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A PRIMER ON VENTURE CAPITAL FINANCIAL CALCULATIONS

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(excerpts from *Venture Capital and High Tech Business Appraisal)*

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TABLE OF CONTENTS

I. BASIC FINANCIAL CONCEPTS AND CALCULATIONS RELEVANT TO VC INVESTING

A. "Present value"and "future value"

Most financial calculations are derivative from the basic formula for compound interest:

$$FV = PV * (1 + i) \wedge N$$

where

FV	=	Future value
PV	=	Present value
i	=	Annual compound interest rate
N	=	Number of years in the future (also "investment holding period")
*	=	A mathematical symbol indicating multiplication
^	=	A mathematical symbol indicating that the previous term (1+i) is being raised to the exponential power indicated by the term that follows (N)

For the situation where $1 is invested today and held for one year at 10% interest, this formula takes the following numerical form:

$$FV = \$1 * (1 + .1) \wedge 1$$

$$FV = \$1 * (1.1)$$

$$FV = \$1.10$$

So, if $1 received today can grow to $1.10 in a year, then a person may be "indifferent" between the two alternatives of a) receiving $1 today, or b) receiving $1.10 one year from now. That is one way of stating the "time value of money."

Suppose we go out in time two years instead of one. The same formula takes on the following numerical form:

FV = $1 * (1 + .1) ^ 2

FV = $1 * (1.1) ^ 2

FV = $1 * (1.21)

FV = $1.21

We can now expand our concept of the "time value of money" by stating that the individual with the opportunity to earn 10% per year return on money will be "indifferent" between having a) $1.00 today, or b) $1.10 one year from now, or c) $1.21 two years from now.

Notice, that in both the above calculations, we start with a given standard for "present value" ($1.00) and then see what "future value" the $1.00 will grow to over time using the compound interest formula. The process starts "present value" and then rolls out in time to solve for various "future values."

Now, suppose we reverse the process. Let's start from a given "future value" and calculate the equivalent "present value." Let's use a numerical example where we already know the answer. We already know that, if an investor can earn 10% per year, then $1.21 two years from now ("future value") has the same value as $1.00 today ("present value").

We can obtain the formula for PV ("present value") by simply dividing both sides of the above compount interest formula by (1 + i) ^ N.

FV = PV * (1 + i) ^N

or

$$\frac{FV}{(1 + i) \hat{} N} = PV$$

For the numerical example we have chosen, the numerical calculation is as follows:

$$\frac{\$1.21}{(1 + .1) \text{ ^ } 2} = PV$$

$$\frac{\$1.21}{1.21} = PV = \$1.00$$

This technique of being able to convert from a given or estimated "future value" back to a calculated "present value" as of the date of investment is the core of venture capital financial analysis. If this concept is understood, then it is possible to do most venture capital financial calculations. Other more complicated calculations are icing on the cake, but not essential.

B. "Present discounted value"

When the compound interest formula is turned around, as we did above, so that it solves for a "present value" rather than a "future value," the terminology changes, even though the concepts are really the same.

The interest rate that is used to convert "future value" back to "present value is called a "discount rate," because it is working from the future to the present.

Likewise, "present value" is then sometimes (but not always) called "present discounted value."

C. Many names for the same before-the-fact "rate" concept:

In venture capital financial analysis, the rate used to convert future values to present values goes by any of the following names:

"Discount rate"

"Rate of return goal"

"Hurdle rate"

"Rate of return cutoff"

"Expectations rate"

"Investment performance standard"

"Required rate of return"

All of these labels refer to the "hoped for" rate of return that is using in analyzing potential future investments. It is used by financial analysts to measure the rate of return that they think is required to be commensurate with the degree of risk and illiquidity existent in a given investment.

In the terminology of the economist, these are all "ex ante" rates of return, or "before the fact" (before the investment period begins) rates of return.

D. After-the-fact rates of return:

The above concepts of "hoped for" or "before-the-fact" rates of return are different from "ex post" rates of return, or "after the fact" (after the investment period is over) rates of return. One can evaluate a venture portfolio after the all the action is over, and then calculate what compound annual rate of return on capital was earned by the investors. These rates are referred to by any of the following labels:

"Achieved rates of return"

"Actual performance rates of return"

"Internal rates of return"

"Actual rates of return"

Measuring actual rate of return performance after the fact is a more complicated form of financial analysis. The techniques for doing that form of analysis are not covered here. For now, all that is necessary is to be warned not to confuse before-the-fact rates of return with after-the-fact rates of return.

Ordinarily, before-the-fact rate of return "goals" greatly exceed after-the-fact "achieved" rates of return. The difference between the two goes by many humorous names, like "the rose colored glasses effect."

E. "Cash-on-cash ratios"

One very simple concept of investment performance, whether viewed before-the-fact or after-the-fact is the ratio between the amount of cash that comes out of the investment at the end of the investment to the amount of cash that goes into the investment at the front end of the investment period. This measure can be used by itself, without any reference to the length of the investment period.

However, more frequently, investment goals are stated in relation to both the cash-on-cash ratio and the length of the investment period. A typical type of investment goal statement is "We look for a five times return over five years."

The compound interent formula we used above can be adapted to examine the relationship between three quantitative measures: a) the length of the investment period, b) the rate of return goal (discount rate, etc.), and c) the cash-on-cash ratio.

$$FV = PV \quad (1 + r) \text{ ^ } N$$

Note that I have replaced the interest rate symbol, "i", with the rate of return goal symbol, "r". Now, if we divide both sides of the equation by PV, we will have a formula in terms of cash-on-cash ratios.

$$\frac{FV}{PV} = \text{Cash-on-cash ratio} = (1 + r) \text{ ^ } N$$

Table 1 shows the cash-on-cash ratios that are obtained from given input combinations of rates of return and investment holding periods.
Table 2 shows the rates of return that are obtained from given input combinations of investment holding periods and cash-on-cash ratios.

Table 3 shows the cash-on-cash ratios that are obtained from given input combinations of rates of return and investment holding periods.

TABLE 1

Equivalency Between Rate of Return Performance Goals (Discount Rates) and Cash-On-Cash Performance Goals

Discount rate = Rate of return performance goal

Holding period	25%	30%	35%	40%	45%	50%	55%	60%
2 years	1.56X	1.69X	1.82X	1.96X	2.10X	2.25X	2.40X	2.56X
3 years	1.95X	2.20X	2.46X	4.20X	3.05X	3.38X	3.72X	4.10X
4 years	2.44X	2.86X	3.32X	3.84X	4.42X	5.06X	5.77X	6.55X
5 years	3.05X	3.71X	4.48X	5.38X	6.41X	7.59X	8.95X	10.49X
6 years	3.81X	4.83X	6.05X	7.53X	9.29X	11.39X	13.87X	16.78X
7 years	4.77X	6.27X	8.17X	10.54X	13.84X	17.09X	21.49X	26.84X
8 years	5.96X	8.16X	11.03X	14.76X	19.54X	25.63X	33.32X	42.95X
9 years	7.45X	10.6X	14.89X	20.66X	28.33X	38.44X	51.64X	68.72X

TABLE 2

Relationships between Cash-On-Cash Returns, Holding Periods and Rates of Return

	Holding Period						
COC	2 years	3 years	4 years	5 years	6 years	7 years	8 years
2X	41.4%	26.0%	18.9%	14.9%	12.2%	10.4%	9.1%
3X	73.2%	44.2%	31.6%	24.6%	20.1%	17.0%	14.7%
4X	100.0%	58.7%	41.4%	32.0%	26.0%	21.9%	18.9%
5X	123.6%	71.0%	49.5%	38.0%	30.8%	25.8%	22.3%
6X	144.9%	81.7%	56.5%	43.1%	34.8%	29.2%	25.1%
7X	164.6%	91.3%	62.7%	47.6%	38.3%	32.0%	27.5%
8X	182.8%	100.0%	68.2%	51.6%	41.4%	34.6%	29.7%
9X	200.0%	108.0%	73.2%	55.2%	44.2%	36.9%	31.6%
10X	216.2%	115.4%	77.8%	58.5%	46.8%	38.9%	33.4%
11X	231.7%	122.4%	82.1%	61.5%	49.1%	40.9%	35.0%
12X	246.4%	128.9%	86.1%	64.4%	51.3%	42.6%	36.4%

TABLE 3

Percentage of Ownership Required to yield a 35% Rate of Return Over a Five Year Holding Period

Estimated Value of the Company After Five Years (in millions)

Capital required (in millions)	$5	$10	$15	$20	$25
$1	90%	45%	30%	30%	18%
$2	N/A	90%	60%	45%	36%
$3	N/A	N/A	90%	67%	54%
$4	N/A	N/A	N/A	90%	72%
$5	N/A	N/A	N/A	N/A	90%

N/A = Not applicable. Investment would not be made.

II. THE BASIC FORMULAS FOR VC "PRICING" (REQUIRED % VC OWNERSHIP)

Some VCs responded to the 1986 QED survey of venture capital valuation methods by stating "I don't have to do valuation. I just determine a percentage VC ownership required." We never had the nerve to come back and ask "How on earth do you do that without going through the intermediate step of determining how much the company is worth?" More sophisticated respondents did occasionally comment that valuation and pricing (required VC % ownership) are two separate but related issues.

For this example, let us assume that there is only one round of financing expected, only one VC investor, the VC is putting up all the money, and the entrepreneur is just putting up the idea. The required VC percentage ownership is determined by the following formula:

$$\% = \frac{\text{Required capital}}{\text{Present Value of the idea without required capital} + \text{Required capital}}$$

The denominator in the above fraction is the present value of the venture with the capital to carry it out, and with the entrepreneurship to carry it out. Stated in a different formula:

$$\% = \frac{\text{Required Capital}}{\text{Present Value of the venture after capital has been invested in it}}$$

If the required capital is $2 million and the "before-money valuation" is $1 million, the percentage required VC ownership will be:

$$\% = \frac{\$\ 2 \text{ million}}{\$\ 1 \text{ million} + \$\ 2 \text{ million}}$$

$$\% = \frac{\$\ 2 \text{ million}}{\$\ 3 \text{ million}} = 66.7\%$$

The before-money valuation is what the idea is worth without any money invested in it, and without any further time involvement by the entrepreneur. If the idea can be carried out without any further time involvement by the entrepreneur, then one alternative would be for the VC would be to but the idea for $2 million and exploit it without the entreptrneur. The advantage for the VC would be a stronger controlling position. The disadvantage would be the difficulty in finding just the right entrepreneur to carry it out. VCs usually have neither the desire nor the capability of managing an entrepreneurial venture.

In the real world, it is usually very difficult to put a value on a venture under the circumstance where the venture does not have the necessary capital. There is no ready market for "raw ideas." That is why pricing is so difficult at the seed capital stage. Likewise, it is very difficult to separate out the present value of a raw idea and the value of the <u>future</u> involvement of the same entrepreneur in carrying out the venture. The above formulas are useful for conceptual clarity, but the real world is much more cloudy.

To make the above formulas more usable in the real world, they have to be restated in terms of <u>the estimated future value of the venture:</u>

$$\% = \frac{\text{Required capital}}{\dfrac{\text{Future value of the venture}}{\text{Present value factor}}}$$

$$\% = \frac{\text{Required capital}}{\dfrac{\text{Future value of the venture}}{(1 + \text{discount rate})\ \hat{}\ \text{number of years}}}$$

As discussed in the previous section, the discount rate is the same as the required rate of return. The "number of years" is the same as the investment holding period.

Table 3 shows the percentage VC required ownership corresponding to a 35% required rate of return and a 5 year holding period. Entrepreneurs are often shocked at how high these numbers are. If an entrepreneur truly believes in his idea, then he or she should raise all the money possible from a) personal savings, b) borrowing against personal assets (e.g. a second mortgage on the house), c) family and friends, and d) other individual venture investors ("angel investors") who may not have target rates of return (discount rates) as high as the professional VCs.

III. VALUATION APPROACHES USED BY VENTURE CAPITALISTS

A. The Conventional Venture Capitalist Valuation Approach

Throughout this section, we will use the simplifying assumptions that there is only one VC investor involved, that there is only one round of investment contemplated, only one class of stock and that the candidate company is at the Second Stage of Development (manufacturing and shipping in commercial quantities, but not yet profitable).

After the VC has done his skeptical revision of the numbers in the business plan that HITECH INC submits, he arrives at the following conclusions about the company:

1. The current revenue level (represented here by the symbol "R") is $ 2 million.

2. The expected annual rate of growth of revenue (represented here by the symbol "r") is 50%.

3. The expected amount of required capital (represented here by the symbol "K") is $ 2.5 million.

4. The expected number of years between now and cash-out (represented here by the symbol "n"), and also called the "holding period," is 5 years.

5. The expected after-tax profit margin at the time of cash-out (represented here by the symbol "m") is 11%.

6. The expected price/earnings ratio at time of cash-out (represented here by the symbol "P") is 15.

7. The appropriate pre-tax discount rate (represented here by the symbol "d") for a VC investment of this stage, risk, and illiquidity is 40%.

This information can be used to work backward in time from the future point of cash-out to the present value of the company. The following sequence of

steps are involved in the conventional VC valuation method:

1. Compounding the current revenue level of $ 2 million forward at an annual rate of 50% for 5 years yields a revenue level at time of cash-out of %15.19 million.

2. Multiplying the future revenue level of $ 15.19 million time the expected after-tax profit margin at time of cash-out of 11% produces an expected earnings level of $1.67 million as of the date of cash-out.

3. Multiplying the estimated cash-out earnings level of $ 1.67 million times the expected price/earnings ratio of 15 yields a future market valuation of the company of $ 25.06 million.

4. To obtain a "present value factor," it is necessary to raise the quantity 1.40 (that is, 1 + the discount rate of 40%) to the power of 5 (the holding period of 5 years). This yields a present value factor of 5.378.

5. Dividing the future company value of $25.06 by the present value factor of 5.378 produced a present value of the company of $ 4.66 million. This completes the valuation analysis.

To "price the deal," the VC will divide the required capital of $ 2.5 million by the present company value of $4.66 million, to obtain a minimum VC ownership of 53.7%.

The convention VC valuation method can also be represented in algebraic form:

$$\text{Present value of company} = PV = \frac{R * (1 + r) \wedge N * m * P}{\text{present value factor}}$$

$$PV = \frac{R * (1 + r) \wedge N * m * P}{(1 + d) \wedge N}$$

where:

PV	=	Present value of the venture
R	=	Annual revenue rate of the company at present (second stage)
r	=	Average compound rate of growth of revenue between the present stage (second stage) and the liquidity stage.
N	=	Number of years between the present stage and liquidity stage
R * (1 + r) ^ N	=	Estimated level of annual revenue as of liquidity stage
m	=	Estimated future (liquidity stage) after-tax profit margin
P	=	Estimated future (liquidity stage) price/earnings ratio
d	=	discount rate

In the simplified example described above, the $ 2 million current level of revenue is "grown" mechanically at a constant rate of 50% per year. Of course, in the real world, revenue growth is usually very irregular from year to year. A VC will look at the absolute level of revenue in each year relative to the expected size of the market (or market niche), and also the relative market shares of actual and potential competitors.

Another potential complication in applying the conventional VC method is how to treat future tax savings from net operating loss carryforwards, popularly known as "the value of the tax losses." Most VC-backed companies have start-up losses. Indeed, most VC investment goes to cover such start-up losses, rather than for purchase of fixed assets. Although they are labeled "operating losses" on financial statements, they often represent investment in R&D, the most important kind of investment that a high technology company can make. Sometimes the net operating losses are applied to later profitable years and are used up before a company reaches the cash-out point. In those cases, there is no problem. If, however, the tax losses are not projected to be used up at the point of cash-out, the VC analyst should eliminate their effect on projected earnings before applying a price/earnings ratio as part of the conventional VC method. Underwriters and other participants in the IPO markets will ordinarily make this adjustment, so it should be anticipated in the analysis done by the VC.

The conventional VC valuation method, at least in this very simplified form, is an example of what economists call "comparative statics analysis." That is, there are only two points in time. In this case, the two points in

time are the present and the future cash-out date. At the extreme, there is no consideration of the path in between the two dates, or the relevance of events beyond the cash-out date. VCs don't really put blinders on to this extreme extent, but it it good to keep in mind that the conventional VC method does put heavy importance on the cash-out point in time.

B. The First Chicago method -- alternative scenarios:

The First Chicago method[1] could also be called the Golder method, but it isn't. It was originated by Stanley C. Golder while he was President of the Equity Group of First Chicago Corporation (which no longer exists under that name). In 1980, Stan Golder founded Golder, Thoma, and Cressey, another Chicago-based venture fund.

The First Chicago method employs exactly the same financial analysis techniques as the conventional VC method, except that three different "outcome scenarios" are considered and later given probability weightings. The three scenarios are labeled "success," "sideways survival," and "failure." The beauty of the First Chicago method is that it forces the VC to think out three separate and complete "stories" of how the investment might turn out. He can't just chop down the revenue and earnings numbers in the business plan, and then crank the revised numbers through the conventional VC method.

Table 4 shows the three scenarios of success, sideways survival, and failure for HITECH, INC., the same case example that was used above to illustrate the conventional VC method. In the success scenario, revenue grows at 60% per year, and reaches $20.97 million in five years, at which time the company goes public through an IPO. The after-tax profit margin is 15%, so the level of earnings is $ 3.15 million. The price/earnings ratio is expected to be 17, so the market capitalization of the company is $ 53.55 million at the point of cash-out. Using a discount rate of 40%, the five year holding period implies a present value factor of 5.378. Dividing the cash-out value of $ 53.55 million by the present value factor of 5.378 yields a present value of $9.957 million.

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[1] The First Chicago method is described in Stanley C. Golder, "Structuring and Pricing the Financing," in Stanley A. Pratt and Jane K. Morris, Guide to Venture Capital (Venture Economics, 1986).

TABLE 4

An Example of the First Chicago Method
HITECH, INC.

	Success	Sideways survival	Failure
1. Revenue growth rate (from base of $2 million)	60%	15%	0%
2. Revenue level after 3 years	$8.19 million	$3.04 million	$ 2 million (liquidation)
3. Revenue level after 5 years	$20.97 million (IPO)	$4.02 million	
4. Revenue level after 7 years		$5.32 million (acquisition)	
5. After-tax profit margin and earnings at liquidity	15% $3.15 million	7% $ .37 million	
6. Price-earnings ratio at liquidity	17	7	
7. Value of company at liquidity	$53.55 million	$2.61 million	$ .69 million
8. Present value of company using discount rate of 40%	$9.96 million	$ .25 million	$ .25 million
9. Probability of each scenario	.4	.4	.2
10. Expected present value of the company under each separate scenario	$3.98 million	$ .10 million	$ .05 million
11. Expected present value of the company	$4.13 million		
12. Percentage ownership required in order to invest $2.5 million	60.5%		

In the sideways survival scenario, revenue grows at 15% per year, and takes seven years to reach $ 5.32 million, at which time the company is acquired by another company. Note that "survival" doesn't necessarily mean that the company survives as a separate entity. It means that the VC's investment survives. Because of the lower volume of revenue, the after-tax profit margin at point of cash-out is only 7%, and the level of earnings is only $ .37 million. The price/earnings ratio obtained in the acquisition is only 7, because a revenue growth of only 15% per year implies a company that is only growing moderately faster than the 6-10% rate that combines real growth plus inflation in the economy as a whole. Using this price/earnings ratio, the value of the company at the time of acquisition is $ 2.61 million. Using a discount rate of 40%, the seven year holding period implies a present value factor of 10.541. Dividing the cash-out value of $ 2.61 million by the present value factor of 10.541 yields a present value of the company of $ .25 million.

In the failure scenario, revenue never grows beyond the $ 2 million level that existed at the time the $ 2.5 million was invested. The company never becomes profitable, and is liquidated for $.69 million after three years. Using a discount rate of 40%, the three year holding period implies a present value factor of 2.744. Dividing the cash-out value of $ .58 million by the present value factor of 2.744 yields a present value of the company of $ .25 million.

Note that the present value of the company is $ .25 million under both the sideways survival scenario (holding period of 7 years) and the failure scenario (holding period of 3 years). We made the numbers come out this way to illustrate an important point. Even though the cash-out value is $2.61 under the sideways survival scenario, and $ .69 million under the failure scenario, the present value of the company is identical under either scenario. The extra four years of effort have gained nothing in terms of enhancing the present value of the company. There is a saying in venture capital that "lemons mature faster than pearls." That saying compares the holding period of the failure scenario with that of the success scenario. Another truism, illustrated by the scenarios of Figure 2-2, is that the "living dead" (the companies that won't die, but also won't ever be successes by VC standards) can take the longest to mature, if the VC allows the agony to go on that long. From the point of view of maximizing the return to the investors in the VC funds, it may be best not to prolong the agony. Money taken out of sideways companies can be reinvested in follow-on rounds for companies with greater potential.

The use of the First Chicago method has great benefit even if one stops right here. Thinking through three separate scenarios of investment outcome is a very

insightful process. As the VC stares at the scenarios, he is likely to be very sobered by the realization that the particular scenario of success in the company's business plan is only one scenario. There are other very plausible scenarios of sideways survival and failure, and there are even other plausible scenarios of success.

Lines 8 through 11 in Table 4 illustrate the steps involved in finishing up a First Chicago method valuation. The VC must assign probability weights to the three scenarios. These probability weights must add to 1.0. Then, the present value of the company under each scenario is multiplied times the probability to obtain the expected present value of the company under each separate scenario. The total of these numbers is the "expected present value of the company" (shown on line 10 in table 4). For HIGHTECH INC., the expected present value of the company is $ 4.13 million. If the potential investment of $2.5 million is divided by the expected present value of the company of $ 4.13 million, the minimum percentage required ownership for the VC is 60.5%.

The First Chicago method is useful for asking and answering "what if" questions. For example, a VC might ask the question "How much higher would the chances of the success scenario have to be for the expected present value of the company to be $ 5 million?" Since the sideways survival and failure scenarios have the same present value ($ .25 million) in Table 4, we can represent the expected present value formula as follows:

$$\$ 4.13\ M = .4\ (\$ 9.96M) + (1-.4)\ (\$.25M)$$

or

Expected PV of co. =
(prob success)(PV success) + (1-prob success)(PV non-success)

If we are asking what the probability of success has to be to make the expected value of the company $ 5M, than we write the formula as follows:

$$\$ 5M = (\text{prob success})\ (\$ 9.96M) + (1-\text{prob success})\ (\$ .25M)$$

Solving this equation for the probability of success, one learns that the probability of the success scenario has to be .59 in order for the expected present value of the

company to be $ 5 million.

On the downside, one could ask how much lower the probability of success would have to be to lower the expected present value of the company to $ 2.5 million (the amount of the required capital). Going through the same process as shown above, one learns that the probability of the success scenario has to be only .23 for the VC to recover his investment of $ 2.5 million. That may provide enough comfort for the VC to proceed with the investment. As we have seen, using the First Chicago method framework to answer "what if" questions can be a very powerful tool of analysis.

In describing the First Chicago method, we have used the same discount rate (40%) in our example as we used in the conventional VC method. This is the way VCs do it, but it is not really conceptually correct. In the conventional VC method the uncertainty in VC investing is embodied into the discount rate as a "risk premium," whereas in the First Chicago method the uncertainty (or at least some of it) is represented by the use of probability-weighted scenarios. So, to be conceptually correct, one should use lower discount rates when using the First Chicago method. The results of the QED Survey of Venture Capital Valuation Methods indicate that the VCs who say they use the First Chicago method as their primary method don't use any lower discount rates than other VCs. So VCs are either unaware of this conceptual problem, or choose to ignore it.

C. Revenue multipliers (value-to-revenue ratios):

A revenue multiplier is a factor that can be multiplied times the revenue of a company to obtain a rough estimate of the value of the company.

One needs to be clear about the meaning of "revenue." It refers to the level of shipments of product during a period of time. One should not be loose in terminology and refer to "sales" instead of revenue. "Sales" can mean "new orders." The shipment of product (earning of revenue) often occurs months (and sometimes years) after a new order is placed. "Sales" can also mean "revenue" to some people, but this is not the precise meaning of revenue. Likewise, one should not confuse "revenue" and "cash receipts." It can be 30 days, 60days, or 90 days after product is shipped (and thus revenue earned) before payment is received. In accounting terminology, revenue is something that is "accrued" at the time product is shipped. Whether a company keeps its books (or tax records) on a cash or accrual basis, for purposes of valuation it is the accrued revenue that is the relevant variable.

In defining the stages of investment, the dividing line between the First Stage (early development stage) and the Second Stage (expansion stage) is the point when the company begins shipping product in commercial quantities. This does not mean sales of test units to selected customers to get their technical feedback, or the discounted sales of a few units to known customers for "test marketing." This means having a production facility capable of producing in commercial quantities and a marketing structure capable of servicing customers on a routine basis. Once these elements are in place, and there is genuine feedback from the market, it becomes more meaningful to apply revenue multipliers for purpose of valuation. Thus, the usual application of revenue multipliers is from the Second Stage onward.

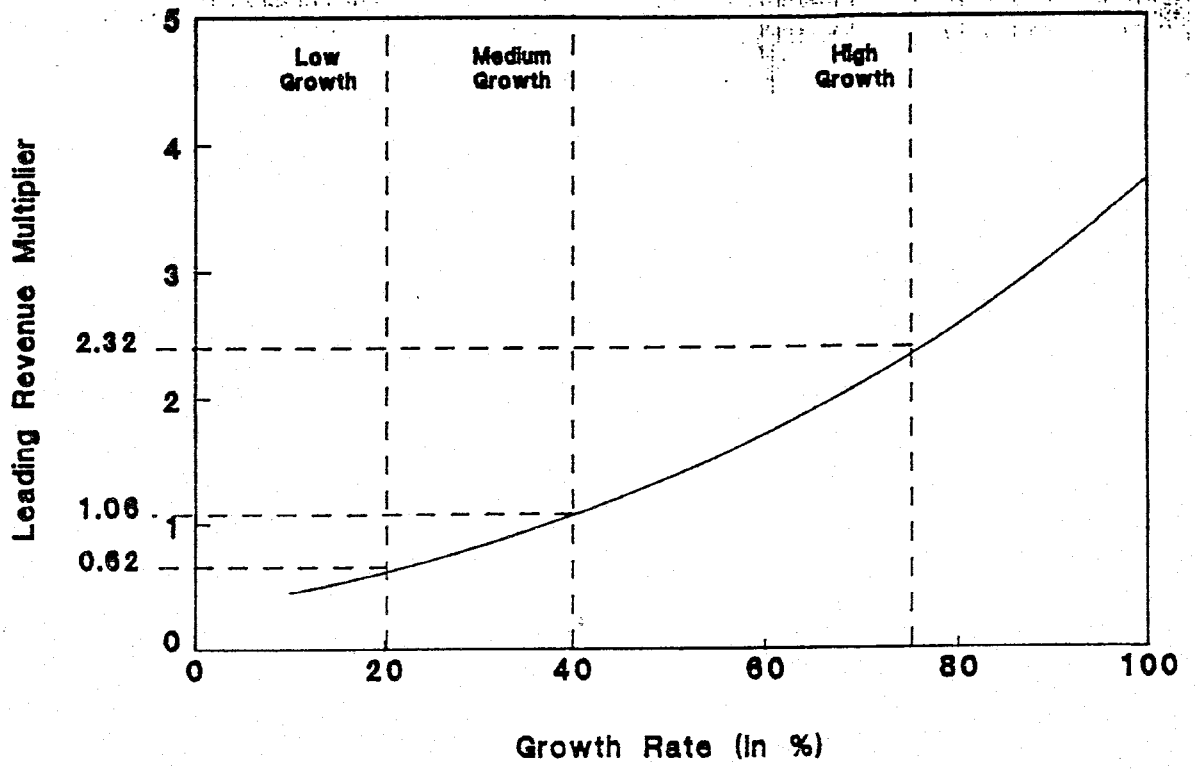
Revenue multipliers can be applied to various definitions of revenue. From the responses to the QED Survey of Venture Capital Valuation Methods, it appears that more VCs use the annual revenue level estimated for the current fiscal year. Almost as many VCs use the revenue estimated (by the VC, not the company) for the next twelve calendar months.

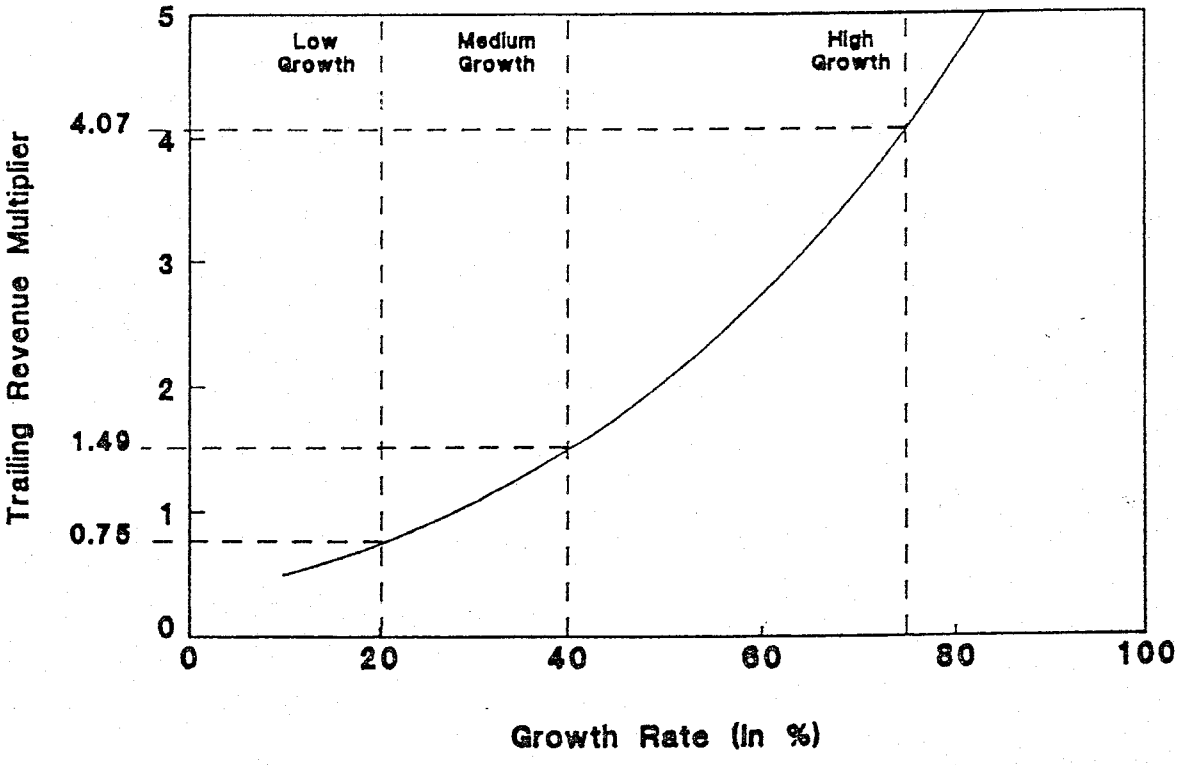
The conceptual weaknesses of using revenue multipliers for valuation are obvious. A valuation based upon a revenue multiplier does not take account of cross-sectional variations in the types of companies in which VCs invest: specifically, variations across industries and products in the level of a) profit margins, b) fixed asset intensity required, c) working capital intensity required, d) R&D intensity required, e) R&D lead times, f) marketing lead times. The analysis of Section 6 attempts to reduce some of these deficiencies. Although revenue multipliers are used very widely, they are just rules of thumb that have evolved mainly by word of mouth. Prior to this research, there was no examination of how they were used in practice, or how they ought to be used.

Figure 5 shows a "QED curve." The size of the revenue multiplier is customized to a) technology sector, b) the development stage of the company, c) the rate of growth of revenue, and d) whether the VC is using a "leading multiplier" definition of the revenue base (next 12 months) or a "trailing revenue multiplier" definition of the revenue base (last 12 months). These curves are one of the most popular feature of the 1987 QED report and the new report, Venture Capital and High Tech Business Appraisal.

TABLE 5

Computer Systems & Software/Second Stage





D. Different emphasis among valuation methods at different stages of investment:

Revenue multipliers are used as a primary valuation method more in the early stages of investment--First Stage, Second Stage, and Third Stage. Since companies at these stages of development have either negative profit margins, or positive profit margins that are smaller than what they would be for volume sales, it is natural to look to valuation techniques that are oriented toward revenue rather than earnings.

As a company moves through the Third Stage, it is possible to get a better feel of what profit margins will be like with volume sales, and a sense from market feedback what the speed and ultimate limits of market penetration are likely to be. Thus, it becomes easier to apply the earnings-oriented methods, and just use revenue multipliers as a backup check.

E. Rate of return -- not a separate valuation method:

Some respondents to the QED Survey of Venture Capital Valuation Methods rebelled at the choices given them and wrote in the margin "I use the rate of return method," or the "internal rate of return method." Using a rate of return by itself cannot yield a present value of a company, and so it cannot be viewed as a separate valuation method.

Also, when someone says they use a rate of return method, it is not clear whether they mean a) they calculate a rate of return from a whole stream of positive and negative cash flows or annual earnings figures, or b) they are just making a rate of return calculation that compares a one-time capital investment with a one-time cash-out.

IV. DOING VC FINANCIAL CALCULATIONS ON AN HP-18C OR AN HP-19C

Any of the above financial calculations can be done on any financial calculator. For example, any of the above equations can be done one and a time on the HP-12C, which is a very popular small financial calculator.

One step up from the HP-12C is the HP-18C, or its later version the HP-19C. These calculators are particularly powerful because they allow you to easily input a series of equations, and these equations are linked if the same variable appears in more than one equation. This means that, after you input the equations and initial numerical values for each variable, you can then do "what if" calculations by changing the numerical value of any single variable. When you do that, the numerical values of all the other variables change automatically.

Much of the above financial analysis can be condensed into the following six equations[2]

FR = R x (1 + r) ^ N

FV = FR x m x P

PV = FV / (1 + d) ^ N

OWN = C / PV

NDIL = ODIL / (1-OWN)

PRICE = PV / NDIL

where:

FR = Future annual revenue level

R = Present annual revenue level

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[2] Note that the HP-18C or HP-19C uses the symbol "x" or ("times") to indicate multiplication, rather than the symbol "*" which was used in our text above. The symbol "*" is favored in spreadsheet programs.

r	=	Estimated coumpound rate of revenue growth thru liquidity
N	=	Number of year in between investment and liquidity
FV	=	Estimated future value of company as of liquidity date
m	=	Estimated after-tax profit margin as of future liquidity date
P	=	Estimated price/earnings ratio as of future liquidity date
d	=	Discount rate (target rate of return for the VC)
OWN	=	Ownership proportion required by the VC
C	=	Cash investment level being considered by the VC
NDIL	=	New dilution (total shares + options + warrants) after the VC investment
ODIL	=	Old dilution before the VC investment occurs
PRICE	=	Price per share for the VC investment

V. DOING VC FINANCIAL CALCULATIONS ON A LOTUS SPREADSHEET

As powerful as the HP-18C or HP-19C is for doing "what if" excursions off of a base case scenario, it can still deal with only one scenario at a time. With a Lotus 1-2-3 spreadsheet program, or any other spreadsheet program (Excel, Quattro Pro), you can simultaneously incorporate more than one scenario in your analysis, and see how the "expected value answer" varies with different probabilities of occurence of each scenario.

Table 6 shows a spreadsheet presentation of the "First Chicago method" as it was applied to a case study used a few years ago at the Venture Capital Institute. The "expected value solution" is shown in the column on the right.

The six steps involved in going from future estimated annual revenue to an implied price per share are identical to the six equations that were used above for the HP-18C and the HP-19C. Only with the Lotus 1-2-3 spreadsheet, the equations are built into the codes for calculating the values in each cell of the spreadsheet.

TABLE 6: SPREADSHEET ANALYSIS OF VC PRICING

Base revenue level(year 0)=	$5,000			
Discount rate=	35%			
Old dilution=	22026			
After-tax profit margin=	7%			
Price/earnings ratio=	12			
Proposed VC investment=	$765			
REVENUE GROWTH(COMPOUND	30.0%	54.7%		EXPECTED VALUE
PROBABILITY OF OCCURING	15%	50%	35%	
1984 LIQUIDITY				
Future revenue level	$10,985	$18,511	$5,000	$12,653
Future value	$9,227	$15,550	$4,200	$10,629
Present value	$3,750	$6,320	$1,707	$4,320
Required VC ownership %	20.40%	12.10%	44.81%	24.80%
New total dilution	$27,670	$25,059	$39,912	$30,649
Implied price per share	$136	$252	$43	$161
1985 LIQUIDITY				
Future revenue level	$14,280	$28,637	$5,000	$18,211
Future value	$11,996	$24,055	$4,200	$15,297
Present value	$3,612	$7,242	$1,264	$4,605
Required VC ownership %	21.18%	10.56%	60.50%	29.63%
New total dilution	27946	24627	55760	36022
Implied price per share	$129	$294	$23	$174