NOTE ON FREE CASH FLOW VALUATION MODELS

Identifying the Critical Factors that Affect Value

Introduction

The purpose of this note is to focus on some of the analytical issues in valuing cash flow streams. Among the issues that will be addressed are:

(1) What is the definition of cash flow?

(2) What effect do changes in the discount rate have on valuation?

(3) How sensitive is value to changes in assumptions about the underlying characteristics of the cash flow stream?

(4) How does growth affect value?

(5) How does the use of leverage affect value?

(6) What are price-to-earnings ratios (PER)?

(7) What factors affect PERs?

A simple three-stage valuation model is presented that enables an analyst to forecast and value a cash flow stream such as might be generated by a company or a specific project. In the section that follows, definitions are provided. Later, the results are analyzed in detail with emphasis on understanding the intuition of the model.

The Mechanics of Discounted Cash Flow[1]

The present value of a cash flow stream is defined as follows:

$$V_0 = \frac{CF_1}{(1 + k)} + \frac{CF_2}{(1 + k)^2} + \frac{CF_3}{(1 + k)^3} + \ldots + \frac{CF_T}{(1 + k)^T},$$

where,

---

[1] See Appendix A for an annotated bibliography on the subject of discounted cash flow and valuation models.

V_0 = present value as of today (time 0)
CF_1 = cash flow in year 1
k = the appropriate discount rate (the "cost of capital")
T = the final year of cash flows (can be infinite)

In valuing a company or a project, there are two clear issues: (1) what should go in the numerator - i.e., what is the appropriate definition of cash flow?; and (2) what should the denominator be - i.e., what is the cost of capital? We turn first to the issue of deciding what to discount. Later in the note, the factors that effect discount rates will be addressed in more depth.

Free Cash Flow

The cash flow generated by a company or project is defined as follows:

	Earnings Before Interest and Taxes (EBIT)
Less	Tax Exposure (tax rate times EBIT)
Plus	Depreciation and other Non-Cash Charges
Less	Increase in Operating Working Capital
Less	Capital Expenditures

Economists call this figure "free cash flow." The definition takes into account the benefits of investing - the income generated - and the costs of investing - the amount of investment in working capital and plant and equipment required to generate a given level of sales and net income.

The definition can fruitfully be refined further. Operating working capital is defined as:

	Transactions Cash Balances
Plus	Accounts Receivable
Plus	Inventory
Plus	Other Operating Current Assets (e.g., Prepaid Expenses)
Less	Accounts Payable
Less	Taxes Payable
Less	Other Operating Current Liabilities (e.g., Accrued Expenses)

Finally, this expanded definition can be collapsed into a simpler one:

	Earnings Before Interest but After Taxes (EBIAT)
Less	Increase in Net Total Operating Capital (FA + WC)

where, Increase in Net Total Operating Capital is defined as:

	Increase in Operating Working Capital
Plus	Increase in Net Fixed Assets.

The Free Cash Flow Input Parameters

In the model (See Exhibit 1), this definition of free cash flow is substituted into the numerator in the discounted cash flow formula. The analyst provides as inputs estimates of each of the key variables in the simpler model above. The required inputs are defined below:

(1) Initial Sales: the sales as of the year prior to the first forecast period;

(2) The estimated rate of growth of sales for the first five years, the second five years, and for the years beyond the tenth year (i.e., years 11 to infinity);

(3) The ratio of EBIAT to Sales for these three periods; and,

(4) The ratio of Net Total Operating Capital to Sales for these three periods.

Based on these inputs, the analyst can determine free cash flow in any given year by means of the following formula:

$$FCF = \{ \frac{EBIAT}{SALES} - (\frac{FA + WC}{SALES} * \frac{g}{(1 + g)})\} * SALES, \text{ where}$$

FCF = Free Cash Flow
EBIAT = Earnings Before Interest but After Taxes
FA = Net Fixed Assets
WC = Net Operating Working Capital
g = Rate of Growth of Sales

By dividing each side by SALES, the ratio of FCF to SALES can also be calculated:

$$\frac{FCF}{SALES} = \{ p - (a * \frac{g}{(1 + g)})\}, \text{ where}$$

$$p = \frac{EBIAT}{SALES} = \text{the profit margin}$$

$$a = \frac{FA + WC}{SALES} = \text{the asset intensity ratio}$$

This formula makes sense because it states that the free cash flow generated in a given year is a function of the profitability of the firm, the asset intensity, and the rate of growth. Holding all other factors constant, free cash flows are higher, the higher is the profit margin, the lower is the capital intensity ratio, and the lower is the rate of growth.

: Cash Flows and Valuation

Exhibit 1

Key Assumptions

Years 1 - 5:		Years 6 - 10:		Terminal Years (Year 11 on):	
Initial Sales	100.0				
Growth Rate	20.0%	Growth Rate	15.0%	Terminal Growth Rate	6.0%
EBIAT/S	10.0%	EBIAT/S	10.0%	Terminal EBIAT/S	10.0%
(FA+WC)/S	50.0%	(FA+WC)/S	50.0%	Terminal (FA+WC)/S	50.0%

anel A

Year	Sales	Growth Rate	EBIAT/ Sales	FA+WC/ Sales	EBIAT	FA+WC	Change FA+WC	FCF	Cumul-ative FCF	FCF/ EBIAT
0	100.0	NA	NA	50.0%	NA	50.0	NA	NA	NA	NA
1	120.0	20.0%	10.0%	50.0%	12.0	60.0	10.0	2.0	2.0	16.7%
2	144.0	20.0%	10.0%	50.0%	14.4	72.0	12.0	2.4	4.4	16.7%
3	172.8	20.0%	10.0%	50.0%	17.3	86.4	14.4	2.9	7.3	16.7%
4	207.4	20.0%	10.0%	50.0%	20.7	103.7	17.3	3.5	10.7	16.7%
5	248.8	20.0%	10.0%	50.0%	24.9	124.4	20.7	4.1	14.9	16.7%
6	286.2	15.0%	10.0%	50.0%	28.6	143.1	18.7	10.0	24.8	34.8%
7	329.1	15.0%	10.0%	50.0%	32.9	164.5	21.5	11.4	36.3	34.8%
8	378.4	15.0%	10.0%	50.0%	37.8	189.2	24.7	13.2	49.4	34.8%
9	435.2	15.0%	10.0%	50.0%	43.5	217.6	28.4	15.1	64.6	34.8%
10	500.5	15.0%	10.0%	50.0%	50.0	250.2	32.6	17.4	82.0	34.8%
11	530.5	6.0%	10.0%	50.0%	53.1	265.3	15.0	38.0	120.0	71.7%

Total Present Value of Free Cash Flows

anel B

Discount Rate	Terminal Growth Rate 0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%
10.0%	234.6	247.5	263.6	284.2	311.8	350.4	408.3	504.8	697.7
12.0%	171.2	177.5	185.2	194.5	206.1	221.1	241.0	268.9	310.8
14.0%	129.3	132.5	136.3	140.8	146.2	152.8	161.1	171.7	185.8
16.0%	100.2	101.9	103.9	106.1	108.7	111.8	115.5	120.1	125.7
18.0%	79.4	80.3	81.3	82.4	83.7	85.1	86.9	88.9	91.3
20.0%	64.1	64.5	65.0	65.5	66.1	66.8	67.5	68.4	69.5
22.0%	52.5	52.7	52.9	53.1	53.4	53.6	53.9	54.3	54.7
24.0%	43.7	43.7	43.8	43.8	43.9	43.9	44.0	44.1	44.2
26.0%	36.7	36.7	36.7	36.6	36.6	36.6	36.5	36.5	36.4
28.0%	31.3	31.2	31.1	31.1	31.0	30.9	30.8	30.7	30.5
30.0%	26.9	26.8	26.7	26.6	26.5	26.4	26.3	26.2	26.0

EBIAT = Earnings Before Interest, But After Taxes
FA = Net Fixed Assets
WC = Operating Working Capital
FCF = Total Free Cash Flow = EBIAT - (Change in FA and WC)
Total Present Value = Present Value of FCF + Present Value of Terminal Value
Terminal Value = FCF in year 11 divided by (Discount Rate - Terminal Growth Rate)

D. The First Chicago method — alternative scenarios:

The First Chicago method[2] 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. In 1980, he founded Golder, Thoma, and Cressey, a 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.

Figure 2-2 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 the company of $9.957 million.

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 public 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 liquidity 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

---

[2] 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).

Figure 2-2
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%		

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 liquidity 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.[3] Using a discount rate of 40%, the three year holding period implies a present value factor of 2.744. Dividing the liquidity value of $ .69 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 liquidity value is $2.61 under the sideways survival scenario, and only $ .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.

---

[3] Obviously, throughout this report there is a huge difference between achieving "liquidity" (exiting a VC illiquid investment in exchange for a liquid asset) and "liquidation" (a sale of company assets and dissolution of a company to satisfy the creditors and shareholders).

Lines 9 through 12 in Figure 2-2 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 11 in Figure 2-2). For HITECH, 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%.

h

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 Figure 2-2, we can represent the expected present value formula as follows:

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

or

$$\boxed{\begin{array}{l}\text{Expected} \\ \text{PV of co.} = (\text{prob success})(\text{PV success}) + (1-\text{prob success})(\text{PV non-success})\end{array}}$$

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

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

Solving this equation for the probability of success, one learns that the probability of the success scenario has to be ~~.53~~ .49 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.