Venture Capital Funds Management: Portfolio Selection, Operation, and Control

By: **Terry Dorsey**

Date: 1979

Abstract:

A two-phase model for venture capital portfolio selection and management is presented. The portfolio selection phase of the model, based on data collected in a 1974 study of 140 venture capital firms and 368 venture capital investments, permits the computation of an investment multiple and a target rate of return, both of which are adjusted for two types of risk. These values can be used to measure the profitability of a potential venture capital investment and evaluate its acceptability for inclusion in the venture capital portfolio. The second phase of the model builds on the first to develop a managerial methodology for assessing the progress of venture capital funds performance relative to stated multi-goals and for identifying sources of performance failure.

Keywords: venture capital; funds management; finance

Institute for Constructive Capitalism Technical Series no. 2

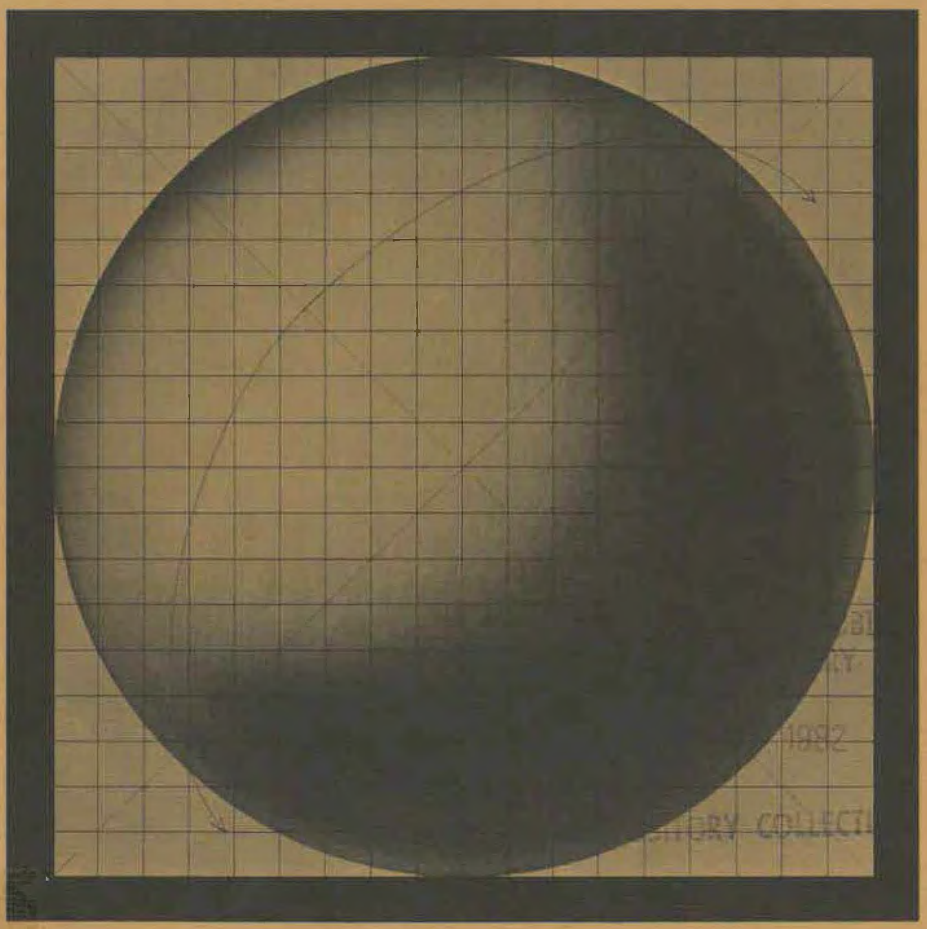
THE UNIVERSITY OF TEXAS AT AUSTIN

IC² Institute, The University of Texas at Austin
http://ic2.utexas.edu

TWO

VENTURE CAPITAL FUNDS MANAGEMENT

By Terry Dorsey



TECHNICAL SERIES

The Institute for Constructive Capitalism
The University of Texas at Austin

VENTURE CAPITAL FUNDS MANAGEMENT:

PORTFOLIO SELECTION,

OPERATION, AND CONTROL

by

Terry Dorsey*

*Terry Dorsey is a financial consultant with the Chase Information Group, a subsidiary of the Chase Manhattan Bank, and holds a Ph.D. in the management of technology from the University of Texas at Austin.

ABSTRACT

A two-phase model for venture capital portfolio selection and management is presented. The portfolio selection phase of the model, based on data collected in a recent study of 140 venture capital firms and 368 venture capital investments, permits the computation of an investment multiple and a target rate of return, both of which are adjusted for two types of risk. These values can be used to measure the profitability of a potential venture capital investment and evaluate its acceptability for inclusion in the venture capital portfolio. The second phase of the model builds on the first to develop a managerial methodology for assessing the progress of venture capital funds performance relative to stated multi-goals and for identifying sources of performance failure.

VENTURE CAPITAL FUNDS MANAGEMENT

PORTFOLIO SELECTION, OPERATION, AND CONTROL

For the venture capitalist, whose primary objective is capital gains, commonly used investment-selection techniques like net present value, net terminal value, or internal rate of return may not prove satisfactory. The investor, who thinks of himself as being in "the capital gains business," generally expects the gains realized on the sale of an equity position after a holding period of several years to be his sole source of investment profitability. Therefore, a valuation method that measures the profitability of the original investment in terms of a multiple to be realized after a stated period of time is appropriate.

The first section of this paper presents a model for computing this multiple. The product of the multiple and the amount of the original investment is the value which that investment position must attain within a stated time horizon to warrant selection for the venture capital portfolio.

The second part of the paper builds on this model to develop an operational methodology that enables the funds manager to evaluate the actual performance of investments in a venture capital portfolio in relation to portfolio performance objectives. The portfolio manager is thus able to assess the likelihood of achieving portfolio objectives, identify sources of performance failure, and take corrective action if necessary.

I. PORTFOLIO SELECTION

Investment Objectives and Portfolio Return

The venture capital valuation model presented here is based on three explicit assumptions of portfolio performance as well as certain empirically-derived parameters of profitability. Investments in a venture capital portfolio can be classified in three groups: 1) those which result in substantial losses of invested capital; 2) those which are essentially "break-even" situations but which lock up significant amounts of capital due to investment illiquidity; and 3) those which produce positive investment returns. The portfolio valuation and selection model developed here recognizes the relative contribution to overall portfolio performance made by each of these three investment categories.

The model incorporates the following performance objectives and the assumed or estimated values of these objectives:

1. The overall rate of return desired from total invested funds (r).
2. The maximum proportion of invested capital which will be lost (μ).
3. The minimum proportion of invested capital which will meet objectives for individual investment situations (β).

Using these goals as well as other empirically-derived parameters, we are able to compute the target, risk-adjusted rate of return (r_s) that

those investments constituting the profitable proportion of the portfolio should achieve in order to meet overall portfolio objectives.

The model is weighted for two types of risk. The first arises from actual capital losses. The second type of risk occurs whenever an investment position proves to be unprofitable, and either actual capital loss results, or a "break-even" situation occurs in which case neither profit nor significant loss is realized upon liquidation. This risk is the loss of return on investment of unprofitable, illiquid capital and is equivalent to the opportunity cost of foregoing investment in more profitable situations.

A venture capitalist may stipulate that for a $500,000 position in a venture to be successful as an investment, its value must increase 2.5 times within seven years, to $1,250,000; this is equivalent to a 20.02% compound annual increase in value. The desired investment multiple, IM_i, as well as the desired compound annual growth in value, r_i, are computed in the following manner:

(1) $IM_i = V_i/C_i = (1 + r_i)^n$, and

$r_i = \sqrt[n]{IM_i} - 1.0 = \sqrt[n]{V_i/C_i} - 1.0$, where

r_i = the compound (or geometric) rate of return on security i,

IM_i = the desired investment multiple on security i,

C_i = the original amount of the investment position (at cost)

$V_i = C_i \times IM_i$ = the desired value of the investment position at the end of the holding period, and

n = the holding period of the investment stated in years.

Note that the value r_i is the geometric mean return. Francis and Archer write: "The geometric mean return over n periods has the virtue that when compounded, it equals the ratio V_n/V_o at the nth period."[1] In the above formulation r_i is the geometric mean rate of return, while IM_i is equivalent to the ratio described by Francis and Archer.

In a recent study of venture capital firms and investee ventures by the Diebold Group, 140 venture capitalists were asked to state multiples which their original investment positions would have to achieve within 5 years in order to meet their objectives.[2] The responses of the 110 firms which replied are summarized in Table I.

Table I shows the number of firms whose investment objectives fell within the indicated range of multiples. The average multiple value is 4.6; this translates into an average, target rate of return of approximately 35.69%.

Venture capital portfolio objectives should not be confused with objectives for single investments. While investment returns do, in aggregate, constitute portfolio return, other factors tend to offset positive investment returns and thus diminish overall portfolio returns. Three such factors are capital losses from unprofitable investments; the proportion of total capital invested in unprofitable (or marginal) situations and thus unavailable to make positive contributions to portfolio performance; and the costs of servicing portfolio investments. To be considered adequate, the return from an investment position should make positive and sufficient contributions toward: 1) recouping capital

TABLE I

INVESTMENT OBJECTIVES OF 110
VENTURE CAPITAL FIRMS

Investment Objectives: Multiple of Original Investment, To Be Achieved Within Five Years	Equivalent Annual Rate of Return	Number of Firms in Each Category
0 - 2.49X	0 - 20.00%	29
2.50X - 4.99X	20.01% - 37.91%	23
5.00X - 7.49X	37.99% - 49.59%	42
7.50X - 9.99X	49.63% - 58.46%	0
9.99X+	58.46%+	16
Average 4.6X*	Average 35.69%	Total 110

* The average investment multiple was computed by adding the actual responses given by investors and dividing by the number of responses. The ranges given in the table were compiled from single values for each respondent. The average equivalent annual compound rate of return was derived in the same manner.

losses; 2) offsetting returns lost through investment of capital in losing or break-even situations in which the lack of liquidity prohibits investment in more profitable situations; 3) portfolio management costs; and 4) achieving overall portfolio objectives. The impact of these factors are examined next in depth.

For purposes of this paper--the following assumptions are made:

1. The portfolio becomes fully invested at the beginning of the holding period.
2. Holding period requirements for all investments are equal.
3. Annual portfolio management costs remain constant. All management costs are paid at the end of the holding period.
4. All investments assume the form of equity and/or debt instruments with no provision for periodic interest payment. However debt instruments may be convertible into equity, and they may be discounted at the time of investment so that upon maturity receipt of par value permits receipt of interest income.

The above assumptions are made to simplify the mathematical formulation developed below. Relaxing these assumptions would significantly increase the complexity of the formulation while only marginally improving our understanding of the parameters that shape venture-capital profitability. Thus a minor amount of validity has been sacrificed to gain a significant amount of mathematical simplification.

The contribution to portfolio performance made by each investment, as well as overall portfolio performance, is stated by the following:

$$(2)\quad \sum_{i=1}^{z} C_i(1 + r_i)^n - n\,S = V(1 + r)^n,\quad \sum_{i=1}^{Z} C_i = V$$

where

C_i = the amount of capital invested in investment situation i;

r_i = the compound or geometric rate of return achieved by investment i;

n = the investment holding period requirement, in years;

S = the annual cost of managing the venture capital fund;

V = the total amount of venture capital which is invested; and

r = the desired annual compound rate of return for the entire portfolio.

The value of the portfolio at the end of holding period n equals $V(1+r)^n$. This consists of initial invested capital plus gains made by successful investments minus: 1) losses from investment in loss situations and 2) total cost of servicing the portfolio during the life of the portfolio.

For the purposes of convenience, assume that investment situations i = 1,2,...,m provide positive returns ($r_i>0$, $1\leq i\leq m$) while investments i = m+1,m+2,...,z are unprofitable (either losses or breakeven)($r_i\leq 0$, i>m). Now the value of the portfolio at the end of n may be described as the sum of the value of profitable investments and the value of unprofitable investments, minus total management costs:

$$(3)\quad \sum_{i=1}^{m} C_i(1 + r_i)^n + \sum_{i=m+1}^{z} C_i(1 + r_i)^n - n\,S = V(1 + r)^n;\quad \sum_{i=1}^{z} C_i = V$$

Now define C_s and r_s such that

$$C_s = \sum_{i=1}^{m} C_i$$

and $$C_s(1 + r_s)^n = \sum_{i=1}^{m} C_i(1 + r_i)^n$$

Thus C_s may be viewed as the total capital invested in profitable situations, and r_s is the overall rate of return achieved by investment in profitable situations. Substitution yields

$$(4) \quad C_s(1 + r_s)^n + \sum_{i=m+1}^{z} C_i(1 + r_i)^n - n\,S = V(1 + r)^n$$

Now investment in situations i = m+1,m+2,...,z has yielded results such that total capital losses of L are sustained; the proportion of total capital lost is L/V or μ. Define the amount of capital invested in unprofitable situations as C_L:

$$C_L = \sum_{i=m+1}^{z} C_i = V - C_s$$

$$\text{Thus} \quad \sum_{i=m+1}^{z} C_i(1 + r_i)^n = \sum_{i=m+1}^{z} C_i - L = C_L - L$$

Since $C_L = V - C_s$, and $L = V\nu$

$$(5) \qquad \sum_{i=m+1}^{z} C_i(1 + r_i)^n = (V - C_s) - L = V - V\nu - C_s = V(1 - \mu) - C_s$$

Interpretation of (5) is obvious: the value of capital invested in unprofitable situations at the end of n, $\sum_{i=m+1}^{z} C_i(1 + r_i)^n$, equals the amount of capital originally invested in such situations, C_L, or $(V - C_s)$

minus total capital losses, L.

Substitution into (4) yields

$$(6)\quad C_s(1 + r_s)^n + [V(1 - \mu) - C_s] - n\,S = V(1 + r)^n$$

Now both sides are divided by V:

$$(7)\quad \frac{C_s}{V}(1 + r_s)^n + \frac{V}{V}(1 - \mu) - \frac{C_s}{V} - n\,\frac{S}{V} = \frac{V}{V}(1 + r)^n$$

The term $\frac{C_s}{V}$ may be considered the proportion of total capital invested in profitable situations or β; the term $\frac{S}{V}$ is the total annual cost of servicing the portfolio, stated as a proportion of total invested capital, or Θ. Thus

$$(8)\quad \beta(1 + r_s)^n + (1 - \mu) - \beta - n\,\Theta = (1 + r)^n$$

It is now possible to solve (8) for r_s:

$$\beta(1 + r_s)^n + (1 - \mu) - \beta - n\,\Theta = (1 + r)^n$$

$$\beta(1 + r_s)^n = (1 + r)^n - (1 - \mu) + \beta + n\,\Theta$$

$$(1 + r_s)^n = \{(1 + r)^n - (1 - \mu) + \beta + n\,\Theta\}/\beta$$

$$(9)\quad r_s = [\{(1 + r)^n - (1 - \mu) + \beta + n\,\Theta\}/\beta]^{\frac{1}{n}} - 1$$

The investment multiple (IM_s) which would result from attainment of r_s in year n may also be computed:

$$(1)\quad IM_s = (1+r_s)^n$$

$$= \left[1 + \left| [\{ (1 + r)^n - (1 - \mu) + \beta + n\,\Theta\}/\beta]^{\frac{1}{n}} - 1 \right|\right]^n$$

$$= \left[[\{(1 + r)^n - (1 - \mu) + \beta + n\,\Theta\}/\beta]^{\frac{1}{n}}\right]^n$$

$$= [\{(1 + r)^n - (1 - \mu) + \beta + n\ \Theta\}/\beta] \quad (10)$$

Solution for r_s is dictated by the nature of r_s. In order for the above equation to retain its integrity, r_s necessarily defines that rate of return which the profitable portion of the portfolio must achieve for the purposes of: 1) recovering capital losses; 2) offsetting returns lost through investment of capital in unprofitable, illiquid situations; 3) paying portfolio management costs; and 4) achieving portfolio objecjectives. Thus r_s may be viewed as the risk-adjusted, "target" rate of return that an investment ought to achieve in order to make an adequate contribution to portfolio performance. To be selected for inclusion in a portfolio, an investment position must be capable of achieving a rate of return that is equal to or greater than r_s. In addition, the value of that investment must appreciate to an amount which, when divided by its original cost, is equal to or exceeds IM_s.[3]

Investment Selection

It is now possible to develop a methodology for venture capital investment selection based on the preceding formulation for r_s and IM_s. In order to apply that formulation, it is first necessary to estimate values for the parameters which compose that formulation. These parameters may assume a range of values so that our estimates include both a range and the single value that best approximates that range. Estimates of these ranges were developed from data in the Diebold study and were refined by Dorsey in his dissertation. The range as well as the single value which most closely approximates values in that range

are now given for all parameters in the formulation except r_s and IM_s:

1. The proportion of capital losses, μ, is estimated in the Dorsey dissertation at 14%-17%, the single value approximating this range is estimated at 17%.
2. Holding period requirements, n, are estimated to exist over a range of 5-10 years. The single value approximating this range is estimated at 7 years.
3. The desired portfolio rate of return, r, is an objective whose attainment must be possible. It should also be an objective consistent with the expectations of investors who furnish money to the venture capital fund. Finally, if investors expect superior funds performance, relative to prior capital ventures, the rate of return objective should approximate that of more successful efforts. Liles (p. 150) reported that the rates of return achieved by American Research and Development (ARD) and Boston Capital Corporation (BCC) were 15.8% and 9.7%; these rates of return were achieved over periods of 25 years and 10 years respectively. An appropriate range for r would thus seem to be 8-20% while the single value used for r in the balance of this paper is 20%.
4. Annual costs of servicing the portfolio, θ, are estimated to be 0%-6% of the amount of invested capital. The value which approximates this range is estimated at 2%.
5. The appropriate range for that proportion of total capital

invested in satisfactorily profitable situations, β, is perhaps the most difficult to estimate. The Diebold survey of 140 venture capitalists indicated that the proportion of investments with "satisfactory" performance averaged 65.4%. However this parameter is assumed to exist over a range of 50%-70%.

Given estimates that μ = 17%, r = 20%, and θ = 2% with appropriate ranges of n = 5-10 years and β = 50%-70%, what multiple of original cost must the value of an investment position achieve in order to be selected for a portfolio? These values may now be substituted into (8) and (10) to compute values for r_s and IM_s:

	n=					
	5	6	7	8	9	10
β = 50%						
r_s =	35.20%	33.06%	31.47%	30.10%	29.18%	28.34%
IM_s =	4.52X	5.55X	6.79X	8.26X	10.02X	12.12X
β = 70%						
r_s =	28.56%	27.28%	26.32%	25.58%	24.98%	24.50%
IM_s =	3.51X	4.25X	5.13X	6.18X	7.44X	8.95X

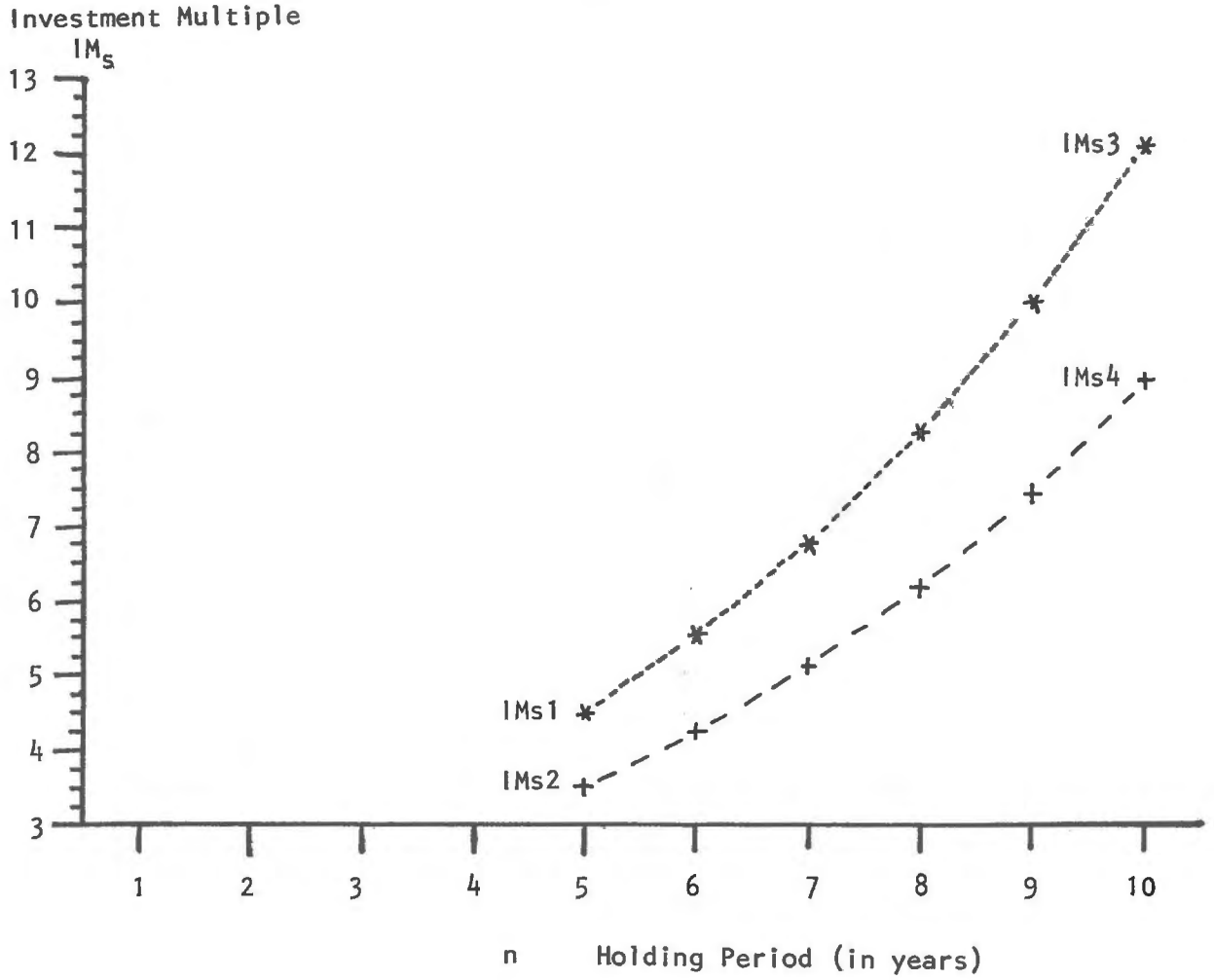
Using these values for n and IM_s, it is now possible to construct two sets of two-dimensional investment frontiers (Figure I).

The frontier IM_{s1} - IM_{s3} describes the minimum investment multiple that a venture should meet in 5-10 years if it is to make an adequate contribution to a portfolio with the following characteristics:

a) Rate of return objective is at least 20% per year on total invested capital ($r \geq .20$).

b) Capital loss objective is 17% of invested capital or less ($\mu \leq .17$).

Figure I



(Note: the frontier described by line IM_{s1} - IM_{s3} assumes 50% of total capital invested in profitable situations, and the portfolio indicated by line IM_{s2} - IM_{s4} assumes 70% of total capital invested in satisfactorily performing investments.)

c) At least 50% of all capital will be invested in situations such that the rate of return will meet or exceed r_s; that is the investment multiple will meet or exceed IM_s for at least 50% of all invested capital ($\beta \geq .50$).

d) Cost of servicing the portfolio will be 2% of invested capital per year ($\theta = .02$).

Line IM_{s1}-IM_{s3} contains multiples which an investment must meet or exceed if it is to be included in a portfolio. (Note: if the proportion of invested capital expected to be profitable were 70%, line IM_{s2}-IM_{s4} would describe the minimum multiples which an investment would have to meet in 5-10 years. Because a greater proportion of total capital is expected to be profitable, the performance required of individual investments is, of course, lessened.)

Once the investment multiples that any position must achieve in order to meet portfolio objectives have been established, it becomes necessary to estimate the actual multiple that a specific investment position may be expected to achieve. The multiple for a specific investment position may be derived in the following manner:

1. Given the earnings forecast of a venture for the last year of the holding period, an appropriate price/earnings multiple (P/E) is applied to derive a total value for the firm's equity. Determination of an appropriate P/E multiple is beyond the scope of this paper but would depend on the fundamental analysis of the conditions in the venture, venture industry and

other macro-economic factors such as the price/earnings ratio of the firms that comprise the Dow Jones Industrial Average.

2. Multiplying the value of the total equity of the venture by the proportion that is included in the venture capital portfolio yields the value of that investment position.
3. Dividing the value of the investment position by its original cost produced the investment multiple.

The imprecise nature of forecasting venture performance (as well as the value of equity positions in those ventures) makes it useful to forecast investment performance in ranges just as the parameters of venture capital portfolio performance are stated. Thus the value of an investment position (as well as the resulting investment multiple) at a point in time may reasonably be expected to vary under different performance scenarios.

Performance scenarios might vary for different reasons:

1. Performance of the venture may be forecast as a range of values. For example, earnings during year six may be forecast at between $5 million and $6 million. The same price/earnings multiple applied to each earnings level would result in a venture whose value can only be predicted within a range. If earnings during year six are expected to range between $5 million and $6 million, the investment will have a value of between $25 million and $30 million assuming a P/E multiple of 5X.
2. The applicable P/E multiples may differ according to perfor-

mance. For example, the venture that earns $6 million in year six may command a P/E of 8X, but the applicable P/E multiple might turn out to be only 6X if the venture achieves earnings of $5 million in that year. Total value of the venture in year six would then range between $30 million and $48 million.

Note that the model would yield an estimate of the values of a developing venture's total equity. The value of an equity position in such a venture would, of course, derive from the proportion of total equity owned by the investment group. Therefore, it is necessary to estimate that total value and to divide it by the original investment position to compute the expected investment multiple. For example, an investment of $1.05 million which purchases 20% of the equity in a venture whose performance scenarios suggests a total value of $30 million-$48 million at the end of year six will result in an investment position with a value of $6 million-$9.6 million. The expected investment multiple would range between 5.71X ($\frac{\$6}{\$1.05}$) and 9.14X ($\frac{\$9.6}{\$1.05}$); the rate of return would be between 33.69% ($\sqrt[6]{5.71X} - 1$) and 44.60% ($\sqrt[6]{9.14X} - 1$).

Now that performance scenarios for a venture have been translated into the resulting investment multiples for different points in time, it is possible to evaluate the attractiveness of an investment position relative to stated portfolio objectives.

Table II contains projected investment multiples from a performance scenario that might be prepared for a potential investee venture

for the fifth through the tenth years subsequent to the proposed investment. The table also contains minimum investment multiples, the same multiples described by line IM_{s1}-IM_{s3} in Figure I for the same period. Figure II graphically depicts both scenarios as well as minimum investment criteria. Except for performance scenario A in year 5, performance of the venture is expected to result in investment multiples which would contribute to attainment of portfolio objectives. Investment in the venture would thus be warranted.

TABLE II

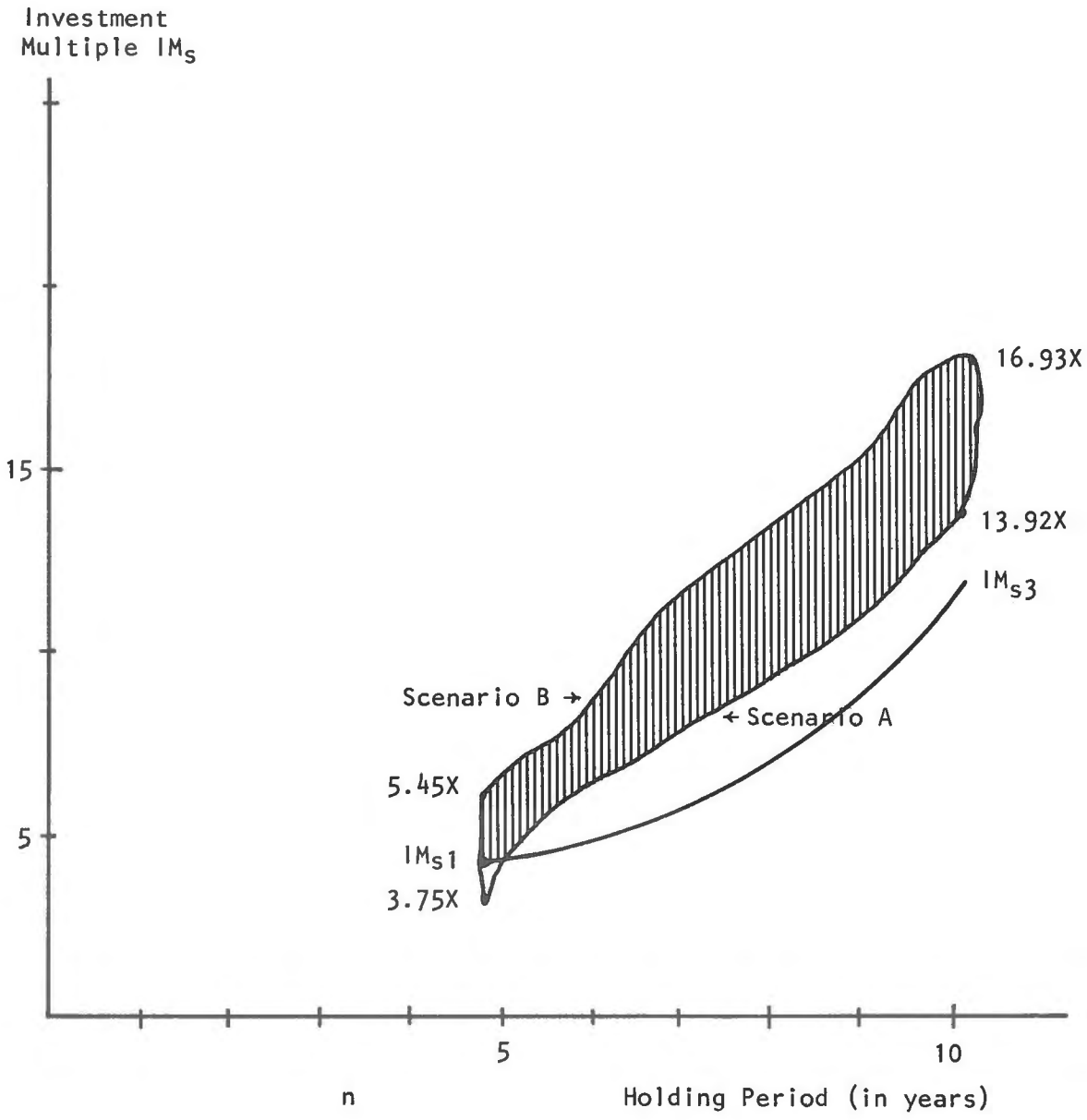
	n=					
	5	6	7	8	9	10
Projected Investment Multiples for Performance Scenario A	3.75X	5.88X	7.34X	9.24X	10.71X	13.92X
Projected Investment Multiples for Performance Scenario B	5.45X	7.90X	9.46X	12.62X	14.09X	16.93X
Required Minimum Investment Multiple (IM_s)	4.52X	5.55X	6.79X	8.26X	10.02X	12.12X

Summary--Portfolio Selection

We have seen how the model for venture capital portfolio selection developed in this paper recognizes the relative contribution to overall portfolio performance made by each of the three categories of investments (capital loss, break even, and satisfactory performance). The model is based on three explicitly stated assumptions about portfolio performance:

1. The overall rate of return desired from total invested funds, r.

FIGURE II


Investment
Multiple IM_s
15
5
16.93X
13.92X
IM_{s3}
Scenario B →
← Scenario A
5.45X
IM_{s1}
3.75X
5
10
n
Holding Period (in years)

2. The maximum proportion of invested capital which will be lost, μ.

3. The minimum proportion of invested capital which will meet objectives for individual investment situations, β.

Based on these assumptions as well as empirically-derived estimates of other parameters of venture capital profitability, the model includes a mathematical formulation to compute the risk-adjusted rate of return that an individual investment should achieve to warrant selection in a portfolio. The desired portfolio rate of return will then be achieved if: 1) the maximum proportion of capital losses (μ) is not exceeded, and 2) the minimum proportion of invested capital which meets the stated performance objectives for individual investments (β) is achieved. Thus the selection model facilities achievement of the desired portfolio rate of return despite the inevitabilities of capital losses and illiquid investments in break even situations.

II. PORTFOLIO MANAGEMENT: OPERATION AND CONTROL

Once a portfolio is selected, the venture capital funds manager must be able to lessen the impact of capital losses and cope with periods of considerable uncertainty if portfolio objectives are to be met. By building on the model developed in the first part of this paper, we can derive a methodology for evaluating actual performance in relation to planned investment performance and assess the likelihood of achieving stated portfolio objectives. The methodology also identifies

sources of performance failure when actual performance indicates that desired objectives will not be met.

Portfolio Review and Funds Objectives

For a performance analysis to be effective, it should provide the funds manager with the information required: (1) to review overall portfolio performance to date; (2) to estimate the likelihood of achieving overall portfolio objectives; and (3) to identify sources of performance failure when it appears that portfolio objectives will not be met. Such performance analysis begins with a review of individual investments; by then aggregating the performance of individual investments, we can analyze overall portfolio performance.

The performance of an investment position in a new venture can be analyzed in several ways: (1) the current value of the investment position may be estimated periodically; (2) actual venture performance to date may be compared to planned performance; (3) based on this comparison, the forecast of venture performance upon which the investment decision was predicated may be revised; and (4) the amount expected to be received at the end of the investment holding period may be revised to reflect the new forecast of venture performance. Of these methods, we shall examine in more detail the ability of periodic investment valuation to estimate ultimate portfolio performance as a preface to developing a more comprehensive methodology for portfolio review.

In a study of the valuation techniques employed by ten venture

capital firms, Donald Caldwell found that four of these firms had formalized periodic valuation policies which are described in Table III. Valuation policies are described in cases of publicly traded securities, the presence of significant third-party investment transactions, write-downs due to investee deterioration, markups from superior performance, and other circumstances. While the firms generally seemed to carry investments at cost until a public market was established, the presence of "a significant, subsequent investment in an investee by an arms-length third party" would cause an investment to be revalued at the most recent price.

Caldwell perceives three reasons for periodic valuation of portfolio investments. First is the need to report the current value of the venture portfolio to stockholders. Second is the need for a "yardstick" by which the venture capital firms can measure progress to date. The third reason stems from the fact that some professional venture capitalists receive compensation at least partially tied to portfolio performance.

Note that while most of the valuation policies in Table III value investment positions as a function of performance to date, none seem to incorporate assumptions about projected venture (and investment) performance, and only one compares planned vanture performance with actual venture performance. Indeed the reasons for valuation seem to focus on performance to date rather than on assessing the likelihood of achieving portfolio objectives.

TABLE III

VALUATION POLICIES OF FOUR VENTURE CAPITAL FIRMS

Firm	Cost or Public Market	Significant Third Party Investment Transactions	Writedown	Markup	Other
A	Cost or Public Used		Rare; occurs only if significant occurs	Rare; writeup is small if undertaken	
J	Costs used until public market develops. Public market price discounted 15-20% to reflect amount of stock held.		Two steps upon deterioration a. Writedown by subjectively determined percentage b. Liquidation value	Four possibilities a. Markup occurs upon large recent investment. b. Subjectively determined markup upon material progress. c. Markup based upon very conservative multiple of earnings. d. Markup based on public market price, discounted 15-20% to reflect amount of stock held.	
F	If public, valued at 40% below bid price.	Writedown or markup due to subsequent investments occurs only if recent investment larger than $500,000 and has occurred within last six months.	Two possibilities a. Liquidation value b. More often: one-year work-out rather than fire sale price.	Upon substantial progress, but with out recent investments, earnings multiple of 9-15 rather than 30-40 is used.	1. Convertible debentures, if any, are valued at higher of face value and conversion price 2. Unprofitable firm, which is making its payments is valued at 15% yield basis. 3. If investment not yielding 15% face value of debt lowered to point where 15% yield is reached. 4. If Rule 144 stock is held, portion of stock marketable within six months is discounted 20%; stock not marketable within six months discounted 30%. Applies to publicly traded stock only.

TABLE III - Continued

Firm	Cost or Public Market	Significant Third Party Investment Transactions	Writedown	Markup	Other
B	Cost used only first two or three months-public market price, if applicable, discounted to reflect amount of stock held.	Markup or write-down occurs only upon "third party, significant investment"			1. After first few months, actual performance is compared to forecast. Value changed to reflect deviation. 2. Valuation also based upon guidelines such as public price of similar companies, merger value, forecast earnings, liquidation value over one year, etc.

SOURCE: Donald R. Caldwell, Valuation--Art or Science, Summary of Master's thesis, Harvard Graduate School of Business, 1970.

A deterioration of venture performance or complete failure by a venture to perform as well as planned undoubtedly undermines the value of investors' positions; such occurrences may well result in the loss of capital. Consequently writedowns of investment value are appropriate since the probability of acceptable or superior investment performance is lessened. A drain on portfolio performance becomes likely and should be recognized. However, for ventures whose actual performance meets or exceeds forecast performance, valuation at current levels of performance is a poor predictor of ultimate investment performance and contributes little to the assessment of eventual portfolio performance.

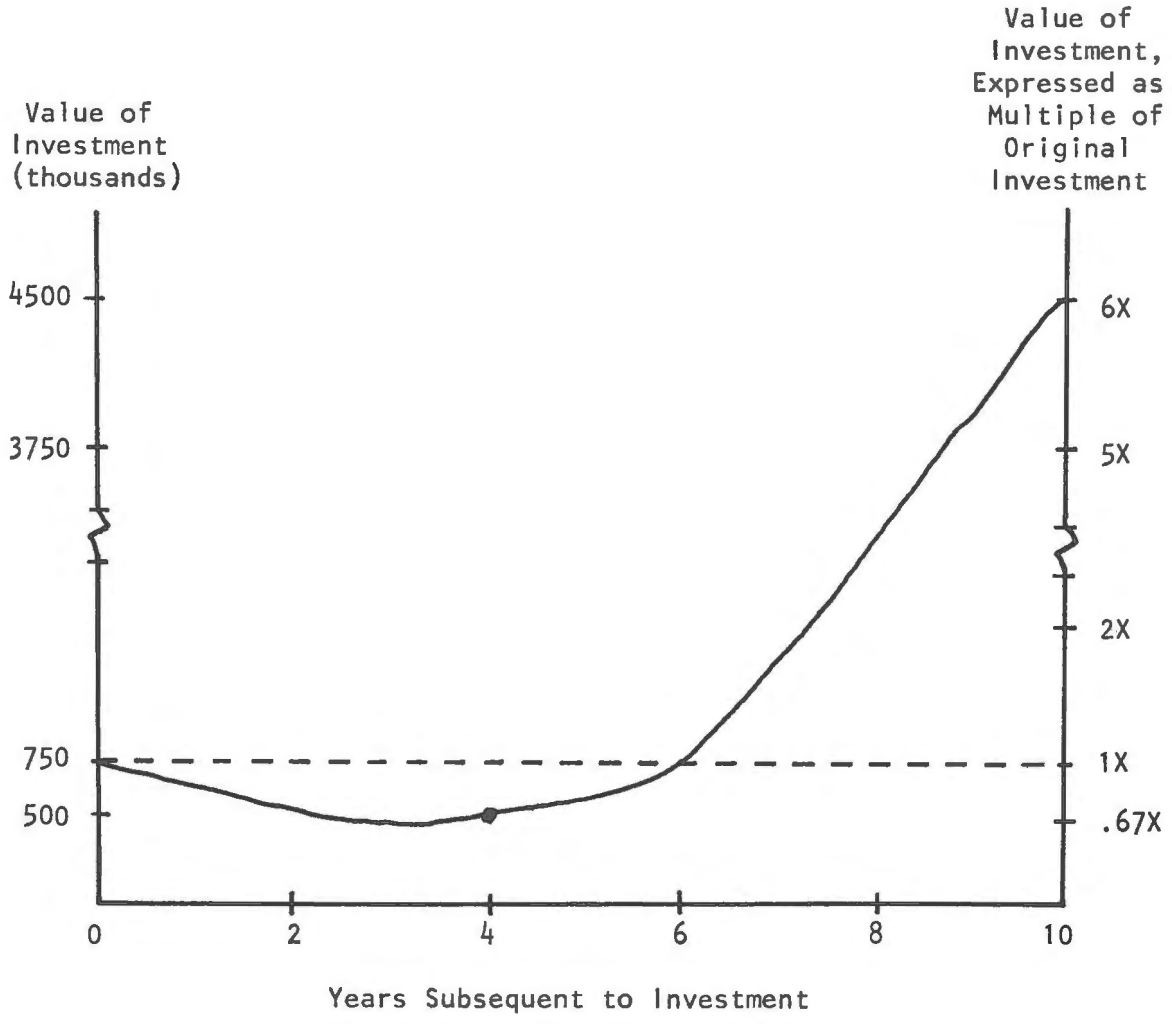
The fact that periodic valuation policies fail to address the likelihood of achieving long-term portfolio objectives is illustrated by an examination of the nature of investment performance measures. Computation of the compound or geometric rate of return requires three inputs: (1) the amount of initial investment; (2) the value received upon termination of the investment; and (3) the investment holding period stated in years.

In the case of a typical investment held for 5-10 years, performance over the first few years is likely to suggest a valuation of no more than original cost even though performance (and investment appreciation) in the last years prior to termination might be quite dramatic. To illustrate, Figure III tracks the value of a very profitable capital

venture investment from time of investment to termination. Although value declines initially, eventual performance provides a termination value of 6 times the original investment at the end of year ten and a compound rate of return of 19.62%. Since the value declines to 0.67 times the original investment at the end of year four, the compound rate of return for the first four years is -9.53% ($\sqrt[4]{.67}-1$); however, appreciation to 6 times the original investment produces a 44.10% ($\sqrt[6]{6/.67}-1$) compound rate of return over years five through ten. Evaluation of profitable investments based on periodic valuation may thus indicate the stage of investment performance over a portion of the holding period (in this case the first four years versus the last six years) rather than overall performance.

Note that the need for periodic review of investment and portfolio is not questioned. However, to be truly useful to the portfolio manager, a review should evaluate the likelihood that portfolio performance will meet or exceed stated objectives and, if necessary, should identify the reasons why objectives will not be met in order to facilitate corrective action. Periodic valuation of portfolio investments is inadequate to both these tasks. A methodology that does evaluate progress toward stated portfolio objectives and that identifies sources of performance failure when portfolio objectives are not being met follows.

FIGURE III


Value of Investment (thousands)
Value of Investment, Expressed as Multiple of Original Investment
4500
3750
750
500
6X
5X
2X
1X
.67X
0
2
4
6
8
10
Years Subsequent to Investment

A Methodology for Analysis of Funds Performance

Analysis of individual investment performance consists of three sequential steps: (1) comparison of actual venture performance with planned performance to identify ultimately unprofitable or marginally profitable investments; (2) revision, if necessary, of forecasted venture performance during the investment holding period and (3) revision, if necessary, of the expected value to be received upon termination. In the case of a venture whose actual performance has deteriorated and will be liquidated or a venture that might be considered for early sale due to marginal performance, the valuation techniques for writedowns discussed by Caldwell are appropriate. In such a case, estimating the amount of capital expected upon liquidation of a losing or breakeven investment provides sufficient information for portfolio review.

Comparison of actual and planned venture performance in combination with a revised forecast of venture performance forms the basis for re-estimating the value expected to be received from profitable investments. Having revised the value expected to be received upon termination of each profitable investment, we can compute a revised rate of return for that investment:

$$r_i' = (V_i'/C_i)^{\frac{1}{n}} - 1.0, \text{ where}$$

r_i' = the revised rate of return expected from investment in situation i,

V_i' = the amount expected to be received upon termination of investment i,

C_i = the amount invested in situation i, and

n = the investment holding period in years.

Similarly it is possible to compute a revised estimate of the rate of return expected from the profitable portion of the venture portfolio

$$r_p = \left(\sum_{i=1}^{m} V_i' / \sum_{i=1}^{m} C_i\right)^{\frac{1}{n}} - 1.0, \text{ where}$$

r_p = the rate of return now expected from the profitable portion of the portfolio.

Next it is possible to compute that proportion of the total portfolio which is expected to be profitable:

$$\beta' = \left(\sum_{i=1}^{m} C_i\right)/V, \text{ where}$$

β' = the revised estimate of the portfolio which will be profitable and

V = the total amount of capital invested in all ventures, at cost.

Turning to investments expected to be unprofitable, we may use the amounts which can be received upon termination of these situations (termination values have been estimated by the writedown techniques described by Caldwell) to compute a revised estimate of the proportion of total capital which will be lost:

$$\mu' = \left(\sum_{i=m+1}^{z} L_i'\right)/V \text{ where}$$

μ' = the revised estimate of the proportion of total capital expected to be lost through liquidation of unprofitable investments, and

L_i' = the total amount now expected to be lost upon liquidation of unprofitable investment i.

By integrating the above values for β' and μ' into the original model for investment selection, we can compute the revised target rate of return that the profitable portion of the portfolio must achieve if the overall rate of return is to meet the original objective:

$$r_s' = [\{(1 + r)^n - (1 - \mu') + \beta' + n\,\Theta\}/\beta']^{\frac{1}{n}} - 1, \text{ where}$$

r_s' = the revised rate of return required from the profitable portion of the portfolio in order to meet desired portfolio objectives,

r = the desired portfolio rate of return, and

Θ = annual cost of servicing the portfolio stated as a percentage of total invested capital.

Next comes the acid test, the comparison of r_p and r_s'. If the revised rate of return expected from the profitable portion of the portfolio exceeds the revised target rate of return required to meet portfolio objectives ($r_p \geq r_s'$), we may infer that portfolio objectives will be met. If r_p is less than r_s, portfolio objectives will not be met, and corrective action is indicated.

Note that the performance review process occurs at two levels:

the portfolio level as well as the level of the individual venture/ investment. At the portfolio level the process permits replacements of the values for β and μ used in the investment selection model with β' and μ'. The original values were estimated empirically from large samples of capital ventures as well as portfolio investments and are appropriate for use as inputs during the portfolio selection process. Subsequent to investment, however, it becomes necessary to replace them with values more descriptive of the portfolio at hand. Integrating these revised values into the original selection model converts the selection model into a managerial model capable of assessing the likelihood of achieving desired portfolio objectives.

If $r_p < r_s'$, then portfolio objectives are not likely to be met, and it becomes necessary to identify the sources of performance failure so that corrective action can be taken.

Table IV presents the variables and relationships used for portfolio selection during the investment process and to delineate sources of performance failure during the portfolio review process. These are described at the levels of the investee venture, the individual investment, the investment/portfolio, and the portfolio itself. The identification of performance failure would begin at the portfolio level where the comparison of r_p and r_s' provides an aggregate indicator of performance; other measures at this level compare planned and actual proportions of profitable investment, target rates of return, and capital losses. At the investment/portfolio level, the comparison of r_i' and r_s'

TABLE IV

Operational Level	Variables and Parameters used During Investment Process*	Variables and Parameters Used During Portfolio Review to Identify Sources of Favorable/Unfavorable Performance	
		Favorable	Unfavorable
Investee Venture	$IM_i = V_i / C_i$	$IM_i' \geq IM_i$	$IM_i' < IM_i$
	$V_i = EPS_i \times P/E_i \times SH_i$	$V_i' \geq V_i$	$V_i' < V_i$
	EPS_i	$EPS_i' \geq EPS_i$	$EPS_i' < EPS_i$
	P/E_i	$P/E_i' \geq P/E_i$	$P/E_i' < P/E_i$
Investment	$IM_i = V_i / C_i$	$IM_i' \geq IM_i$	$IM_i' < IM_i$
	r_i	$r_i' \geq r_i$	$r_i' < r_i$
Investment/ Portfolio	$r_i > r_s$	$r_i' \geq r_s'$	$r_i' < r_s'$
Portfolio	β	$\beta' \geq \beta$	$\beta < \beta$
	r_s	$r_s' \geq r_s$ } $r_p \geq r_s$	$r_s' < r_s$ } $r_p < r_s'$
	μ	$\mu' \leq \mu$	$\mu' > \mu$

*Note: The following variables were described, but not explicitly defined as inputs to the investment selection process:

EPS_i = forecasted earnings per share for venture i for year n when investment termination is expected;

P/E_i = price-earnings multiple expected to be applicable to earnings of venture i at end of year n;

SH_i = number of shares of venture i to be purchased by the venture-capital fund when the investment is made

identifies investments whose performance is not likely to exceed the revised target rate of return for profitable investments.

There are two reasons the return from an investment might now be considered inadequate: at the portfolio level r_s' might have increased ($r_s' > r_s$), or r_i' might have diminished ($r_i' < r_i$). If r_i' has diminished, then the problem lies at the investment level and is ascertained by comparing r_i and r_i'. Analyzing the reasons for investment performance failure is conducted at the venture level, where the revised earnings forecast is combined with a new estimate of the price/earnings multiple to generate a revised estimate of the value of the investment position upon termination.

Note that the review focuses primarily on investments still expected to be profitable. Situations where losses are expected will impact μ', the proportion of capital expected to be lost.

Summary--Portfolio Operation and Control

The portfolio review methodology developed here incorporates revised estimates of performance from different operating levels into the original portfolio selection model to make an assessment of whether or not performance goals will be met. If a negative answer is obtained, then the methodology facilitates identification of reasons for performance failure at each operational level.

III. CONCLUSION

This paper presents a two-phase model for venture capital funds management. The first section of the paper develops a portfolio selection model which computes either an investment multiple or the target rate of return that an investment position should be able to attain if it is to warrant selection in the portfolio. The model is weighted for two types of risk: 1) actual expected capital losses; and 2) the loss of return on capital invested in unprofitable (either break even or actual loss) situations. The first section also develops a methodology whereby the performance forecast of a new venture can be used to generate inputs for the portfolio selection model. In the second section the portfolio selection model is used to develop a methodology for evaluating progress toward stated portfolio goals. As investment situations develop over time, updated performance scenarios are used to generate both the revised target rate of return now required from profitable situations as well as the revised rate of return actually expected from profitable situations. Comparison of these two rates of return permits an assessment of whether or not portfolio goals are likely to be met.

In addition to evaluating the likelihood of achieving the target rate of return, the methodology presented in the second section also facilitates identification of those operational levels responsible for

performance failure when goals are not being met.

This two-phase model should thus prove useful to both the venture capitalist and the portfolio manager. The model can act as a guide to the investment selection process, and it can also serve as a managerial tool for performance evaluation and control.

ENDNOTES

[1]Jack Clark Francis and Stephen Archer, Portfolio Analysis, p. 13.

[2]Diebold Group, Inc., Final Report-Phase Three Venture Capital Investment Guarantee Study, prepared for the National Science Foundation, December 1974. The Diebold study was undertaken to evaluate alternative investment guarantee programs that might be employed by the government to encourage venture capital investment. The study was conducted in six stages; in the first three stages data on the characteristics of 140 venture capital firms was collected, and subsequent stages included data on some 368 individual investments made between 1960 and 1973.

[3]Referring to (8), it is possible to achieve the overall, desired rate of return r even though capital losses exceed μ, and the proportion to total capital that is profitable is less than β. Investment in one or two ventures whose actual performance far exceeds forecast performance would facilitate such an occurrence. Implications of such an occurrence will be examined in the second part of this paper; however, it will be demonstrated that such a possibility does not alter the relevance or appropriateness of the portfolio selection model developed here. Further, it will be demonstrated that this model may be used as a funds management tool to evaluate portfolio performance over time.

BIBLIOGRAPHY

Caldwell, Donald R. Valuation--Art or Science; Summary of Masters thesis. Harvard Graduate School of Business, 1971.

Dorsey, Terry. "The Measurement and Assessment of Capital Requirements, Investment Illiquidity and Risk for the Management of Venture Capital Funds." Dissertation. The University of Texas at Austin, 1977.

Francis, Jack Clark and Stephen H. Archer. Portfolio Analysis. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

Liles, Patrick R. Sustaining the Venture Capital Firm. Cambridge, Massachusetts: Management Analysis Center, 1977.