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Finding Firm Value "Quickly" With an Analysis of Debt

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Finding Firm Value "Quickly" With An Analysis Of Debt

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A firm value calculator (FVC) is introduced that is much faster and less tedious than its pro forma counter-part. The additional benefit of this FVC over what is available in the existing literature is a direct analysis of the effect of leverage. The debt analysis is captured within both the firm's cash flow and the discount rate for the firm's cash flow. The calculator can be implemented on a hand-held calculator or on an Excel spreadsheet making the analysis very amenable to the classroom.

INTRODUCTION

Pro forma analysis is still one of the major means by which practitioners are able to generate the value of a given firm or project. Essentially a time series of cash flows is estimated and then discounted to produce the valuation. Many assumptions are necessary and are often adjusted to produce different scenarios. The process can be tedious and prone to mistakes even when all of the underlying assumptions are correct. This is not only frustrating to practitioners but to students as well.

In a recent article, Arnold and James [2000] produce a Firm Value Calculator (FVC) that can replace or be used as a means to correct a pro forma analysis. The FVC discounted Free Cash Flows and was much simpler and quicker than a pro forma analysis. The FVC took advantage of growth annuity and growth perpetuity calculations to produce the valuation. However, the effect of a particular capital structure only enters into the FVC by the selection of the discount rate. Further, if one considers the tax shield of debt as a component in the valuation, the FVC calculation falls short.

In the following sections, a new Firm Value Calculator is produced that incorporates the tax shield of debt (we'll call it the FVCD). Further, a means by which the discount rate can adjust for a firm's or project's capital structure and taxation is incorporated. The result is a more robust valuation tool that is easier to implement and more amenable to demonstrating the consequences of capital structure and taxation.

By eliminating much of the tedium involved in pro forma analysis, the student can focus on the issues of capital structure, leverage, and tax shelters. The only additional assumption beyond that of the FVC is the use of a target debt-to-equity ratio.

In section one, a five period sales-driven pro forma analysis to calculate the Free Cash Flow and the Cash Flow from Assets is created. In section two, the FVCD valuation method is generated followed by a discussion of the problem of using the previous pro forma statement for firm valuation. In section three, the discount rate is adapted to adjust for the firm's capital structure and taxation using a "levered-beta" approach. Section four summarizes the paper.

A SALES-DRIVEN PRO FORMA ANALYSIS WITH A TARGET DEBT-TO-EQUITY RATIO

The pro forma model (for illustration purposes) assumes a specific growth rate for the firm's sales for the next five years. It also assumes that the firm consciously maintains a specific target debt-to-equity ratio, where the debt-to-equity ratio is defined as the ratio of long-term debt to total equity. Other specifications for the debt-to-equity ratio can be incorporated as well. The pro forma analysis used is an adaptation of a pro forma model illustrated in Benninga and Sarig [1997].

Portions of the balance sheet and income statement are produced as a percentage of the projected sales figure. However, a "slack" or "plug" term exists in the balance sheet in order for the balance sheet to balance. In this example, assume the slack term to be the stock account. Since the stock account is not actually dependant on information from the income statement, it can be calculated in a direct manner without the aid of an iteration routine (iteration routines are necessary when a circular reference occurs within the pro forma analysis and is a common occurrence when long-term debt is the plug value). More specifically, the assumption of a target debt-to-equity ratio will create specific proportions for the long-term debt account relative to the total equity account (total equity is the stock account plus the retained earnings account).

To develop the pro forma analysis, take an initial income statement and balance sheet, assume a sales growth rate, and generate inputs for the analysis. Figure 1 displays the initial financial information necessary.

Assume that sales will grow over the next five years at a rate of 7% and further assume that operating expenses, current assets, fixed assets, and current liabilities are all a constant proportion of sales. This is equivalent to assuming that these four accounts also grow at 7%, but it is much easier to calculate the accounts as a proportion of sales instead of allowing the accounts to grow individually. The proportions are set by taking the given accounts initial value and dividing it by the initial sales value. Thus, operating expenses (cost of goods sold plus salaries, general, and administrative expenses) are 70% of sales ($700 / $1,000), current assets are 12% of sales ($120 / $1,000), fixed assets are 85% of sales ($850 / $1,000), and current liabilities are 5% of sales ($50 / $1,000). These four inputs along with the sales growth rate provide half of the necessary inputs for the

Figure 1. Initial Financial Information

Initial Income Statement

Sales Revenue:	$1,000.00
Operating Expenses (COGS and SG&A):	$700.00
Depreciation Expense:	$42.50
EBIT (Earnings Before Interest and Taxes):	$257.50
Interest Expense:	$12.40
EBT (Earnings Before Taxes):	$245.10
Taxes:	$98.04
EAT (Earnings After Taxes):	$147.06
Paid as Dividends:	$88.24
Paid to Retained Earnings:	$58.82

Initial Balance Sheet

Assets:	
Current Assets:	$120.00
Fixed Assets at Cost:	$850.00
Accumulated Depreciation:	$300.00
Net Fixed Assets:	$550.00
Total Assets:	$670.00
Liabilities and Equity:	
Current Liabilities:	$50.00
Long-Term Debt:	$124.00
Total Liabilities:	$174.00
Stock:	$396.00
Accumulated Retained Earnings:	$100.00
Total Equity:	$496.00
Total Liabilities and Equity:	$670.00

pro forma analysis. The other five inputs pertain to depreciation, interest expense, taxation, dividend policy, and capital structure. These inputs are developed in the order proposed in the previous sentence.

Assume depreciation expense to be straight-line over a number of years. The number of years of depreciation becomes the pro forma analysis input and is determined

Figure 2. Pro Forma Input Parameters Developed From the Initial Income Statement and Balance Sheet Information

Pro Forma Input:	Input Value:	Calculation:
Sales Growth Rate:	7%	given
Operating Expenses* per Sales:	70%	$700.00 / $1,000.00
Current Assets per Sales:	12%	$120.00 / $1,000.00
Fixed Assets per Sales:	85%	$850.00 / $1,000.00
Current Liabilities per Sales:	5%	$50.00 / $1,000.00
Depreciation Periods:	20 years	$850.00 / $42.50
Interest Expense:	10%	$12.40 / $124.00
Tax Rate:	40%	$98.04 / $245.10
Dividend Payout Ratio:	60%	$88.24 / $147.06
Target Debt-to-Equity Ratio**:	25%	$124.00 / $496.00

*Operating Expenses include cost of goods sold and salary, general, and administrative expenses

**Debt-to-Equity ratio is defined as long-term debt over total equity

by taking the initial fixed assets figure and dividing it by the initial depreciation expense. Thus, depreciation is taken over a 20 year period ($850 / $42.50). Alternatively, one could view the depreciation expense as a rate of 5% per year (1 / 20 years or $42.50 / $850).

The pro forma analysis input for the interest expense is determined by the interest rate on the long-term debt. Take the initial interest expense and divide it by the initial long-term debt figure to produce the long-term interest rate. Consequently, the long-term interest rate is 10% ($12.40 / $124). Similarly, the tax rate (another input) is 40% and found by taking the initial tax figure and dividing it by the initial earnings before taxes (EBT) figure ($98.04 / $245.10).

The final two pro forma analysis inputs are the dividend payout ratio and the debt-to-equity ratio. The dividend payout ratio is computed by dividing the initial amount paid in dividends by the initial earnings after taxes. Similarly, the debt-to-equity ratio is the initial long-term debt divided by the initial total equity figure. In this case, the dividend payout ratio is 60% ($88.24 / $147.06) and the debt-to-equity ratio is 25% ($124/$496). Figure 2 summarizes all of the pro forma analysis inputs.

To generate the pro forma income statement and balance sheet for the following year, simply allow the sales figure to grow by 7% to $1,070 ($1,000*(1 + 7%)) and then start calculating the remaining accounts using the remaining nine inputs. Earnings before interest and taxes (EBIT), earnings before taxes (EBT), and earnings after taxes (EAT) are calculated in the standard fashion (EBIT = sales – operating expense – depreciation expense, EBT = EBIT – interest expense, and EAT = EBT – taxes). For this reason the discussion will be limited to calculations of the particular accounts pertaining to the inputs (input signified by bold lettering).

Beginning with the income statement, operating expense is **70%** of the current sales and becomes $749. Depreciation expense is the average of last period's fixed assets with this period's fixed assets divided by **20** periods. Consequently, the current period's fixed asset figure is necessary, which is $909.50 (**85%** of current sales). As a result, depreciation expense is $43.99 (($850 + $909.50) / 2 / 20). EBIT is calculated to be $277.01.

Although it may seem like a detour, portions of the balance sheet need to be calculated before returning to the income statement. The current assets are **12%** of current sales, which is $128.40. The accumulated depreciation is simply the previous year's accumulated depreciation ($300) plus the current depreciation expense of $43.99. Thus, the net fixed assets are $565.51 ($909.50 less $343.99). This yields a calculation for total assets of $693.91.

The current liabilities account is **5%** of current sales, which is $53.50. It is known that the remaining liability and equity accounts must add to $640.41 (total assets less current liabilities). Given a debt-to-equity ratio of **25%** based on long-term debt over total equity, we have the ability to apportion the $640.41. The proportion of the $640.41 that is long-term debt is 20% based on the associated debt ratio (debt ratio = 1 – 1 / (1 + debt-to-equity ratio)). Thus, long-term debt is $128.08 (20%*$640.41). The remaining $512.33 ($640.41 - $128.08) is the total equity. The income statement can now be finished.

From EBIT, the interest expense is subtracted to find EBT. The interest expense is **10%** multiplied by the long-term debt of $128.08 yielding $12.81. Notice, the balance sheet calculations were necessary to find the long-term debt and, in turn, the interest expense. The associated EBT is $264.20 ($277.01 - $12.81). The tax rate is **40%** creating a tax expense of $105.68 (40%*EBT). After accounting for taxes, the EAT is $158.52 ($264.20 - $105.68). The dividends are **60%** (dividend payout ratio) of the EAT, which is $95.11. The remaining EAT ($63.41) is added to the retained earnings account. With this last piece of information, the balance sheet can be completed.

The retained earnings is the previous retained earnings plus the amount of EAT remaining after paying dividends. Thus, $163.41 ($100.00 + $63.41) of the total equity of $512.33 belongs to retained earnings. The remaining equity of $348.92 ($512.23 - $163.41) remains in the stock account. Technically, the stock account is the plug value equal to total assets less total liabilities less retained earnings, although it has been

Figure 3. Pro Forma Calculations Projected for One Year

Income Statement Account:	Projection:	Calculation:
Sales Revenue:	$1,070.00	$1,000.00 * (1 + 7%)
Operating Expenses*:	$749.00	Current Sales * 70%
Depreciation Expense:	$43.99	(Average F/A**) / 20
EBIT:	$277.01	
Interest Expense:	$12.81	10%*(Long-term Debt)
EBT:	$264.20	
Taxes:	$105.68	40%*EBT
EAT:	$158.52	
Paid as Dividends:	$95.11	60%*EAT
Paid to Retained Earnings:	$63.41	Remaining EAT
Balance Sheet Asset Accounts:	**Projection:**	**Calculation:**
Current Assets:	$128.40	Current Sales*12%
Fixed Assets:	$909.50	Current Sales*85%
Accumulated Depreciation:	$343.99	Previous Amount + $43.99
Net Fixed Assets:	$565.51	
Total Assets:	$693.91	
Balance Sheet Liability Accounts:	**Projection:**	**Calculation:**
Current Liabilities:	$53.50	Current Sales*5%
Long-term Debt:	$128.08	25%*(Total Assets less C/L***)
Total Liabilities:	$181.58	
Balance Sheet Equity Accounts:	**Projection:**	**Calculation:**
Stock (Plug figure****):	$348.92	
Retained Earnings:	$163.41	Previous Amount + $63.41
Total Equity:	$512.33	
Total Liability and Equity:	$693.91	

*Operating Expenses include cost of goods sold and salary, general, and administrative expenses
**F/A is fixed assets, Average F/A = ($850.00 + $909.50)/2
***C/L is Current Liabilities
****Plug figure is Total Assets less Total Liabilities less Retained Earnings

calculated through a different means here. Theoretically, an increase/decrease in the stock account means the firm raises/repays capital by issuing/retiring stock.

As mentioned earlier, the stock account is deterministic and does not rely on an iteration routine. Since this is the case, one could simply build the pro forma statements using a calculator. However, the moving back and forth between the income statement and the balance sheet for information makes for tedious work. Consequently, a spreadsheet package is the analyst's tool of choice in this situation. Figure 3 reiterates the previous pro forma calculations.

The goal of the pro forma analysis is not necessarily to produce only financial statement projections. Generally, the desire is to project some measure of cash flow. It is the present value of these projected cash flows that produce the value of the firm (or project). The cash flow to be calculated is the decision of the analyst. Arnold and James [2000] used Free Cash Flow (FCF) in their FVC (Firm Value Calculator) defined as:

(Revenues – Operating Expenses –Depreciation Expense)*(1 – Tax Rate) +
Depreciation Expense – Change in Net Working Capital – Change in Fixed Assets

However, one could add to the FCF a term that includes the tax advantage of carrying debt. More specifically, define Cash Flow from Assets (CFA) as:

FCF + Interest Expense*Tax Rate

This calculation of CFA is consistent with the definition given by Ross, Westerfield, and Jordan [2000]. The issue as to which cash flow calculation is more valid is not pursued in this paper. However, in theory, either valuation should be the same due to differing applicable discount rates. In practice, this just does not seem to happen. However, the CFA calculation does have the benefit of allowing us to see the direct consequences of capital structure and is the calculation of choice for this application for this reason.

Before concluding this section, the pro forma analysis is extended to five periods in Figure 4. Both cash flow calculations (FCF and CFA) over the five years are present valued using a 15% discount rate to produce some target values for the development of a new Firm Value Calculator that includes the benefit of debt (FVCD).

FIRM VALUE CALCULATOR WITH DEBT (FVCD)

In order to develop the FVCD, a number of growth annuity and growth perpetuity relationships are utilized. These relationships are already developed in Arnold and James [2000] and are simply listed here. Allow CF_0 to represent a present cash flow that is growing at a periodic rate "g" and is discounted at a rate "k". Given these definitions, equation one is a growth annuity utilizing "k^*". The k^* calculation can be inputted into spreadsheet functions and financial calculators similar to the discount rate for a regular

Figure 4. Five Period Sales-Driven Pro Forma Analysis

Income Statement:	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Sales Revenue:	$1,000.00	$1,070.0	$1,144.90	$1,225.04	$1,310.80	$1,402.5
Operating Expenses:	$700.00	$749.00	$801.43	$857.53	$917.56	$981.79
Depreciation Expense:	$42.50	$43.99	$47.07	$50.36	$53.89	$57.66
EBIT:	$257.50	$277.01	$296.40	$317.15	$339.35	$363.11
Interest Expense:	$12.40	$12.81	$13.25	$13.71	$14.21	$14.75
EBT:	$245.10	$264.20	$283.16	$303.44	$325.14	$348.36
Taxes:	$98.04	$105.68	$113.26	$121.38	$130.06	$139.34
EAT:	$147.06	$158.52	$169.89	$182.06	$195.08	$209.02
Paid as Dividends:	$88.24	$95.11	$101.94	$109.24	$117.05	$125.41
Paid to Retained	$58.82	$63.41	$67.96	$72.83	$78.03	$83.61
Balance Sheet (Assets):	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Current Assets:	$120.00	$128.40	$137.39	$147.01	$157.30	$168.31
Fixed Assets:	$850.00	$909.50	$973.17	$1,041.29	$1,114.18	$1,192.1
Accumulated	$300.00	$343.99	$391.05	$441.42	$495.30	$552.96
Net Fixed Assets:	$550.00	$565.51	$582.11	$599.87	$618.87	$639.21
Total Assets:	$670.00	$693.91	$719.50	$746.88	$776.17	$807.51
Balance Sheet (Liab)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Current Liabilities:	$50.00	$53.50	$57.25	$61.25	$65.54	$70.13
Long-term Debt:	$124.00	$128.08	$132.45	$137.12	$142.13	$147.48
Total Liabilities:	$174.00	$181.58	$189.70	$198.38	$207.67	$217.60
Balance Sheet (Equity):	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Stock:	$396.00	$348.92	$298.44	$244.31	$186.28	$124.08
Retained Earnings:	$100.00	$163.41	$231.37	$304.19	$382.23	$465.83
Total Equity:	$496.00	$512.33	$529.80	$548.50	$568.50	$589.91
Total Liability & Equity	$174.00	$181.58	$189.70	$198.38	$207.67	$217.60
Cash Flow Calculation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Sales Revenue:		$1,070.0	$1,144.90	$1,225.04	$1,310.80	$1,402.5
Operating Expenses:		$749.00	$801.43	$857.53	$917.56	$981.79
Depreciation Expense:		$43.99	$47.07	$50.36	$53.89	$57.66
EBIT:		$277.01	$296.40	$317.15	$339.35	$363.11
EBIT*(1 – Tax Rate):		$166.21	$177.84	$190.29	$203.61	$217.86
Depreciation Expense:		$43.99	$47.07	$50.36	$53.89	$57.66
Change in NWC*:		$4.90	$5.24	$5.61	$6.00	$6.42
Change in Fixed Assets:		$59.50	$63.67	$68.12	$72.89	$77.99
Free Cash Flow (FCF):		$145.80	$156.00	$166.92	$178.61	$191.11
Interest Expense*Tax		$5.12	$5.30	$5.48	$5.69	$5.90
Cash Flow from Assets:		$150.92	$161.30	$172.41	$184.29	$197.01
Present Value (FCF):		$126.78	$117.96	$109.75	$102.12	$95.01
Sum of Present Value	$551.62					
Present Value (CFA**):		$131.23	$121.96	$113.36	$105.37	$97.95
Sum of Present Value	$569.87					

*NWC is Net Working Capital and **CFA is Cash Flow from Assets annuity. This is much more convenient than using standard formulas for growth-adjusted annuities.

$$k^* = \frac{(1+k)}{(1+g)} - 1$$

$$\therefore \frac{CF_0}{k^*}\left[1 - \frac{1}{(1+k^*)^N}\right] = \frac{CF_o(1+g)}{(1+k)} + \frac{CF_0}{(1+k)^2} + \cdots + \frac{CF_0(1+g)^N}{(1+k)^N} \qquad (1)$$

Equation two is the first difference for the growth annuity equation and is useful in computing the change in net working capital and the change in fixed assets.

$$\therefore \frac{CF_0}{k^*}\left[1 - \frac{1}{(1+k^*)^N}\right]\left(1 - \frac{1}{(1+g)}\right) = \frac{CF_o(1+g) - CF_0}{(1+k)} + \cdots + \frac{CF_0(1+g)^N - CF_0(1+g)^{N-1}}{(1+k)^N} \qquad (2)$$

Equation three is the one period average for the growth annuity equation and is useful for the computation of depreciation expense.

$$\therefore \frac{CF_0}{k^*}\left[1 - \frac{1}{(1+k^*)^N}\right]\left(1 - \frac{1}{(1+g)}\right)\frac{1}{2} = \frac{CF_o(1+g) - CF_0}{2(1+k)} + \cdots + \frac{CF_0(1+g)^N - CF_0(1+g)^{N-1}}{2(1+k)^N} \qquad (3)$$

Letting the cash flows run into perpetuity and assuming that "g" is less than "k", yields three corresponding equations for growth perpetuities:

$$\frac{CF_0(1+g)}{(k-g)} \qquad (4)$$

$$\frac{CF_0(1+g)}{(k-g)}\left(1 - \frac{1}{(1+g)}\right) \qquad (5)$$

$$\frac{CF_0(1+g)}{(k-g)}\left(1 - \frac{1}{(1+g)}\right)\frac{1}{2} \qquad (6)$$

First, growth annuity equations are used to generate the present value of the first five periods of the pro forma FCFs and CFAs. Growth perpetuity equations will be used later

Figure 5. Present Value of the First Five FCFs Using Growth Annuities

Inputs:	Value:			Excel Syntax:
				A
Sales Growth Rate:	7%		1	7%
Oper. Exp. per Sales***:	70%		2	70%
C/A per Sales***:	12%		3	12%
F/A per Sales***:	85%		4	85%
C/L per Sales***:	5%		5	5%
Depreciation Periods:	20		6	20
Interest Expense:	10%		7	10%
Tax Rate:	40%		8	40%
Dividend Payout Ratio:	60%		9	60%
Target D/E Ratio***:	25%		10	25%
Discount Rate:	15%		11	15%
Initial Sales:	$1,000.00		12	$1,000.00
FCF Calculation:	Value:	Calculation:		Excel Syntax:
Sales Revenue:	$4,048.40	See footnote	13	=PV((1+A11)/(1+A1)-1,5,-A12)
Operating Expenses:	$2,833.88	70%*($4,048.40)	14	=A2*A13
Depreciation Expense:	$166.43	85%*Avg(Sales)* /20	15	=A4*A13*(1 + 1/(1+A1))/2/A6
EBIT:	$1,048.09		16	=A13-A14-A15
EBIT*(1 – Tax Rate):	$628.85	EBIT*(1 – 40%)	17	=A16*(1 – A8)
Depreciation Expense:	$166.43	Same as above	18	=A15
Change in NWC***:	$18.54	7%*FD(Sales)**	19	=(A3 – A5)*A13*(1 – 1/(1+A1))
Change in F/A***:	$225.12	85%*FD(Sales)	20	=A4*A13*(1 – 1/(1+A1))
Free Cash Flow (FCF):	$551.62		21	=A17+A18-A19-A20

Footnote: the calculation is $(1{,}000.00/ 7.4766\%)*(1 - 1 / (1.074766)^5)$ where 7.4766% is (1.15)/(1.07) – 1

Avg(Sales) is $4,048.40(1 + 1 / (1+7%)) / 2

**FD(Sales) is $4,048.40*(1 – 1 / (1+7%)) and 7%=(12% - 5%)

***Oper. Exp. is Operating Expenses, C/A is Current Assets, F/A is Fixed Assets, C/L is Current Liabilities, NWC is Net Working Capital, and D/E is debt-to-equity

to evaluate all cash flows.

To find the present value of the first five FCFs in our example using growth annuities, assume a 15% discount rate which generates a k^* of 7.4766% ((1+15%) / (1+7%) – 1). Use the growth annuity to discount the sales revenue over the five year period ($CF_0 = \$1{,}000$ and $N = 5$) and generate a calculation of $4,048.40. The operating expenses are 70% of the sales figure, which is $2,833.88. Similar to the construction of pro forma statements there is a need to detour to find the present value of the fixed assets in order to calculate the depreciation expense. The fixed assets are 85% of sales and consequently equal to $3,441.14. To find the depreciation expense, take the one period average of the total assets figure and divide it by the 20 years figure for

Figure 6. The Firm Value Calculator (FVC) of Arnold and James [2000]

Inputs:	Value:		Excel Syntax:
			A
Sales Growth Rate:	7%	1	7%
Years of Current Growth:	5	2	5
Perpetual Growth:	4%	3	4%
Oper. Exp. per Sales**:	70%	4	70%
C/A per Sales**:	12%	5	12%
F/A per Sales**:	85%	6	85%
C/L per Sales**:	5%	7	5%
Depreciation Periods:	20	8	20
Interest Expense:	10%	9	10%
Tax Rate:	40%	10	40%
Dividend Payout Ratio:	60%	11	60%
Target D/E Ratio**:	25%	12	25%
Discount Rate:	15%	13	15%
Initial Sales:	$1,000.00	14	$1,000.00
FCF Calculation:	Value:		Excel Syntax:
Sales Revenue:	$10,641.20	15	= PV((1+A13)/(1+A1)-1,A2,-A14) + PV((1+A13) /(1+A1)-1 ,A2,0,-A14*(1+A3)/(A13 –A3))
Operating Expenses:	$7,448.84	16	=A4*A15
Depreciation Expense:	$437.46	17	=A6*A15*(1 + 1/(1+A1))/2/A8
EBIT:	$2,754.90	18	=A15-A16-A17
EBIT*(1 – Tax Rate):	$1,652.94	19	=A18*(1 – A10)
Depreciation Expense:	$437.46	20	=A17
Change in NWC**:	$48.73	21	=(A5 – A7)*A1*(1 – 1/(1+A1))
Change in F/A**:	$591.73	22	=A6*A15*(1 – 1/(1+A1))
Free Cash Flow (FCF):	$1,449.94	23	=A19+A20-A21-A22

**Oper. Exp. is Operating Expenses, C/A is Current Assets, F/A is Fixed Assets, C/L is Current Liabilities, NWC is Net Working Capital, and D/E is debt-to-equity

depreciation periods. The present value of the depreciation expense becomes $166.43 ($3,441.14(1 + 1 / (1+7%)) / 2 / 20). The EBIT is $1,048.09 ($4,048.40 - $2,833.88 - $166.43). Multiply the EBIT by one minus the tax rate to produce a figure of $638.85 ($1,048.09(1 – 40%)). Adding back the depreciation expense yields a total of $795.28.

To complete the calculation, the present value of the change in net working capital and the change in fixed assets are necessary. To find the change in net working capital, take the difference between the current assets and current liabilities measured as a percentage of sales (12% - 7% = 5%). Then multiple the 5% percentage difference by the sales growth annuity and take the first difference (5%*$4,048.40(1 – 1 / (1+7%) = $18.54).

The present value of the change in fixed assets is simply the first difference of the present value of the fixed assets ($3,036.30(1 – 1 / (1+7%)) = $225.12).

Putting it all together, the present value of the first five FCFs is $551.62 ($795.28 - $18.54 - $225.12). Figure 5 demonstrates the previous calculations and produces Excel functions to program the calculations.

Assuming the final FCF grows at 4% in perpetuity, we can produce the FVC of Arnold and James [2000] by allowing the sales revenue to grow in perpetuity at 4% after five years (i.e.use a growth perpetuity). All of the previous calculations required to find the present value of the FCFs apply in the same fashion as above. Figure 6 is analogous to Figure 5 except that the valuation is now in perpetuity producing the FVC.

The present value calculation of CFA has only one more term than the present value of FCF. However, this term is difficult to produce. Essentially, one needs to calculate the present value of total assets, subtract the present value of the current liabilities, apportion the result between long-term debt and equity, take the associated interest expense of the long-term debt, and produce the term that is added to FCF to produce CFA. First, find the present value of total assets.

Total assets are current assets plus fixed assets less accumulated depreciation. The current assets plus the fixed assets are simply 97% of sales (12% + 85%). The difficulty lies in the calculation of accumulated depreciation since it does not grow at a rate equivalent to sales. However, it is perpetual in nature in that as depreciation expense is accumulated, it stays in the balance sheet forever. Thus, the present value of the accumulated depreciation is a combination of the initial accumulated depreciation taken into perpetuity plus the present value of the depreciation expense taken into perpetuity.

We'll proceed by producing the five year calculation and then developing the algorithm for the FVCD (which is much simpler).

For the five year calculation, take the initial accumulated depreciation of $300 and divide it by the 15% discount rate yielding a perpetuity of $2,000. For the second part of the calculation, take the present value of the depreciation expense ($166.43), divide it by the 15% discount rate, and then multiple it by one plus the discount rate. In a sense, it is the situation of a "perpetuity due" producing a calculation of $1,275.95 (($166.43 / 15%)*(1+15%)). Adding the two figures together produces a calculation of $3,575.95. Unfortunately, this figure is much too large because it needs to have all portions calculated for year six and beyond subtracted out.

One could simply present value on a five year basis the accumulated depreciation in year five taken into perpetuity. This requires the use of the pro forma statement, which is counter-productive since it is the desire to create a firm value calculator that replaces or checks the calculations of the pro forma analysis. An algorithmic solution that is not dependant on the pro forma analysis is preferred. Fortunately, an algorithmic solution does exist:

- take the future value annuity of the initial sales using the 7% growth rate

($6,153.29)

- multiple it by 85% to convert the sales figure to fixed assets ($5,230.30)
- take the one period average divided by 20 ($5,230.30(1 + 1 / (1+7%)) / 2 / 20 = $252.96)
- add the initial accumulated depreciation figure of $300.00 to the $252.96
- take the sum into perpetuity using the 15% discount rate ($3,686.40)
- discount the result five years using the 15% discount rate ($1,832.79)

By subtracting $1,832.79 from $3,275.95 (producing $1,443.16), the present value of the accumulated depreciation for the first five years emerges.

As a consequence, the present value of the total assets is $2,483.79. It is 97% (percentage of current assets per sales plus the percentage of fixed assets per sales) multiplied by the present value of the sales revenue less the present value of the accumulated depreciation. Subtract the present value of the current liabilities (7% of the present value of sales) from the present value of the total assets, which is $2,281.37. As found earlier, a debt-to-equity ratio of 25% corresponds to a debt ratio of 20%. Take the debt ratio and multiply it by the $2,281.37 figure producing the present value of long-term debt ($456.27). The present value of the interest expense is simply the interest rate multiplied by the present value of the long-term debt, which is $45.63.

Finally, the present value of the CFA for five years is the present value of the corresponding FCFs plus the tax rate multiplied by the present value of the interest expense (40%*$45.63 = $18.25). Thus, the present value of the CFA over five years is $569.87 ($551.62 + $18.25). Needless to say, the algorithm to produce this answer may not seem very convenient or very quick. However, do not let these first impressions dismiss the algorithm; it is actually much easier to implement when the associated cash flows continue into perpetuity.

To generate an algorithm for the present value of all of the CFAs (i.e. the value of the firm), let %F/A, %C/A, %C/L, D/E, %Int, and %Tax, represent the percentage of fixed assets per sales, the percentage of current assets per sales, the percentage current liabilities per sales, the debt-to-equity ratio, the interest rate on long-term debt, and the tax rate respectively. Further, let PV(*) be the present value operator. Then the present value of CFA can be calculated as:

PV(CFA) = PV(FCF) + [(%F/A + %C/A - %C/L)*PV(Sales) –
PV(Accumulated Depreciation)]*[1 – 1 / (1 +D/E)]* %Int*%Tax

This calculation is the first step in creating the FVCD. Given the associated calculations for the FVC, the present value of accumulated depreciation is the initial accumulated depreciation taken into perpetuity plus the present value of the depreciation expense taken as a "perpetuity due" (recall, these particular perpetuity calculations are based on the actual discount rate "k" and not the growth adjusted

Figure 7. The Firm Value Calculator With Debt (FVCD)

Inputs:	Value:		Excel Syntax:
			A
Sales Growth Rate:	7%	1	7%
Years of Current Growth:	5	2	5
Perpetual Growth:	4%	3	4%
Oper. Exp. per Sales**:	70%	4	70%
C/A per Sales**:	12%	5	12%
F/A per Sales**:	85%	6	85%
C/L per Sales**:	5%	7	5%
Depreciation Periods:	20	8	20
Interest Expense:	10%	9	10%
Tax Rate:	40%	10	40%
Dividend Payout Ratio:	60%	11	60%
Target D/E Ratio**:	25%	12	25%
Discount Rate:	15%	13	15%
Initial Sales:	$1,000.00	14	$1,000.00
Initial Acc. Dep.**:	$300.00	15	$300.00
CFA Calculation:	Value:		Excel Syntax:
Sales Revenue:	$10,641.20	16	= PV((1+A13)/(1+A1)-1,A2,-A14) + PV((1+A13) /(1+A1)-1,A2,0,-A14*(1+A3)/(A13 – A3))
Operating Expenses:	$7,448.84	17	=A4*A16
Depreciation Expense:	$437.46	18	=A6*A16*(1 + 1/(1+A1))/2/A8
EBIT:	$2,754.90	19	=A16-A17-A18
EBIT*(1 – Tax Rate):	$1,652.94	20	=A19*(1 – A10)
Depreciation Expense:	$437.46	21	=A18
Change in NWC**:	$48.73	22	=(A5 – A7)*A16*(1 – 1/(1+A1))
Change in F/A**:	$591.73	23	=A6*A16*(1 – 1/(1+A1))
Free Cash Flow (FCF):	$1,449.94	24	=A20+A21-A22-A23
Interest Expense*Tax Rate:	$35.52	25	=((A6+A5-A7)*A16 - A15 / A13 - A18*(1+A13) / A13)*(1 – 1 / (1+A12))*A9*A10
Cash Flow From Assets:	$1,485.46	26	=A24+A25

**Oper. Exp. is Operating Expenses, C/A is Current Assets, F/A is Fixed Assets, C/L is Current Liabilities, NWC is Net Working Capital, Acc. Dep. is Accumulated Depreciation, and D/E is debt-to-equity

discount rate “k*”). Thus, the FVCD algorithm becomes:

FVCD = FVC + [(%F/A + %C/A - %C/L)*PV(Sales) –
(Initial Accumulated Depreciation) / k –
PV(Depreciation Expense)*(1+k)/k] *[1 – 1 / (1 +D/E)]* %Int*%Tax

Figure 7 displays the calculation of the FVCD calculator.

Like the FVC, the FVCD can be performed on a hand calculator or on a spreadsheet. It is still quicker and less tedious than a full pro forma analysis. Also, one may not have noticed, but it is incorrect to take the last CFA figure and run it into perpetuity to produce a terminal value for the pro forma analysis like one can with the last FCF figure. The reason is that the interest tax shield term does not grow at the same rate as the sales. Thus, not only is the FVCD quicker and simpler than the pro forma analysis, it is also more accurate.

An analysis of the firm's capital structure can be pursued at this point, but one will simply find that more debt in the capital structure increases firm value through the interest tax shield (with no effect on the FCFs). To really see the effect of debt on the firm, one needs to have the discount rate affected by the level of debt. The interest tax shield may be outweighed by the consequences of a higher discount rate. Thus, in the next section a "levered-beta analysis" is used to incorporate capital structure sensitivity into the FVCD.

SENSITIVITY ANALYSIS OF LEVERAGE USING THE FVCD

In the previous sections a 15% discount rate is simply incorporated to produce firm/project valuations. In practice, one would investigate a number of alternatives in deciding on an appropriate discount rate. However, given that an appropriate discount rate has been found (15% in this example), one can decompose the discount rate based on a combination of the Capital Asset Pricing Model [Sharpe, 1964] and the debt-to-equity ratio.

In this example, assume a risk free rate of 3% and an expected market rate of 12%. Given this information, solve for the "beta" of the firm by setting the discount rate of the firm equal to the risk free rate plus beta multiplied by the market premium of 9% (expected market rate less risk free rate). The firm's beta is found to be 1.3333 (1.3333 = (15% - 3%) / (12% - 3%)).

Further, one can incorporate a relationship between the firm's beta and the beta of a similar firm except that the similar firm is composed entirely of equity. Call the firm's beta "β_L" because it is a beta for a levered firm and call the beta for the similar un-levered firm "β_U". Using "D/E" and %Tax to represent the debt-to-equity ratio and the tax rate respectively, the following relationship exists between the two betas (consistent with Ross, Westerfield, and Jaffe Chapter 17, [1999]).

$$\beta_U = \frac{\beta_L}{[1 + (1 - \%Tax) * D / E]} \tag{7}$$

$$\beta_U = \beta_U * [1 + (1 - \%Tax) * D / E] \tag{8}$$

Figure 8. The Firm Value Calculator With Debt (FVCD) and Leverage Sensitivity

Inputs:	Value:		Excel Syntax:
			A
Sales Growth Rate:	7%	1	7%
Years of Current Growth:	5	2	5
Perpetual Growth:	4%	3	4%
Oper. Exp. per Sales***:	70%	4	70%
C/A per Sales***:	12%	5	12%
F/A per Sales***:	85%	6	85%
C/L per Sales***:	5%	7	5%
Depreciation Periods:	20	8	20
Interest Expense:	10%	9	10%
Tax Rate:	40%	10	40%
Dividend Payout Ratio:	60%	11	60%
Initial D/E Ratio***:	25%	12	25%
Proposed D/E Ratio***:	100%	13	100%
Initial Discount Rate:	15%	14	15%
Proposed Discount Rate:	19.70%	15	=A19 + A21*(1 + (1 – A10)*A13)*(A18 –A19)
Initial Sales:	$1,000.00	16	$1,000.00
Initial Acc. Dep.***:	$300.00	17	$300.00
Expected Market Rate:	12%	18	12%
Risk Free Rate:	3%	19	3%
Firm Beta:	1.3333	20	=(A14 – A19) / (A18 – A19)
Un-levered Beta:	1.1594	21	=A20 / (1 + (1 – A10)*A12)
CFA Calculation:	Value:		Excel Syntax:
Sales Revenue:	$7,399.37	22	= PV((1+A15)/(1+A1)-1,A2,-A16) + PV((1+A15) /(1+A1)-1,A2,0,-A16*(1+A3)/(A15 – A3))
Operating Expenses:	$5,179.56	23	=A4*A22
Depreciation Expense:	$304.19	24	=A6*A22*(1 + 1/(1+A1))/2/A8
EBIT:	$1,915.63	25	=A22-A23-A24
EBIT*(1 – Tax Rate):	$1,149.38	26	=A25*(1 – A10)
Depreciation Expense:	$304.19	27	=A23
Change in NWC***:	$33.88	28	=(A5 – A7)*A22*(1 – 1/(1+A1))
Change in F/A***:	$411.46	29	=A6*A22*(1 – 1/(1+A1))
Free Cash Flow (FCF):	$1,008.22	30	=A26+A27-A28-A29
Interest Expense*Tax Rate:	$68.71	31	=((A6+A5-A7)*A22 - A17 / A15 – A24*(1+A15) / A15)*(1 – 1 / (1+A13))*A9*A10
Cash Flow From Assets:	$1,076.93	32	=A30+A31

***Oper. Exp. is Operating Expenses, C/A is Current Assets, F/A is Fixed Assets, C/L is Current Liabilities, NWC is Net Working Capital, Acc. Dep. is Accumulated Depreciation, and D/E is debt-to-equity

Using this relationship, find the beta for the respective un-levered firm. It is 1.1594.

Further, what this relationship allows one to do upon constructing the unlevered beta is to produce different valuations of the FVCD based on different capital structures via the debt-to-equity ratio. In other words, one can generate a sensitivity analysis based on leverage that incorporates the discount rate and taxation. By construction (and by intuition), increasing debt increases the interest tax shield term in the FVCD, but it will also increase the discount rate (which may offset the gain from the tax shield). In essence, this trade off in firm/project valuation can be incorporated into the FVCD with a few more inputs. This is also applicable for the FVC of Arnold and James [2000] because increased debt will affect the discount rate, however, there is no trade off with a tax shield pertaining to debt. Consequently, the FVC calculator always favors less debt because less debt means a lower discount rate. Figure 8 demonstrates the incorporation of the leverage sensitivity portion into the FVCD.

In Figure 8 the effect of increasing the debt-to-equity ratio to 100% can be seen relative to the FVCD calculation in Figure 7. The interest tax shield increases from $35.52 to $68.71. However, the firm value has decreased from $1,485.46 to $1,076.93 due to the discount rate increasing from 15% to 19.70%. In this stylized example the increase in debt does little benefit to the firm value even with the additional tax shield. It can clearly be seen that an increase in debt without an additional operational benefit is demonstrated to be foolish. Even though the example is stylized, one can see that capital structure has to affect operations and not simply be manipulated for taxation consequences. Many times this insight becomes lost when viewing debt solely as a means of funding which creates the enticement of levering up a project for a larger tax shield. This distinction is often difficult to demonstrate to the student since portions of the analysis are viewed separately. However, in this framework, the student can visualize all of the consequences of debt without being required to perform pro forma analysis.

SUMMARY AND CONCLUSION

A Firm Value Calculator with Debt (FVCD) is generated that is faster, simpler, and more accurate than its pro forma counter-part. In addition, the firm valuation incorporates the capital structure of the firm/project. The benefit of this latter facet is to illustrate to the student in a "real world" manner the effects of debt on firm valuation. Specifically, the trade off between the interest tax shield and the discount rate for the firm becomes readily apparent.

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