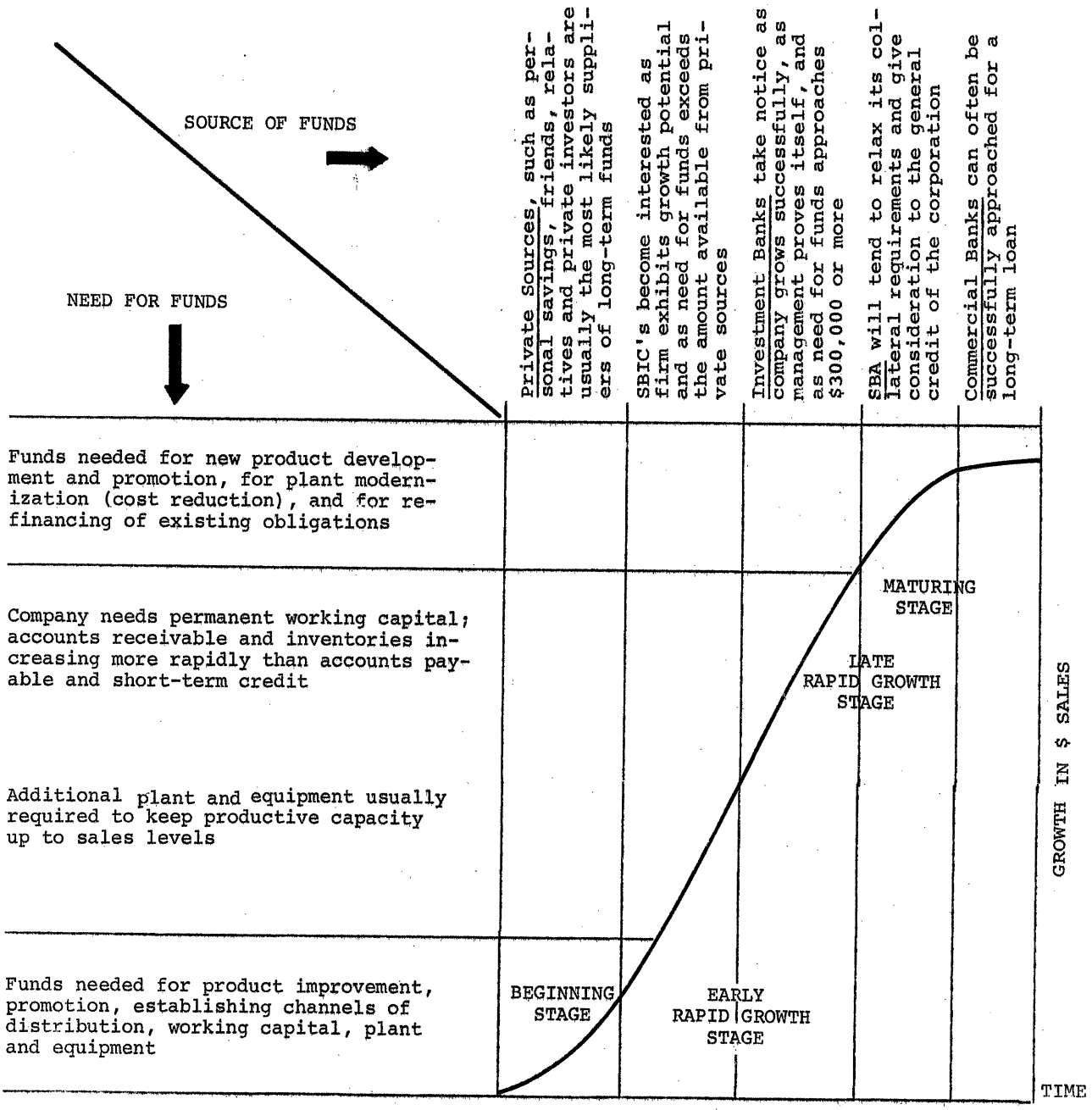
11/ James F. Mahar and Dean C. Coddington, The Financial Gap--Real or Imaginary (Denver, Col.: Denver Research Institute, University of Denver, 1962), p. 17.



Source: James F. Mahar and Dean C. Coddington, The Financial Gap--Real Or Imaginary (Denver, Colo.: Denver Research Institute, University of Denver), Figure 1, p. 17.

Fig. 6. Need versus availability of long-term funds related to typical growth curve.

efficiencies, and leverages. Their explanations of the variation in these ratios between the three age groups can be interpreted to support the hypothesis that sales and the amount of capital needed are related. They found that firms three-to-six-years old had significantly higher turnovers of current assets and total assets than did firms one-to-two-years old, and they interpreted this fact to indicate that the firms in the age group which had the most sales growth (three to six years) experienced the greatest financial needs.[12/] They also found that firms in the three-to-six-year age category (the age category of rapid sales growth) had significantly lower liquidity ratios; this was interpreted as a reflection of their increased need for higher levels of inventory, accounts receivable, and cash as their sales grew rapidly. It was in the second year that firms began to feel the financial pressure of product development and market development costs. The higher turnover of current assets and of total assets for the three-to-six-year firms can be interpreted as an indication of a need for a greater amount of capital as sales increase rapidly. The higher leverage ratios of the three-to-six-year-old firms can be interpreted to mean a more ready acceptance of these firms by such debt capital sources as financial institutions and by the more conservative venture capital firms.[13/]

The findings of Mahar and Coddington are also especially relevant to the model used in this research. They found that

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[12/] Lamont and Melicher, "Small Technology-Based Firms," p. 5.

[13/] Ibid.

personal sources were most important during the beginning sales stage of the firm and that as sales increased, venture capital firms such as SBICs and investment bankers became available sources of funds. This could be expected when the probable levels of risk at each sales stage are fitted to the probable relative risk aversions of the venture capital sources. They also found that the reason for the capital need and the amount that was needed was related to the stage of the firm's sales (see Figure 6).[14/]

New technology-oriented venture firms usually begin operations without a standard marketable product and usually incur operating losses early in their lives. What is important is the stage in the firm's product development and sales history rather than the level of sales itself. I suggest three threshold points in the firm's development of its product and its sales growths that are related to the firm's financial needs and to the preferences of venture capital suppliers. The first threshold is the development of a working product prototype. The first prototype may be developed within a few months of the venture firm's start-up or, in the case of a firm begun as an R & D firm, may occur years later. The second threshold is the beginning of sales of a standard product. Sales of a standard product would indicate to venture capital suppliers that the firm has found a market and is capable of generating a cash flow to sustain future operations. The first two thresholds in the firm's life define two periods for the firm—from start-up

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[14/] Mahar and Coddington, The Financial Gap, p. 17.

to first product prototype and from first product prototype to first sales. The third period in the firm's sales history is the stage of rapid growth of sales. These three stages correspond roughly to the first three stages of Mahar and Coddington's model. Lamont and Melicher found that the rapid growth stage was followed by a leveling off in sales in the seven-to-twelve-year period.[15/]

The second two stages of the sales variable are only relevant for firms that eventually develop standard products. R & D and custom product firms that do not evolve into standard product firms never go beyond the first stage. For these firms the sales volume will be used as the first measure of their track records. The direction of the relationships between the product and sales stage variable and the variables that describe the terms of investment demands met by venture capital suppliers are depicted in Figure 7.

The relationships between the earnings stage variable and the variables describing the venture firms' financial needs as well as the terms of the investment demands that are met should be similar to the relationships for the sales stage variable. Two stages in the earnings history are hypothesized as important—the stage of operating losses and the stage of operating profits. They are separated in time by the break-even point. The firm's attainment of its break-even point indicates its ability to sustain itself in business. This event should have the result of reducing the risk that is perceived by venture

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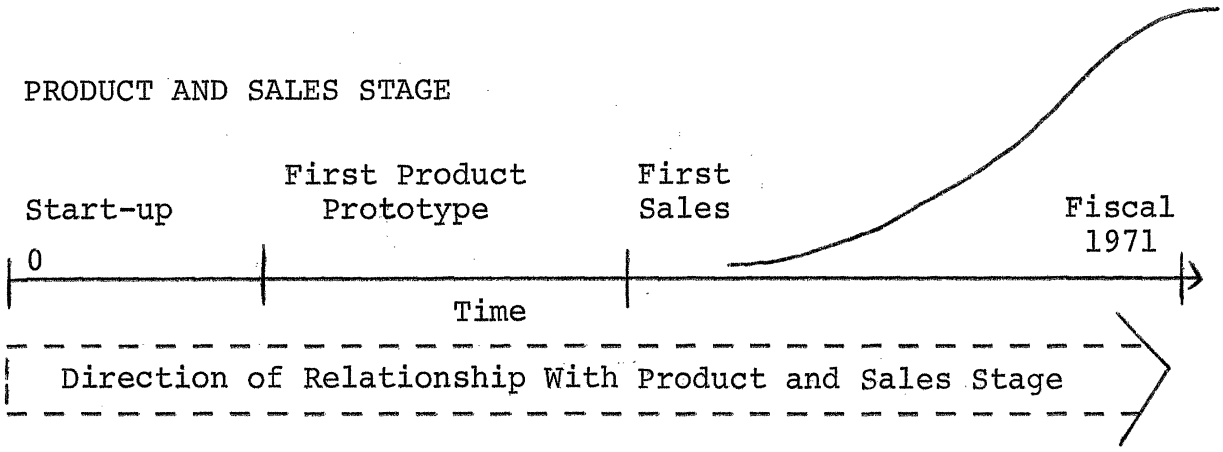
[15/] Lamont and Melicher, "Small Technology-Based Firms," p. 7.



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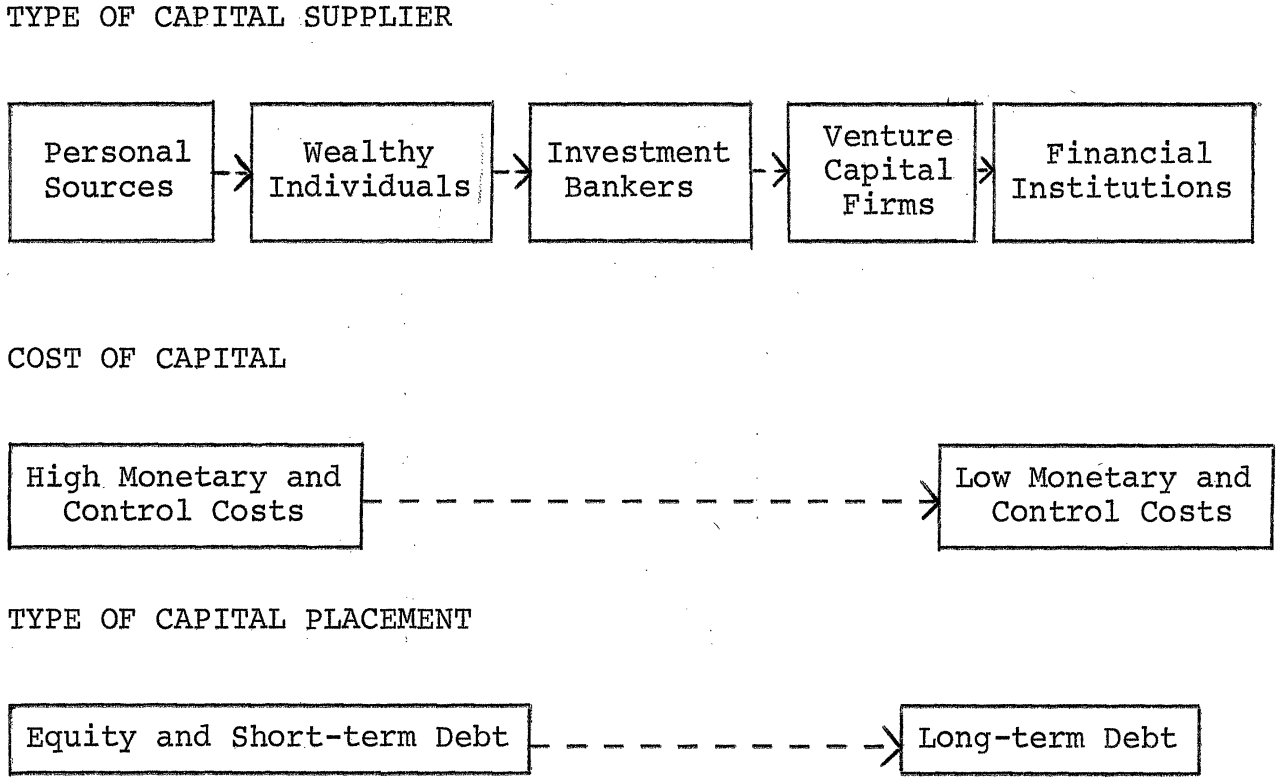
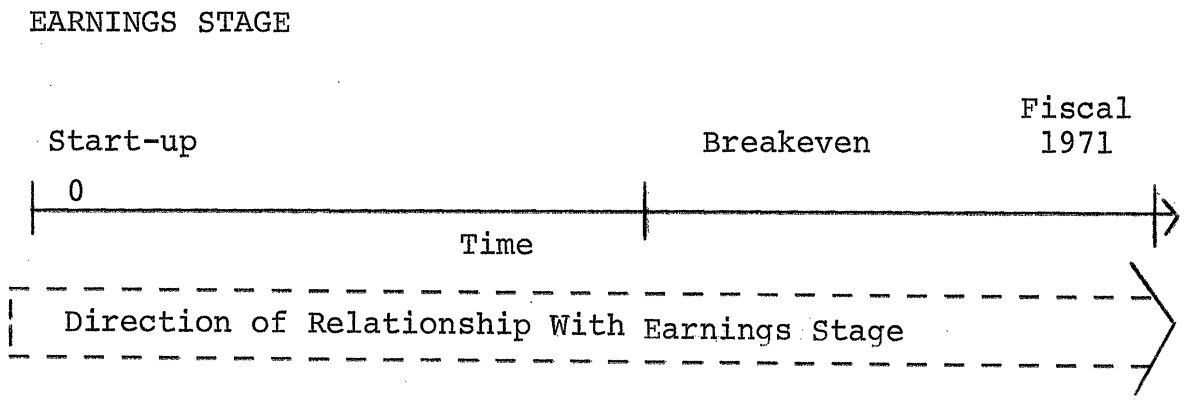


Fig. 7. Relationships between product and sales stage and terms of investment demands met by venture capital suppliers.

capital suppliers, reducing the cost of obtaining capital, and lengthening the period during which suppliers are willing to commit themselves. The hypothesized relationships between earnings stage and terms of investment demands met by venture capital suppliers are shown in Figure 8.

Investment needs of the high-technology firm. The preceding discussion has been concerned with the relationships between the variables that describe the venture firm at the time it seeks capital and the variables that describe its capital needs and the terms under which its investment needs are met. In the third set of hypotheses the model suggests that venture capital suppliers have preferences for firms with certain capital needs and that the venture firms' capital needs are related to the type of capital supplier who meets the needs and the cost of capital to the firm.

It is hypothesized that the amount of capital the venture firm needs is related to the type of supplier that provides the capital. Personal sources meet smaller capital needs while venture capital firms and financial institutions meet larger needs. The relationship between leasing as a source of capital and the amount of capital needed depends mainly on the item that is being leased. I suspect that leasing has been used in a wide range of amounts and that the decision to purchase or lease land, plant, and equipment is related more to the availability and cost of capital for purchasing and to the characteristics of the firms themselves than to the amount of capital needed.



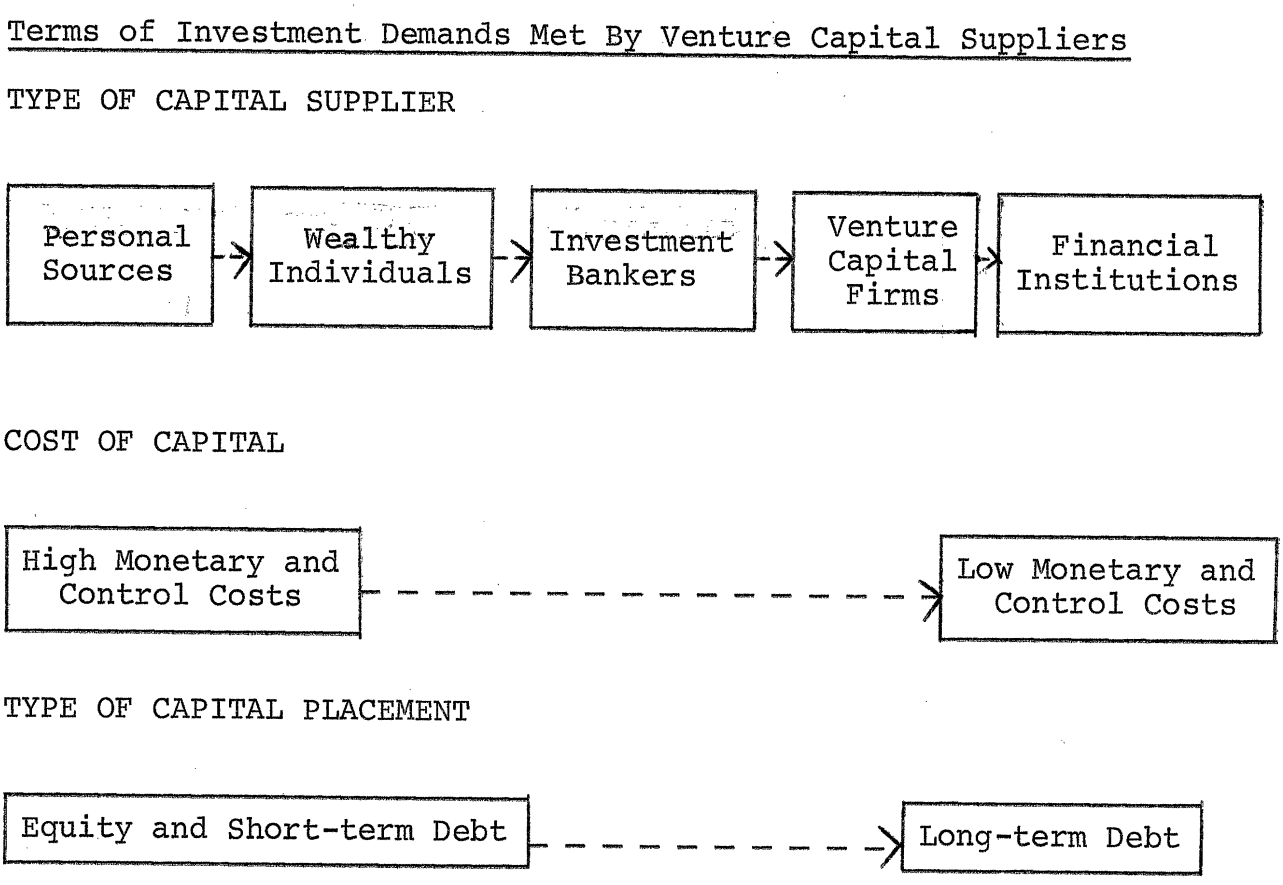


Fig. 8. Relationships between earnings stage and terms of investment demands met by venture capital suppliers.

The model also indicates relationships between the firm's age when it goes to the capital market and (1) the type of capital supplier used, (2) the cost of the capital, and (3) the type of capital placement. Much of the research in the venture capital field has used the age of the venture firm to explain variations in the capital needs and suppliers of funds. Since many of the characteristics and needs of venture firms follow similar patterns during their lives, age can serve as a composite measure of many other variables such as size and sales. However, firms differ in their timing of variables such as size and sales, and an explanation of what happens to these firms during their early years as well as how this affects their financial support should increase the understanding of their needs and their support more than an explanation based solely on age. The primary purpose of the research is to accomplish this by testing the model empirically. Through further research I expect to find that personal sources are used to meet the very early capital needs of venture firms by means of equity and short-term debt placements, and that these are followed in time by individual venture capitalists, then by private and public venture capital firms, and finally by financial institutions with long-term debt. Leasing is used early and becomes less important as the firm ages. The monetary and control costs of capital are high early in the firms' lives and become less high as the firms age. Figure 9 diagrams the relationships between the age of the venture capital firm and the type of capital suppliers, the costs of capital, and the type of capital placement.

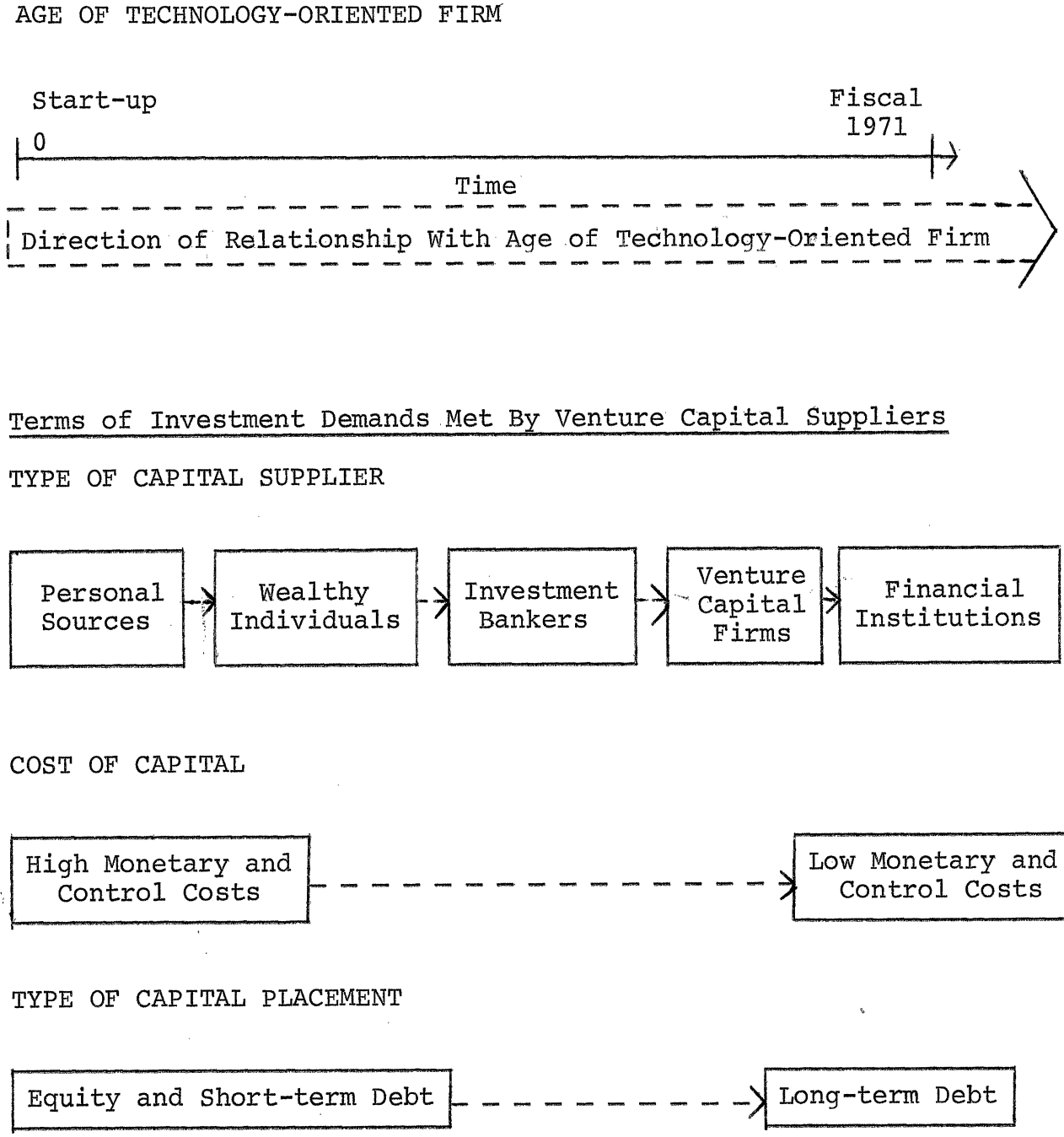
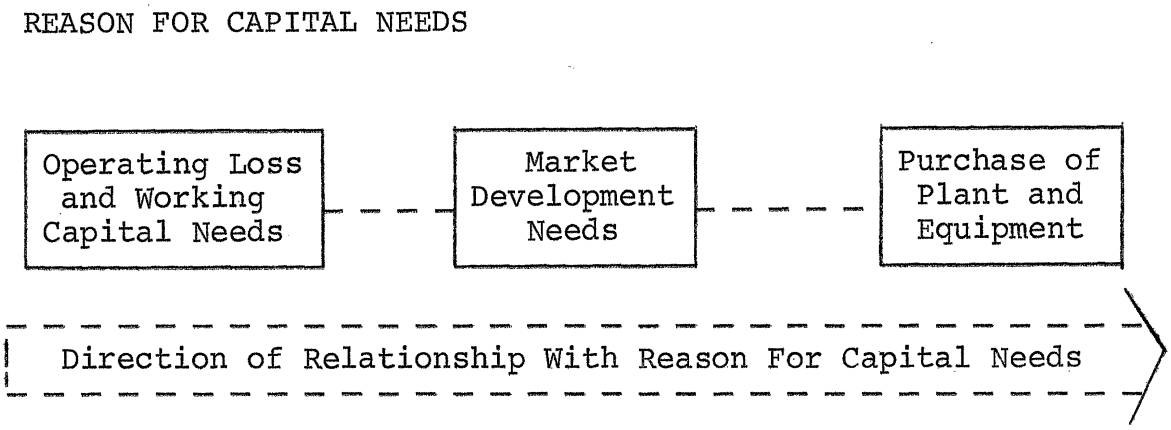


Fig. 9. Relationships between age of the technology-oriented firm and terms of investment demands met by venture suppliers.

I also expect to find that the reason for the capital need is related to the type of capital supplier used and the type of capital placement. Leasing is used primarily for fixed capital needs, while personal sources and individual venture capitalists are used to meet organization costs, product development costs, and early working capital needs. Venture capital firms provide equity and short-term debt to meet early production costs, working capital needs, and the cost of developing markets. Financial institutions are used to meet later working capital needs with short-term debt, and for purchasing plant and equipment with long-term debt. The hypothesized relationships between the variables that describe the reason for the capital need and the type of capital supplier, the costs of capital, and the types of capital placement are shown in Figure 10.

The fourth set of hypotheses deals with the differences between the characteristics and financial needs of the technology-oriented firms and the terms of their venture capital supplies in the two geographical regions. While there is very little evidence to support hypotheses concerning the direction of differences between the characteristics and financial needs of technology-oriented firms and the terms of their venture capital support in the two areas, there does appear to be more organized venture capital support for these firms in the Boston area than in the Ann Arbor-Detroit area. For instance, there are eight SBICs in the Boston area, compared to two in the Ann Arbor-Detroit area. I expect to find that the Boston area technology-oriented firms receive more support from SBICs and



Terms of Investment Demands Met By Venture Capital Suppliers

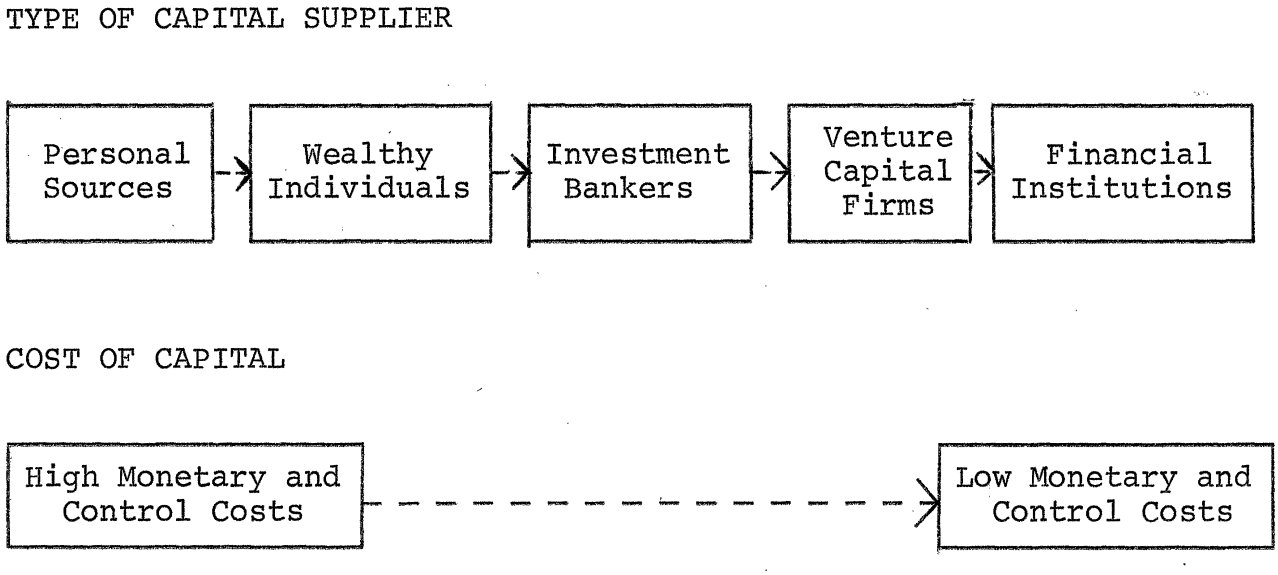


Fig. 10. Relationships between reason for capital need and terms of investment demands met by venture capital suppliers.

private venture capital firms earlier in their lives and with less of a track record than do Ann Arbor-Detroit firms. There is some evidence from personal discussions and from the literature that Boston commercial banks play a larger role in venture capital than do Ann Arbor-Detroit banks, primarily in the form of referring venture firms to venture capital resources in the Boston area.[16/]

Conceptually, the model herein is a descriptive supply-and-demand model. The major difference between this and the traditional supply-and-demand model is that this model represents an attempt to explain the reasons behind supply and demand, as well as its level. The first and third sets of hypotheses deal with the supply side of the venture capital relationship, i.e., who supplies capital to technical ventures and for what capital needs they supply it. The second set of hypotheses deals with the demand side of the relationship, i.e., who needs venture capital, when they need it, how much they need, and why they need it.

IV

FUTURE RESEARCH

This research will be continued and the model will be tested empirically. Recent financial histories of approximately 50

16/ Claude E. Rogers, "The Availability of Venture Capital for New Technically-Based Enterprises" (unpublished Master's thesis, Massachusetts Institute of Technology, 1966), p. 33.

technology-oriented firms in the Ann Arbor-Detroit and Boston areas that incorporated during the years 1965-70 will be examined. Data will be gathered from Dun and Bradstreet reports, the firms' incorporation papers and Michigan franchise tax reports, public security issue prospectuses (for those firms that have had a public issue), a mail questionnaire, and follow-up interviews.

The analysis will consist of a series of cross-tabulations of the data that measure the variables of the model for each fiscal year since each firm's incorporation. Nonparametric statistical tests will be applied where they are appropriate and where the sample cells are large enough. The relationships between the variables will be isolated by standardizing the cross-tabulations for differences in the other variables and then will be compared between the two geographic regions.

Conclusions will be drawn concerning the validity and relevance of the relationships hypothesized in the model based on inductive judgments gathered through interviews as well as nonparametric tests of the relationships that are measured quantitatively. The analysis will concentrate on the circumstances of each firm's capital financings and on the sequence of events that occurred during each year of the firm's existence. Conclusions will also be drawn concerning the differences between the tests of the model's relationships in the two geographic areas. The purpose of the analysis will be to determine the direction of the relationships between the characteristics and

financial needs of technology-oriented venture firms and the terms of their investment demands that are met by venture capital suppliers, and to compare differences between venture capital needs and support for Ann Arbor-Detroit and Boston technology-oriented firms.

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