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A NOTE ON VALUATION OF VENTURE CAPITAL DEALS

When times are mysterious serious numbers are eager to please.
—Musician, Paul Simon, in the lyrics to his song *When Numbers Get Serious*

In this note, I discuss some of the fundamental issues of valuation in venture capital deals. The topics discussed are not necessarily limited to venture capital backed companies, but they frequently surface in entrepreneurial companies that are financed either by venture capitalists or other private equity investors.

In section 1, I introduce the so-called venture capital method. This is really a simple net present value (NPV) method that takes the perspective of the investor instead of the firm. This method has the advantage of extreme simplicity, but it makes many strong assumptions that limit its usefulness. I focus on three main issues in the remaining sections. In section 2, I examine the problem of determining the terminal value. In section 3, I examine the treatment of risk. In section 4, I examine how to determine the funding requirements and I examine a number of ways of dealing with multiple financing rounds. In section 5, I briefly cover the use of these methods in actual negotiations.

1. THE BASIC VENTURE CAPITAL METHOD

1.1. An Example

There exists a simple approach to valuation that is sometimes referred to as the venture capital method. The method is sometimes explained in the language of internal rates of return (IRR) and sometimes in terms of NPV. Since most of you have been more exposed to the NPV framework, I will use that language. I will then show that it is in fact *identical* to the IRR framework.

To illustrate my method I will use a fictional start-up company called "SpiffyCalc" that is seeking financing from a venture capital fund by the name of "Vulture Ventures." Studying their crystal ball, the founders of SpiffyCalc expect to be able to sell the company for $25 million in

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This note was prepared by Thomas Hellmann, Assistant Professor of Strategic Management, Stanford University, as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

four years.[1] At this point they need to raise $3 million. Vulture Ventures considers this a risky business and wants to apply a discount rate of 50 percent to be adequately compensated for the risk they will bear.[2] The entrepreneurs also decided that whatever valuation they would get, they wanted to own 1 million shares, which they thought would be a cool number to brag about.

It is useful to define variables for the key assumptions we have made.

V = terminal value (at time of exit) = $25 million (in four years)
t = time to exit event = 4 years
I = amount of investment = $3 million
r = discount return used by investors = 50 percent
x = number of existing shares (owned by the entrepreneurs) = 1 million

Step 1: Determine the post-money valuation

The only positive cash flow in this model occurs at the time of exit (typically an IPO or an acquisition), where we measure the terminal value of the company, denoted by V = $25 million. This means that after receiving the required $3 million, the initial value of the company is simply the discounted terminal value in 4 years' time. If Vulture Ventures is using a discount rate of 50 percent, the NPV of the terminal value in four years is $V/(1+r)^t$ = $25 million / $(1.5)^4$ = $4,938,272 = POST. This is called the post-money valuation, i.e., the value of the company once the initial investment has been made. Intuitively, this is the value that is being placed on the entire company. This value is obviously not realized at the time of financing, as it depends on the belief that there will be great financial returns in the future.

Step 2: Determine the pre-money valuation

Subtracting the cost of the investment of $3 million from the post-money valuation yields PRE = $1,938,272. This is called the pre-money valuation.

Step 3: Determine the ownership fraction

Vulture Ventures is investing $3 million in a venture valued at $4,938,272. In order to get back its money it therefore needs to own a sufficient fraction of the company. If they own a fraction F = $3 million / $4,938,272 = 60.75 percent, they get their required rate of return on their investment.

Step 4: Obtain the number of shares

The founders want to hold 1 million shares. When Vulture Ventures makes its investment it needs to calculate the number of shares required to achieve its desired ownership fraction. In order to obtain a 60.75 percent ownership share, Vulture Venture makes the following calculation: let x be the number of shares owned by the founders (x = 1 million) and y be the

[1] In section 2, I discuss how one might replace the crystal ball by a liquid crystal display screen, as a slight improvement in the art of future telling.
[2] In section 3, I discuss discount rates in more detail.

number of shares that Vulture Ventures requires, then y / (1,000,000 + y) = F = 60.75 percent. After some algebraic transformation we get y = 1,000,000 [0.6075 / (1-0.6075)] = 1,547,771. Vulture Ventures thus needs 1,547,771 shares to obtain their desired 60.75 percent of the company.

Step 5: obtain the price of shares

The price of shares is thus given by $3 million / 1,547,771 = $1.94.

1.2. The General Case

We can calculate all important variables of a deal in a simple five step procedure:

Step 1: $POST = V/(1+r)^t$
POST is the post-money valuation.

Step 2: PRE = POST - I
PRE is the pre-money valuation.

Step 3: F = I / POST
F is the required ownership fraction for the investor.

Step 4: y = x [F/(1-F)]
y is the number of shares the investors require to achieve their desired ownership fraction.

Step 5: $p_1 = I / y$
p_1 is the price per share.

1.3 Sensitivity Analysis with the Basic Venture Capital Method

It is interesting to do some sensitivity analysis. How will the value of the company change if we change our assumptions? We will examine the effect of changing the following assumptions:

Variation 1: reduce the terminal value by 10 percent
Variation 2: increase IRR by 10 percent
Variation 3: increase investment by 10 percent
Variation 4: increase time to exit by 10 percent
Variation 5: increase the number of exiting shares: this has no effect on any real values!

Single period NPV method		**Base Model**	**Variation 1**	**Variation 2**
Exit Value	V	$25,000,000	**$22,500,000**	$25,000,000
Time to exit	t	4	4	4
Discount rate	r	50.00%	50.00%	**60.00%**
Investment amount	I	$3,000,000	$3,000,000	$3,000,000
Number of existing shares	x	1,000,000	1,000,000	1,000,000
Post-Money	POST	$4,938,272	$4,444,444	$3,814,697
Pre-Money	PRE	$1,938,272	$1,444,444	$814,697
Ownership fraction of investors	F	60.75%	67.50%	78.64%
Ownership fraction of entrepreneurs	1-F	39.25%	32.50%	21.36%
Number of new shares	y	1,547,771	2,076,923	3,682,349
Price per share	p	$1.94	$1.44	$0.81
Final wealth of investors		$15,187,500	$15,187,500	$19,660,800
Final wealth of entrepreneurs		$9,812,500	$7,312,500	$5,339,200
NPV of investors' wealth		$3,000,000	$3,000,000	$3,000,000
NPV of entrepreneurs' wealth		$1,938,272	$1,444,444	$814,697

Single period NPV method		**Variation 3**	**Variation 4**	**Variation 5**
Exit Value	V	$25,000,000	$25,000,000	$25,000,000
Time to exit	t	4	**4.4**	4
Discount rate	r	50.00%	50.00%	50.00%
Investment amount	I	**$3,300,000**	$3,000,000	$3,000,000
Number of existing shares	x	1,000,000	1,000,000	**2,000,000**
Post-Money	POST	$4,938,272	$4,198,928	$4,938,272
Pre-Money	PRE	$1,638,272	$1,198,928	$1,938,272
Ownership fraction of investors	F	66.83%	71.45%	60.75%
Ownership fraction of entrepreneurs	1-F	33.18%	28.55%	39.25%
Number of new shares	y	2,014,318	2,502,235	3,095,541
Price per share	p	$1.64	$1.20	$0.97
Final wealth of investors		$16,706,250	$17,861,700	$15,187,500
Final wealth of entrepreneurs		$8,293,750	$7,138,300	$9,812,500
NPV of investors' wealth		$3,300,000	$3,000,000	$3,000,000
NPV of entrepreneurs' wealth		$1,638,272	$1,198,928	$1,938,272

1.4. The Treatment of Option Pools

One subtle point in this calculation is the treatment of an employee option pool. Most venture capital deals include a nontrivial amount of shares for the option pool. This option pool will be depleted over time as the company hires executives and other employees. How do we account for the option pool in these calculations? The norm is that the entrepreneurs' shares and the option pool are lumped into one. Consider an example where the entrepreneurs receive 2 million shares, the investors receive 2 million shares, and there is an option pool of 1 million shares. Investors are investing $2 million at $1 per share. We then say that the post-money valuation is $5 million and the pre-money valuation is $3 million. Note, however, that from the

entrepreneurs' perspective they are getting only $2 million of the pre-money valuation. The other $1 million is reserved for the option pool.

1.5. An Alternative Phrasing of the Venture Capital Method in Terms of IRR

The so-called venture capital method is often explained in the language of IRRs. While the IRR is often a problematic method in finance, our venture capital method is sufficiently simple that the IRR and the NPV method give *exactly the same answer*. Below I use the above example to walk you through the logic of the IRR calculation in the way it is sometimes presented as the venture capital method.

Step 1: Determine the future wealth that Vulture Ventures needs to obtain in order to achieve their desired IRR.

When Vulture Ventures decides to invest in a company, it formulates a "desired rate of return." Suppose that Vulture Ventures is asking for 50 percent IRR. Also, SpiffyCalc needs an investment of $3 million. We can then determine how much money Vulture Ventures needs to accumulate in order to achieve its desired return. Vulture Ventures would want to make $3 million $\times (1.5)^4 =$ $15,187,500 in three years.

Step 2: Determine the fraction of shares that Vulture Ventures needs to hold in order to achieve the desired IRR.

To find out the required percentage of shares that Vulture Ventures needs to achieve a 50 percent IRR, we simply divide its required wealth by the estimated value of the company, i.e., $15,187,500 / $ 25 million = 0.6075. Vulture Ventures would thus need 60.75 percent of the shares.

Step3: Determine the number of shares.

When Vulture Ventures makes its investment it needs to calculate the number of shares required to achieve its desired ownership fraction. We assume that the founders of SpiffyCalc issued themselves 1,000,000 shares, and nobody else owns any other shares. We then calculate how many shares Vulture Ventures needs to obtain a 60.75 percent ownership share in the company. Using the same reasoning as before let x be the number of shares owned by the founders (x = 1,000,000) and y be the number of shares that Vulture Ventures requires, then y / (1,000,000 + y) = 0.6075. After some algebraic transformation we have y = 1,000,000 [0.6075 / (1-0.6075)] = 1,547,771. Vulture Ventures thus needs 1,547,771 shares to obtain their desired 60.75 percent of the company.

Step 4: Determine the price of shares

Given that Vulture Ventures is investing $3 million, the price of a share is $ 3 million / 1,547,771 = $ 1.94.

Step 5: Determine post-money valuation

The post-money valuation can actually be calculated in a number of ways. First, if an investment of $3 million buys 60.75 percent of the company, then it must be that 60.75 percent * post-money valuation = $3 million. It follows that the post-money valuation is given by $3 million / 0.6075 = $4,938,272. Another way to obtain the post-money valuation is to note that there are 2,547,771 shares in the company that are valued at $1.94, so the post-money valuation is 2,547,771 * $1.94 ≈ $4.94 million (allowing for rounding error).

Step 6: Determine pre-money valuation

To calculate the pre-money valuation we simply subtract the value of the VC's investment from the post-money valuation. This is $4,938,272 - $3 million = $1,938,272. Another way of calculating the pre-money valuation is to evaluate the existing shares at the new price, i.e., 1,000,000 × $1.94 ≈ $1.94 million (again allowing for rounding error).

We note that all the values are exactly the same as for the NPV method. The only difference is that one additional step was needed in the IRR method, namely to calculate the required wealth of the investors at a future point in time.[3]

Again, we can write down the general case:

Step 1: $W = I(1+r)^t$
W is the amount of wealth investors expect to accumulate.

Step 2: $F = W / V$
F is the fraction of share ownership required by investors.

Step 3: $y = x [F/(1-F)]$
y is the number of shares the investors require to achieve their desired ownership fraction.

Step 4: $p_1 = I / y$
p_1 is the price per share.

Step 5: $POST = I / F$ or $POST = p_1 \times (x + y)$
POST is the post-money valuation.

Step 6: $PRE = POST - I$ or $PRE = p_1 \times x$
PRE is the pre-money valuation.

[3] In the spreadsheet that accompanies the case, future wealth is also discounted back into the present to obtain the NPV of the stakes for the entrepreneurs and investors.

2. ESTIMATING THE TERMINAL VALUE

Conceptually the terminal value represents the value of the company at the time of an exit event, be it an IPO or an acquisition.[4] Probably the most frequently used method to determine the terminal value is to take a multiple of earnings at the time of exit. Typically an estimate is taken of what the earnings are before tax, and then an industry multiple is taken. The difficulty is obviously to come up with a good estimate of the earnings and to find an appropriate industry multiple. This is particularly difficult for highly innovative ventures that operate in new or emerging industries.

Instead of taking a multiple of earnings, one might also consider taking multiples of sales or assets, or indeed of whatever other accounting measure is meaningful in that specific industry. The common methodology of all these multiples calculations is to look at comparable firms in the industry. One problem is that it is often difficult to find truly comparable companies. Another problem is that one typically looks at recent comparable deals. If a company is financed at a time when the stock market peaks and it uses recent IPOs as a basis of comparison, it will obtain large multiples. But these multiples may not reflect the multiples that it will be able to obtain when it plans to go public several years later.[5]

In principle, better methods of estimating terminal value would be to use NPV, CAPM, APT, or whatever equilibrium valuation model we think fits the data best. The problem, however, is that it is exceedingly difficult to come up with reasonable cash flow projections. And indeed, again one would look at comparable firms in the industry to come up with these estimates. These calculations may therefore not be much more accurate than the rough estimates using the multiples method.

Note that the implicit assumption for these estimates of the terminal value is typically that they measure the value of the company in case of success. This leads us to examine the issue of risk more carefully.

3. ACCOUNTING FOR RISK

In the venture capital method of valuation, the estimate of the terminal value is typically based on some kind of success scenario. Because there is considerable risk involved in a typical venture capital deal, venture capitalists usually apply a very high discount risk "to compensate for the risk." It is not hard to see why they use this method. Venture capitalists are negotiating with entrepreneurs who are often overconfident and have a strong tendency to overstate the prospects of their new ventures. Venture capitalists can argue with them for some time, but rather than having a long and aggravating debate about these estimates, the VCs can simply deflate them by applying a higher discount rate. I therefore suspect that the venture capital method is simply a victim of bargaining dynamics. The method, however, is rather confusing, as it combines two distinct reasons for discounting. One of the reasons is that VCs need to be

[4] To be precise, the relevant value is the pre-money valuation at the exit event.

[5] While one would think that venture capitalists take this effect into account (and indeed they typically use that argument to talk multiples down) it is still true that venture capital valuations appreciate in times of rising stock markets.

compensated for holding significant (and typically nondiversifiable) risk. The second is that VCs do not believe that the venture will necessarily succeed. The problem here is that the earnings estimate does not represent the *expected* earnings, but the earnings in case of success.[6] There are two closely related ways of dealing with this.

The first method is to simply recognize the fact that the discount rate incorporates a "risk of failure" component, as well as a true risk-diversification component. Since venture capitalists are not diversified, they may use a high discount rate to account for the variability of returns around their expected value.[7] Suppose for example, that the risk-aversion of the VC fund implies an approximate risk-adjusted discount rate of 20 percent. If it was certain that this company would succeed, then the post-money valuation would simply be given by \$25 million / $(1.2)^4$ = \$12,056,327. But suppose now that the investors actually believe that the company might simply falter (with no value left) and that the probability of that event happening is 20 percent each year. The probability of getting the terminal valuation is only $(80 \text{ percent})^4 = 40.96$ percent, so that that the expected post-money valuation is only 0.4096 * \$12,056,327 = \$4,938,272. We chose those numbers such that we get the same post-money valuation as before. This can be seen from the following: Let π be the probability of failure in any one year, then

$$\text{POST} = \frac{(1-\pi)^t X}{(1+r)^t} = \left(\frac{1-\pi}{1+r}\right)^t X = \frac{X}{(1+\tilde{r})^t} \quad \text{where} \quad \tilde{r} = \frac{1+r}{1-\pi} - 1 = \frac{r+\pi}{1-\pi}$$

In our case $\tilde{r} = \frac{1+0.2}{1-0.2} - 1 = 0.5$: a 20 percent failure rate, combined with a 20 percent discount rate, have the combined effect of a 50 percent discount rate. Note that these numbers do not simply add up, so we need to go through the above formulas.

The second method is to allow for a variety of scenarios to generate a less biased estimate of expected returns. Typically we would try to adjust the terminal value to better reflect our true expectations. For example, SpiffyCalc's estimate of \$25 million may have been based on an estimated earnings of \$2.5 million and a multiple of 10. Suppose now that \$2.5 million earnings is in fact an optimistic estimate. Suppose that there is a possibility that SpiffyCalc's product won't work, in which case the company will have no earnings. Or it may work, but the opportunity is smaller than originally hoped for, so that earnings in year three are only \$1 million and the multiple is only 5, reflecting a lower growth potential. Suppose now that each of these three scenarios are equally likely. The expected terminal value is not \$25 million but only 1/3*\$0 + 1/3*5*\$1 million + 1/3*10*\$2.5 million = \$10 million.

When valuing the company, the VC may now use a lower discount rate that reflects only the true amount of risk in the venture. Using the corrected estimate of \$10 million and applying a 20 percent discount rate as before leads to a post-money valuation of \$4,822,531. The VC would need to own 62.21 percent of the company.

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[6] Technically speaking, the first aspect is true risk as measured in terms of the variance (or covariance) of returns. The second aspect does not concern the variance, but the overestimation of the mean.

[7] The limited partners of the VC funds, however, tend to be very diversified. This can lead to some conflicts of interest, which we will not dwell on here.

4. INVESTMENT AMOUNTS AND MULTIPLE ROUNDS OF FINANCE

How do we determine the amount of money that needs to be raised? Again, there are a variety of methods. A simple and powerful method is to go to the entrepreneurs' financial projections, and look at their cash flow statement, which tracks the expected cash balances of the company over time. An important insight that comes out of this method is that it is often better to raise money in several rounds. We illustrate this with our hypothetical example of SpiffyCalc.

4.1 An Example

Starting with a cash balance of $0, the company project the following cash balances:

End of year 1	End of year 2	End of year 3	End of year 4	End of year 5
$(1,600,000)	$(2,700,000)	$(4,600,000)	$(2,600,000)	$ 1,200,000

Looking at these numbers, SpiffyCalc realized that raising $3 million would get the company through its first two years. But after two years the company would need some additional money to survive. Indeed, SpiffyCalc estimated that the lowest cash balance would occur at the end of year three, and that it would generate positive cash flows thereafter. The company therefore recognized that it needed to raise a total of $4.6 million. It also thought that it was more prudent to leave itself with some safety cushion, so it decided to raise a total of $5 million dollars. When it put those numbers into its spreadsheet, however, the numbers demonstrated that investors needed to receive 101.25 percent of the company and that its pre-money valuation was -$61,728. This obviously means that at $5 million, the project was a negative NPV project.

But SpiffyCalc also noticed that it didn't need to raise the entire $5 million right from the start. For example, it could initially raise $3 million, and then raise the remaining $2 million after two years. In this case, the valuation method needs to take into account that the equity that first round investors put into the business will be diluted in future rounds. This is a difficult problem, as it requires that we make assumptions about the terms of financing of these future rounds. While these assumptions may be difficult to get by, ignoring them will almost certainly lead to an inaccurate valuation. Indeed, ignoring future dilution will lead the venture capitalist to pay too much. The NPV framework is the most flexible and powerful method to account for future dilution.[8]

Suppose now that SpiffyCalc has already identified "Slowtrain Investors" as a potential investor for that second round. Suppose also that all investors apply a 50 percent discount rate through the four years before SpiffyCalc expects to be acquired. At the end of the second year, when "Slowtrain Investors" makes the second round investment, it would be doing the same calculation as we did above. It would use $POST_2$ = $25 million / $(1.5)^2$ = $11,111,111 as the

[8] It is sometimes argued that future dilution does not matter in efficient markets, but we have to be careful with this argument. In a typical venture capital situation the company can only meet its financial projections if it manages to raise additional capital. In that sense the future dilution applies not to new investment opportunities of the company, but to the realization of the current investment opportunity. As an early round investor we therefore want to take account of the future dilution. This is different from the scenario in which future dilution relates to raising money for future investment opportunities that are additively separable from the current investment.

post-money valuation. It would ask for a 2,000,000 / 11,111,111 = 18.00 percent ownership stake. This means that the existing owners of the firm (the founders) and the first round investors (Vulture Ventures) would jointly only retain 82 percent of the company, or 0.82 * $11,111,111 = $9,111,111. This is also the pre-money valuation at the time of this second round of financing, and no coincidence, since the pre-money valuation measures precisely the value for the existing owners of the firm.

For the first round investment, Vulture Ventures can then expect the company to be worth $9,111,111 at the time of the second round, i.e., in two years' time. It then uses the same method as above to calculate the post-money valuation at the time of the first round, i.e., $POST_1$ = $9,111,111 / $(1.5)^2$ = $4,040,383. This implies that it will ask for 3,000,000 / $4,040,383 = 74.09 percent of the shares of the company. Note, however, that Vulture Ventures will not own 74.09 percent after four years. Instead, it expects a future dilution that will bring its ownership down to f_1 = 0.82 * 0.7409 = 60.75 percent (the lower case notation indicates final ownership, after dilution). This is obviously a familiar number, as we have seen before that Vulture Ventures needs exactly 60.75 percent to get their required return on their investment of $3 million.

So far we haven't said anything about the number of shares and the price of shares for either the first or second round. In fact, we cannot calculate the price and number of shares for the second round before we calculate the price and number of shares for the first round. For this first round, we use the usual method, i.e., $y_1 = x_1 F_1/(1-F_1)$ = 1,000,000 * 0.7409 / (1-0.7409) = 2,858,824 and thus p_1 = 3,000,000 / 2,858,824 = $1.05. For the second round we repeat the exercise. The important step, however, is to use the correct number of shares, namely the total number of existing shares (irrespective of whether they are owned by the entrepreneur or the investor). We have $x_2 = (x_1+y_1)$ = 1,000,000 + 2,858,824 = 3,858,824 as the number of existing shares at the time of the second round. The new number of shares required is thus $y_2 = x_2F_2/(1-F_2)$ = 0.18 / (1-0.18) = 847,059. The price of the second round shares are then given by $2,000,000 / 847,059 = $2.36.

The following table summarizes these assumptions and results.

NPV method with two rounds of financing	**Time of exit**	**Second round**	**First round**
Exit Value	$25,000,000		
Compound discount rate		2.25	2.25
Investment amount		2,000,000	3,000,000
Number of existing shares		3,858,824	1,000,000
Post-Money		$11,111,111	$4,049,383
Pre-Money		$9,111,111	$1,049,383
Ownership Fraction		18.00%	74.09%
Number of new shares		847,059	2,858,824
Price per share		$2.36	$1.05
Ownership shares of entrepreneurs	21.25%		
Wealth of entrepreneurs	$5,312,500	$2,361,111	$1,049,383
Ownership shares of first round investors	60.75%		
Wealth of first round investors	$15,187,500	$6,750,000	$3,000,000
Ownership shares of second round investors	18.00%		
Wealth of second round investors	$4,500,000	$2,000,000	

4.2 The General Case with Multiple Rounds of Financing

We are now in a position to examine the general case. We show the formulas for the case where there are two rounds of financing. All variables pertaining to round 1 (2) will have the subscript $_{1\ (2)}$. The case with an arbitrary number of rounds is a straightforward extension discussed at the end of the section.

Step 1: Define appropriate compound interest rates

Suppose that the terminal value is expected to occur at some date T_3, the second round at some date T_2, and the first round is happening at date T_1. Define $(1+R_2)$ as the compound discount rate between time T_2 and T_3. If, for example, there are three years between the second round and the exit time, and if the discount rate for these three years is 40 percent, 35 percent, and 30%, respectively, then $(1+R_2) = 1.4*1.35*1.3$. The compound discount rate $(1+R_1)$ is defined similarly for the time between dates T_1 and T_2 (not T_3!!!).

Step 2: $POST_2 = V/(1+R_2)$
Where $POST_2$ is the post-money valuation at the time of the second round, V is the terminal value and R_2 is the compound discount rate between the time of the second round and the time of exit.

Step 3: $PRE_2 = POST_2 - I_2$
PRE_2 is the pre-money valuation at the time of the second round of financing and I_2 is the amount raised in the second round.

Step 4: $POST_1 = PRE_2/(1+R_1)$
Where $POST_1$ is the post-money valuation at the time of the first round and R_1 is the compound discount rate between the time of the first and second rounds.

Step 5: $PRE_1 = POST_1 - I_1$
PRE_1 is the pre-money valuation at the time of the first round of financing and I_1 is the amount raised in the second round.

Step 6: $F_2 = I_2 / POST_2$
F_2 is the required ownership fraction for the investors in the second round.

Step 7: $F_1 = I_1 / POST_1$
F_1 is the required ownership fraction for the investors in the first round (this is not their final ownership share, as they will get diluted by a factor of $(1-F_2)$ in the second round).

Step 8: $y_1 = x_1 [F_1/(1-F_1)]$
y_1 is the number of new shares that the investors in the first round require to achieve their desired ownership fraction, and x_1 is the number of existing shares.[9]

[9] If there are no pre-existing shares, one may also fix a total number of shares and then simply allocate them according to the fractions F_1 and $(1-F_1)$.

Step 9: $p_1 = I_1 / y_1$
p_1 is the price per share in the first round.

Step 10: $x_2 = x_1 + y_1$
x_2 is the number of existing shares at the time of the second round.

Step 11: $y_2 = x_2 [F_2/(1-F_2)]$
y_2 is the number of new shares that the investors in the second round require to achieve their desired ownership fraction.

Step 12: $p_2 = I_2 / y_2$
p_2 is the price per share in the second round.

The general case is a straightforward extension of the case with two rounds. First we need to define the compound discount rates between all the rounds. Then we find the post- and pre-money valuations working backwards from the terminal value to each round of financing, all the way back to the first round of financing. For each round we discount the pre-money valuation of the subsequent round to get the post-money valuation of the round. Once we have the post-money valuations for all rounds we can calculate all the required ownership shares. To get the number and prices of shares we begin with the usual formula for the first round and then count up for each round.

4.3 Some Further Examples

Consider a first variation of the model. Suppose that the discount rate is highest in the early years and becomes lower after a while. For example, assume that the discount rate is 60 percent in the first year, stays at 50 percent in years two and three, and falls to 40 percent in the fourth year. This changes our compound discount rates: we have $(1+R_2) = 1.5*1.4 = 2.1$ and $(1+R_2) = 1.6*1.5 = 2.4$

Variation 1	**Time of exit**	**Second round**	**First round**
Exit Value	$25,000,000		
Compound discount rate		2.1	2.4
Investment amount		2,000,000	3,000,000
Number of existing shares		3,661,972	1,000,000
Post-Money		$11,904,762	$4,126,984
Pre-Money		$9,904,762	$1,126,984
Ownership Fraction		16.80%	72.69%
Number of new shares		739,437	2,661,972
Price per share		$2.70	$1.13
Ownership shares of entrepreneurs	22.72%		
Wealth of entrepreneurs	$5,680,000	$2,704,762	$1,126,984
Ownership shares of first round investors	60.48%		
Wealth of first round investors	$15,120,000	$7,200,000	$3,000,000
Ownership shares of second round investors	16.80%		
Wealth of second round investors	$4,200,000	$2,000,000	

There are many other variations that we can examine in this model. A second variation of particular interest is to examine the role of the timing of the second round. Suppose, for example, that SpiffyCalc might be able to delay the timing of the second round by one year. In this case the compound discount rates are given by $(1+R_2) = 1.4$ and $(1+R_2) = 1.6*1.5*1.5 = 3.6$. Delaying the second round of financing would improve the valuation of the company.

Variation 2	**Time of exit**	**Second round**	**First round**
Exit Value	$25,000,000		
Compound discount rate		1.4	3.6
Investment amount		2,000,000	3,000,000
Number of existing shares		3,135,593	1,000,000
Post-Money		$17,857,143	$4,404,762
Pre-Money		$15,857,143	$1,404,762
Ownership Fraction		11.20%	68.11%
Number of new shares		395,480	2,135,593
Price per share		$5.06	$1.40
Ownership shares of entrepreneurs	28.32%		
Wealth of entrepreneurs	$7,080,000	$5,057,143	$1,404,762
Ownership shares of first round investors	60.48%		
Wealth of first round investors	$15,120,000	$10,800,000	$3,000,000
Ownership shares of second round investors	11.20%		
Wealth of second round investors	$2,800,000	$2,000,000	

5. THE DETERMINANTS OF VALUATION: LOOKING BEYOND THE NUMBERS

To put things in perspective, it should be said that any method of valuation depends critically on the assumptions we make. Indeed, any valuation number can be justified by an appropriate choice of the discount rates and the terminal value. There is a more fundamental point here. A valuation method is a sophisticated tool for determining how entrepreneurs and venture capitalists should split the returns of the new venture. But the actual split, i.e., the actual deal, is not really driven by the valuation method, but rather by the outcome of the bargaining between the entrepreneurs and the venture capitalists. The relative bargaining power is thus the true economic determinant of the valuation that entrepreneurs will obtain for their companies. The valuation method, however, is an important tool to master for all parties involved, as it often provides the quantitative basis for the negotiation.