Probability Weighted Discounted Cash Flow Analysis Model

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Abstract

Fundamental Analysis (Value Investing) is a well known and well utilized trading methodology. The basis of this method of investing is simple: find firms with untapped value or potential who the markets are undervaluing and take long positions with a price target in mind. The use of cash flow modeling is essential in this type of investing strategy to extract a firm's equity value. As a result of this type of analysis, an investor can project a quantitative target price for the equity and make an informed decision on whether to long, short or watch for entry positions in a stock price. The model that will be discussed is a more complex evolution of the basic Discounted Cash Flow model, used successfully in the Stevens Student Managed Investment Fund.

Introduction

Investing in the equities market can involve countless strategies and methodologies but there are usually 2 broad categories for this type of work: Technical Analysis and Fundamental Analysis. Technical Analysis consists of analyzing market prices and movements to generate buying and selling signals to enter and exit trades. Fundamental Analysis consists of understanding what those prices and movements mean with the goal of generating a "true" price target of what the stock (and by extension the firm) should be worth. A core tool for Fundamental Analysis is the Probability Weighted Discounted Cash Flow Analysis model, where one can look to the future cash flows of a firm and discount them back to the present time to find what that firm should be worth and if it is undervalued or overvalued. This analysis serves as a quantitative signal for buying and selling an equity position. I will show throughout this paper how this model is constructed, expanded and combined with basic probability measures to make it more effective at predicting a stock target price as well as showing how complimentary models can aid in the conclusions drawn from this model.

Variable and Calculation Referencing

For reference and convenience, please refer to the next two 2 pages for variable acronym declarations and calculations. The first page (Page 2) is a variable table holding the name and acronym of frequently used items. The second page (Page 3) will list the equations for variables that require calculation. I will reference these acronyms and equations while explaining the methodology of this model. Please refer to these pages as needed throughout the paper.

Variable Abbreviation Reference Table

Variable / Term	Abbreviation
Probability Weighted Discounted Cash Flow	PWDCF
Dividend Discount Model	DDM
Cost of goods sold	COGS
Operating Costs (Expenditures)	OPEX
Earnings Before Interest and Taxes	EBIT
Depreciation and Amortization	DA
Capital Expenditures (Fixed Production Assets)	CAPEX
Earnings Before Interest,Taxes and Depreciation/Amortization	EBITDA
Free Cash Flow	FCF
Compounded Annual Growth Rate	CAGR
Risk-free rate	rf
Return of the market	rm
Capital Asset Pricing Model	CAPM
Cost of Equity / weight of equity	ke / we
Cost of debt / weight of debt	kd / wd
Weighted Average Cost of Capital	WACC
Perpetual Growth Rate	pgr
Enterprise Value	EV

Variable and Methodology Reference Equations

COGS:

$$COGS = Sum(FixedProduction/Manufacturingcosts)$$

OPEX:

$$OPEX = Sum(Labor, administrative, variablecosts)$$

Gross Profit

$$GrossProfit = Revenue - COGS$$

EBIT:

$$EBIT = Revenue - COGS - OPEX$$

EBITDA:

$$EBITDA = EBIT + DA$$

CAGR:

$$CAGR = (Value_n/Value_1)^(1/n) - 1, nistime(years)$$

ke (CAPM):

$$ke = CAPM = rf + Beta * (rm - rf)$$

we:

$$(TotalEquity)/(TotalDebt + TotalEquity)$$

kd:

$$kd = (pre - taxdebtrate) * (1 - CorporateTaxrate$$

wd:

$$(TotalDebt)/(TotalDebt + TotalEquity)$$

WACC:

$$(kd * wd) + (ke * we)$$

FCF:

$$FCF = EBIT * (1 - taxrate) + DA - CAPEX - \Delta(WC)$$

EV:

$$EV = [FCF_1/(1 + WACC)^1] + ... + [FCF_n/(1 + WACC)^n] + [TV/(1 + WACC)^n]$$

Terminal Value (Method 1) :

$$TV = (FCF_5 * (1 + pgr))/(WACC - pgr)$$

Terminal Value (Method 2) :

$$TV = (EV/EBITDA_5) * EBITDA_5$$

Value of Equity:

$$ValueofEquity = EV - (LTdebt) + (Cash + CashEqv.)$$

Target Price:

$$TargetPrice = (ValueofEquity)/(TotalSharesOutstanding)$$

1 The Model output

The output of this Model (Figure 1) is the combined analysis of the PWDCF model and 3 complimentary analysis models, along with sensitivity testing measures and statistical analyses. The Output page lists the predicted prices of all models and tests performed, with the bars corresponding to the intervals of possible values reported. Where these intervals come from will be explained later. The boxes on the top of the page report the quantitative output of the 2 more focused models (PWDCF and the DDM), to be explained later). This is also where the analysts can adjust the probabilities of the cases they create to alter the expected price performance as assumptions and market information change. In addition, the top-left boxes display the firm's relevant information such as current price, beta, costs of financing as well as debt ratios and credit scores (another complimentary analysis to be explained later).

This "summary" page graphically represents the output of the model's calculations as well as relevant information needed to monitor the company and understand its financial data. The consolidated value ranges are used to assess areas of upside potential and downside risk based on the area those bars overlap relative to the x-axis (the equity price). This Model has been constructed entirely in Microsoft Excel and depends on Bloomberg Terminal research data to be input, as it is formatted for this specific type of retrieval. The way to interpret this model is twofold. The focused model outputs are shown to give the calculated target prices given the inputs and the probability weightings to the outcome cases that are built. These values are the benchmark target prices generated by the forecasting models. The graphical representation stands to show where all the model's outputs and analysis ranges are landing, allowing one to easily see where the areas of concentration are and identify opportunity and risk.

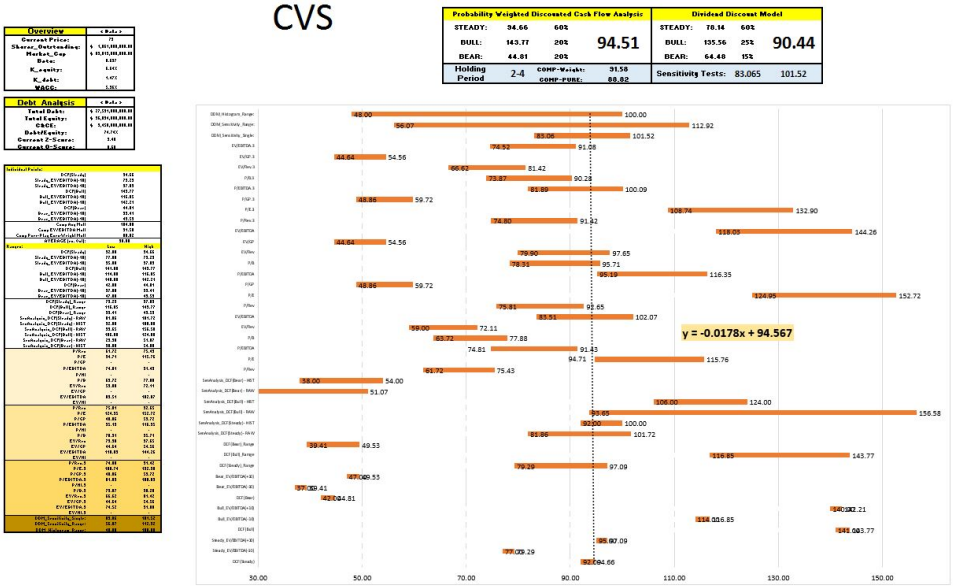


Figure 1: Summary Output Page

2 Data inputs

The financial sheets are loaded into Excel from (.csv) output from Bloomberg. They should hold 10 years of consecutive data to cover both bull and bear markets, especially focusing on the effect of the changes in the cyclical cycle. The bull and bear market cycle usually occur every 10 to 12 years. First, I reference the data categories needed for the EBIT and FCF calculations, treating every subset item as its own stream to increase my accuracy of forecasting the target price. Looking at revenues or costs as 1 single line item decreases the information available and, while making the analysis less complex, it also makes the model less dynamic and less reliable. I extract from the income statement, balance sheets and cash flow statements all of the relevant data into a "loading" page, where the data is organized and ready for analysis. I calculate the year-over-year growth rates using 2 methods; the standard 5 year average growth rate as well as the 5 year CAGR, which is used to smooth the curve and provide us with a clearer picture of the true growth over time. This is done for all line items. (Figure 2)

DCF INPUT PAGE											RATES	
IS	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	CAGR	AVG
Revenue	76329.5	87471.9	98729	95778	107100	123120	126761	139367	153290	177526	7.59%	10.11%
Yoy (%)		13.63%	12.11%	-3.03%	11.17%	13.94%	2.91%	9.48%	9.52%	14.68%		
Subset1											#DIV/0!	#DIV/0!
Yoy (%)		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		
Subset2											#DIV/0!	#DIV/0!
Yoy (%)		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		
Subset3											#DIV/0!	#DIV/0!
Yoy (%)		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		
Subset4											#DIV/0!	#DIV/0!
Yoy (%)		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		
Subset5											#DIV/0!	#DIV/0!
Yoy (%)		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		
COGS	60221.8	69181.5	78349	75559	86539	100632	102978	114000	126762	148669	8.12%	82.24%
% Rev	78.90%	79.09%	79.36%	78.89%	80.80%	81.73%	81.24%	81.80%	82.69%	83.74%		
Gross Profit	16107.7	18290.4	20380	20219	20561	22488	23783	25367	26528	28857	5.11%	17.76%
Gross Margin (%)	21.10%	20.91%	20.64%	21.11%	19.20%	18.27%	18.76%	18.20%	17.31%	16.26%		
OpEx	11314.4	12244.2	13942	14082	14231	15278	15818	16574	16712	18279		
Selling/Marketing	–	–	317	234	211	–	–	–	–	–	#VALUE!	#VALUE!
% Rev	#VALUE!	#VALUE!	0.32%	0.24%	0.20%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!		
General Admin(up)											#DIV/0!	0.00%
% Rev	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		
R&D	–	–	0	0	0	0	0	0	0	#REF!	#REF!	#REF!
% Rev	#VALUE!	#VALUE!	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	#REF!		
D/A	1094.6	1274.2	1389	1469	1568	1753	1870	1931	2092	2475	7.14%	1.41%
% Rev	1.43%	1.46%	1.41%	1.53%	1.46%	1.42%	1.48%	1.39%	1.36%	1.39%		
Other	–	–	13625	13848	14020	15278	15818	16574	16712	18279	3.65%	11.60%
% Rev	#VALUE!	#VALUE!	13.80%	14.46%	13.09%	12.41%	12.48%	11.89%	10.90%	10.30%		
Other											#DIV/0!	0.00%
% Rev	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		
EBIT	4793.30	6046.20	6438.00	6137.00	6330.00	7210.00	7965.00	8793.00	9816.00	10578.00	7.97%	6.16%
EBIT Margin (%)	6%	7%	7%	6%	6%	6%	6%	6%	6.40%	5.96%		
CF												
Depr/Amort	1094.6	1274.2	1389	1469	1568	1753	1870	1931	2092	2475	7.14%	1.41%
% Rev	1.43%	1.46%	1.41%	1.53%	1.46%	1.42%	1.48%	1.39%	1.36%	1.39%		
Chg Non-Cash WC	-577.1	-648	-1299	-40	652	676	-538	912	1219	1298	13.94%	0.45%
% Rev	-0.76%	-0.74%	-1.32%	-0.04%	0.61%	0.55%	-0.47%	0.65%	0.80%	0.73%		
Acq. Fixed Assets	-1805.3	-2179.9	-2548	-2005	-1872	-2030	-1984	-2136	-2367	-2224	1.84%	-1.51%
% Rev	-2.37%	-2.49%	-2.58%	-2.09%	-1.75%	-1.65%	-1.57%	-1.53%	-1.54%	-1.25%		

Figure 2: DCF Input (Referenced cells)

3 Building the Cases

With the data loaded and growth rates calculated, I can now begin quantifying research assumptions. The empirical growth rates are a reasonable guide to forecasting all of these revenue streams, costs and cash related expenditures into the future. As a standard, the model forecasts over a maximum of 5 years as forecasting further can result in too much uncertainty in the output. The cases are all of the possible growth path scenarios, positive or negative that the target company can undergo based on the research conducted. At a minimum, 3 cases will allow the probability weighting to be effective but there is no limit to the number of cases that can be used nor to what degree they intersect, overlap or interact. For these 3 cases, there is a bear (down-side), bull (up-side) and base (neutral) case, which are determined in how I model the growth in the line items. This step is almost completely independent of the PWDCF model, and the assumptions are crucial to modeling the price targets. An analyst will undergo research of the industry, firms and the macro-environment to create a set of assumptions and hypotheses for each case created.

The 5 year average and CAGR growth rates help provide a base-line forecast and a reference level to check assumptions against. To create a baseline one would use the average growth rate as a base for the first 2-3 years and then revert to the CAGR into year 5, with special attention given to how much growth is accounted for in the last year. Multiple cases allow me to explore variability in the outcome of mergers/acquisitions, cost cutting schemes, governance shakeups and a wide array of macro-factors and internal/external catalysts. This also allows headwind and tailwind effects to be modeled accurately and thoroughly. These events or trends are often the biggest source of price appreciation or depreciation.

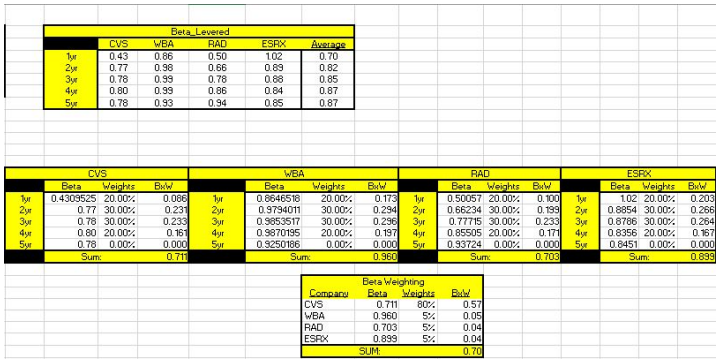
4 Calculating the Variables

There are a important key variables that need to be calculated for this model. These serve the purpose of creating the discount factors, terminal values and forward looking growth rates. The 3 major variables needed here are the weighted average cost of capital, the terminal value and the perpetual growth rate. The WACC is what the modeled cash flows are discounted back to present day value by and the terminal value is the calculated, assumed value of the firm into perpetuity. The pgr is needed to create this terminal value and will represent a broad number of assumptions about future growth and potential fo the firm.

The first variable I need to calculate is the beta. Beta is the stock's correlation to the market, bench marked traditionally against the SP500. It explains how much the stock generally moves when the broader market index moves or how much the broader market movements explain the movements in the stock price. This Beta is used in the CAPM which is used to find ke and in turn, the company's WACC. In excel, I have calculated the betas as the slopes of the regression lines where the index is the predictor and the target stock is the response. The betas are calculated for 1,2...5 years so that they can be weighted relative to the desired holding period of the stock. In addition to the target company beta we need to calculate the betas of 3-5 comparable firms. These firms are either close competitors or companies with similar characteristics or benchmark firms for the evolution of the business (those who have grown from similar positions into market leading ones). Once all of the betas are calculated, the times are weighted for each (the same weights per time per company) and then the weighted average betas of all the firms are pooled and weighted again by their relationship/relevance to the target company. This allows me to dynamically extract the "true" beta and account for multiple factors of influence in the market. (Figure 3)

Next I have to calculate the components of the companies cost of financing. The kd is the yield on the companies outstanding debt and revolver balances. I take the rates corresponding to the times to maturity of the debt and weight them according to a desired holding period for the target stock, just as I did with the betas. In this way, I more accurately asses the cost of the companies financing with respect to debt and my investment horizon. This value is the pre-tax cost of debt. (Figure 4)

The cost of equity is the CAPM formula (See page 3) To obtain the Risk-free rate, I undergo the same process as I did with the weighted cost of debt, but using the yields on the U.S. Treasuries this time. These securities are considered risk free because of the strength of the U.S. economy and the ability of the Treasury to print money to cover the debt and avoid default, therefore making this debt almost risk free in the global market's perspective. To obtain the Return of the market, I look at the yearly returns of the



Beta_Levered

	CVS	WBA	RAD	ESRX	Average
1yr	0.43	0.86	0.50	1.02	0.70
2yr	0.77	0.98	0.66	0.89	0.82
3yr	0.78	0.99	0.78	0.88	0.85
4yr	0.80	0.99	0.86	0.84	0.87
5yr	0.78	0.93	0.94	0.85	0.87

CVS

	Beta	Weights	BxW
1yr	0.4309525	20.00%	0.086
2yr	0.77	30.00%	0.231
3yr	0.78	30.00%	0.233
4yr	0.80	20.00%	0.161
5yr	0.78	0.00%	0.000
	Sum:		0.711

WBA

	Beta	Weights	BxW
1yr	0.8646518	20.00%	0.173
2yr	0.9794011	30.00%	0.294
3yr	0.9853517	30.00%	0.296
4yr	0.9870195	20.00%	0.197
5yr	0.9250186	0.00%	0.000
	Sum:		0.960

RAD

	Beta	Weights	BxW
1yr	0.50057	20.00%	0.100
2yr	0.66234	30.00%	0.199
3yr	0.77715	30.00%	0.233
4yr	0.85505	20.00%	0.171
5yr	0.93724	0.00%	0.000
	Sum:		0.703

ESRX

	Beta	Weights	BxW
1yr	1.02	20.00%	0.203
2yr	0.8854	30.00%	0.266
3yr	0.8786	30.00%	0.264
4yr	0.8356	20.00%	0.167
5yr	0.8451	0.00%	0.000
	Sum:		0.899

Beta Weighting

Company	Beta	Weights	BxW
CVS	0.711	80%	0.57
WBA	0.960	5%	0.05
RAD	0.703	5%	0.04
ESRX	0.899	5%	0.04
SUM:			0.70

Figure 3: Calculating the Weighted Beta

Rate on Debt

Lifespan	Rate	Weights	RxW
1	1.70%		0.000%
2	1.91%	20.00%	0.38%
3	2.20%	50.00%	1.10%
4	2.50%	20.00%	0.50%
5	2.85%	10.00%	0.29%
			0.00%
			0.00%
			0.00%
Average:			2.27%

Figure 4: Calculating the Weighted Cost of Debt (kd)

SP500 over 5 years and weight those returns based again on the investment horizon. This formula yields the cost of equity, or the return required by the company to gain capital through the equity market (return needed to justify investors to go long this company's stock). (Figure 6)

UST Risk Free Rate

Lifespan	Rate	Weights	RxW
2	1.18%	40.00%	0.47%
3	1.40%	40.00%	0.56%
5	1.77%	10.00%	0.18%
7	2.06%	0.00%	0.00%
10	2.25%	0.00%	0.00%
Average:			1.21%

Figure 5: Calculating the Weighted Risk Free Rate (rf)

Now I can calculate the weighted average cost of capital (see page 3). This discount factor is extremely influential to the stock's target price so one needs to be as cautious as possible in analyzing the data properly. If the rate is significantly off, the target price will be as well and that can validate or invalidate hypothesis incorrectly. (Figure 7)

Finally, I am ready to asses the growth rate into perpetuity. It is an influential variable and needs to be constructed in a conservative way. As a benchmark, I look to the yearly growth of the U.S. Gross Domestic Product and use this as a base. For example, if the GDP has grown by an average of 2 percentage points per year over the last 5 years, then one would rate their firms ability based on this growth and see 2% as an upper bound. The perpetuity aspect of this variable is important because it stands to represent "forever", and the growth rate is the expected average growth rate of FCF each year for "forever". With that understood, a large perpetuity growth rate would create a large terminal value that can easily skew the data and influence the target price to increase. In principal, the model is designed to be conservative to limit risk so the growth rate usually will not exceed the growth rate of GDP in the bull case (most optimistic valuation case). In theory, it would be hard to justify that a company's cash flow would grow faster than

RF	1.21%
RM	9.00%
BETA	0.697
CAPM (ke)	**6.64%**

Figure 6: Calculating the Cost of Equity (ke)

(2)_WACC		rR
RF	1.21%	
RM	9.00%	
BETA	0.697	
CAPM (ke)	**6.64%**	
kd_pre	2.27%	
kd_post	**1.47%**	
Current Price:	**79.00**	
Shares Outstanding	**1,061,000,000.00**	
ST Debt	**1,916,000,000.00**	
LT Debt	**25,615,000,000.00**	
Total Debt	**27,531,000,000.00**	**24.7%**
Equity (Mkt Cap)	**83,819,000,000.00**	**75.3%**
	111,350,000,000.00	
WACC	**5.36%**	

Figure 7: Calculating the Weighted Average Cost of Capital (WACC)

the GDP of the U.S. into perpetuity, but if a company is young or in a niche market, exceptions can be presented but it is recommended to distill that optimism over time. This can be accomplished by weighting the pgr over 5 years on a decreasing basis to account for optimism presented by the markets in the short term but to also conserve a risk-adverse strategy in the longer term.

5 Methodology - Calculating the target price

With all of the variables declared and initialized, it is time to through the process of extracting FCF from EBIT and generate the target price (see page 3) Figure 8). The forecast FCF values now need to be discounted to the present day to factor in inflation and then be converted into the true value of equity of the firm.

(1)_FCF Projections																	
(in millions)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Earnings Before Interest and Taxes				4793.30	6046.20	6438.00	6137.00	6330.00	7210.00	7965.00	8793.00	9816.00	8308.217	8806.7098	9599.314	10751.2	11826.35
Effective Tax Rate			35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	38.00%	38.00%	38.00%	38.00%	38.00%
x (1-Tax Rate)		0	0	3115.645	3930.03	4184.7	3989.05	4114.5	4686.5	5177.25	5715.45	6380.4	5151.09	5460.16	5951.57	6665.76	7332.34
+ Depreciation and Amortization				1094.6	1274.2	1389	1469	1568	1753	1870	1931	2092	2769.41	2935.57	3199.77	3583.74	3942.12
- Capital Expenditures (FIX)*-1				1805.3	2179.9	2548	2005	1672	2030	1984	2136	2367	2400.15	2544.16	2773.14	3105.91	3416.50
- Change in Net Working Capital				-577.1	-648	-1239	-40	652	676	-538	912	1219	1232.39	1363.93	1493.23	1672.41	1839.66
= Free Cash Flow	**0**	**0**	**0**	**2982**	**3672.3**	**4325**	**3493.05**	**3158.5**	**3734**	**5661.3**	**4598.45**	**4886.4**	**4228**	**4481.64**	**4885**	**5471.2**	**6018.3**
Growth yoy		####	#DIV/0!	#DIV/0!	23%	18%	-19%	-10%	18%	52%	-19%	6%	-13%	6%	9%	12%	10%
3 year moving average				#DIV/0!	#DIV/0!	#DIV/0!	7%	-4%	-4%	20%	17%	13%	-9%	0%	1%	9%	10%
5 year moving average						#DIV/0!	#DIV/0!	#DIV/0!	6%	12%	4%	10%	9%	6%	-2%	4%	5%

Figure 8: Extracting Free Cash Flow (FCF)

Method 1 - Using Perpetuity

In Method 1 I discount the 5 years of forecast FCF and the terminal value back to the present day. The terminal value in this method has been calculated using the pgr (see page 3). I take what is now discounted and have the enterprise value of the firm. After re-leveraging the firm with its debt (subtracting it out) and I add the cash and cash equivalents back into the company. The debt is an obligation that any owner of the entity will have to pay and the cash is a liquid asset that directly adds value to firm. With this value of equity, or the value the shareholders are buying into, I divide the cash flow among the shares and am left with a target price over a 5 year investment horizon (Figure 9). This, while being a thorough model alone, is only 1 output of this model. It is the most reliable tool in this analysis but any model alone will not be an accurate assessment of the outcome.

(4.1)_DCF_PerpetuityMethod	2016	2017	2018	2019	2020	Terminal
Cash Flow (FCF)	4227.953216	4481.6	4884.984078	5471.2	6018.3	131,509.46
PV(CF)	4012.844757	4037.2	4176.647858	4439.8	4635.341	101289.5382
Enterprise Value	122,591,468,962.54					
-LT debt	25,615,000,000.00					
+Cash/eqv	3,458,000,000.00					
Value of Equity	100,434,468,962.54					
PRICE PER SHARE VALUATION:	**94.66**					

Figure 9: Target Price - Perpetuity

Method 2 - Using Growth by EV/EBITDA multiple

In Method 2 I follow the exact same process of Method 1 but I alter how the terminal value is calculated. Instead of relying on a very subjective pgr, I calculate the EV/EBITDA multiple for the company and then calculate an up-side and down-side movement of 10% in that multiple. I rerun the discounting operation with the 2 new terminal values and acquire 2 more possible price targets to begin forming my ranges. (Figure 10)

EV	122,591,468,962.54	122,591,468,962.54	122,591,468,962.54
EBITDA_yr5	15,768,472,622.62	15,768,472,622.62	15,768,472,622.62
EV/EBITDA_Mult	7.77	6.997020238	8.551913624
Terminal Value	122,591,468,962.54	110,332,322,066.29	134,850,615,858.79
Shares_Outstanding	1,061,000,000.00		1,061,000,000.00
TVal_PerShare	115.5433261	103.9889935	127.0976587

Figure 10: Target Price - Growth

Accounting for Error - Sensitivity to Change and distribution of outcomes

Given that this model utilizes an array of assumptions and possible analyst bias and error, the next step is to conduct layers of sensitivity testing. This process' objective is to create ranges of possible target values given fluctuations in the firm, market, economy or an analysts assumptions and conclusions. It is meant to cover as many alternative paths as possible. To do this, I have employed a set of simple sensitivity analysis tables. (Figure 11) These tables take into account changes from either 1 variable or 2 variables within the model, where those variables are independent predictors and the stock price is the response. There are multiple sets created for all 3 target price cases and both methodologies for extracting the final tare gt price. The sets of variables analyzed can be observed in the following table:

				G vs. WACC			0.75%						
	94.66	-0.150%	0.000%	0.150%	0.300%	0.450%	0.600%	0.75%	1.000%	1.250%	1.500%	1.750%	2.000%	2.250%
	2.8606%	164.12704	172.9523	182.75434	193.7047359	206.018	219.965061	235.8946359	268.15147	310.42192	368.22558	452.05176	584.57742	825.615501
	3.3606%	137.17662	143.4952	150.40416	157.9903376	166.358	175.635863	185.9794147	206.13977	231.076	262.71319	304.17163	360.8649	443.080797
	3.8606%	116.95636	121.6789	126.78315	132.3175031	138.339	144.913798	152.1230631	165.81861	182.13717	201.9121	226.3716	257.40394	298.06979
	4.3606%	101.22794	104.8747	108.78138	112.9766356	117.494	122.371159	127.6538475	137.50628	148.94237	162.37733	178.3854	197.78407	221.778178
	4.8606%	88.646451	91.53588	94.609318	97.88493019	101.383	105.12808	109.1461159	116.53669	124.9507	134.61655	145.83608	159.01662	174.721545
5.36%	5.36%	78.355125	80.69243	83.164312	85.78272574	88.5611	91.5145637	94.66019695	100.38383	106.80366	114.05494	122.31036	131.79404	142.802106
	5.8606%	69.782272	71.70556	73.729889	75.86342907	78.1153	80.4955191	83.01549527	87.561085	92.59962	98.215883	104.51528	111.63053	119.731088
	6.3606%	62.531826	64.13729	65.820303	67.58662553	69.4426	71.395227	73.45226144	77.136471	81.181126	85.641842	90.586298	96.097695	102.279473
	6.8606%	56.320714	57.67733	59.094583	60.57664891	62.1281	63.7538345	65.45941432	68.496062	71.803325	75.419064	79.388549	83.766362	88.6189256
	7.3606%	50.941246	52.09969	53.306335	54.56424795	55.8768	57.2475306	58.6805002	61.218974	63.965157	66.94563	70.191711	73.740562	77.6366151
	7.8606%	46.237588	47.23591	48.273079	49.35139911	50.4734	51.641704	52.85932789	55.007021	57.317155	59.808886	62.504501	65.430091	68.6163999
	8.3606%	42.090531	42.95781	43.856786	44.78921528	45.757	46.762208	47.80703364	49.643041	51.608152	53.716478	55.984269	58.430328	61.0765331
	8.8606%	38.407328	39.16616	39.951123	40.76359615	41.605	42.4770617	43.38132829	44.965131	46.652985	48.455493	50.384748	52.454606	54.6810192

Figure 11: Example of a sensitivity analysis table

Sensitivity Tests Variable 1	Variable 2
WACC	FCF_5
WACC	$EBITDA_5$
Long Term Debt	$EBITDA_5$
Total Debt	Total Equity
rm	beta
pgr	beta
Cash	Long Term Debt

The sensitivity matrices set the current values (of the variables being tested) in the center of the respective column/row and increase/decrease by an analyst-set percentage. The resulting matrix of values represents the target value of the model calculation when the two (2) variables are at their altered levels, assuming all else stays constant in the model. The model also utilizes VBA sub-routines for re-calibration of these matrices as the input assumptions change. Once the % change in the testing variables is set, the analyst can test an unlimited number of assumptions and observe the sensitivity of the price.

The matrix data sets need to be distributed and visually assessed. The data is collected from every sensitivity analysis, organized by table and pooled to create a continuous data set that can be plotted as a distribution .The organized table (Figure 12) also allows the me to identify five number summary of the data sets, cut out outlier cases and select the minimum and maximum from this "raw data" range. The pooled data (Figure 13) allows us to create a histogram distribution and analyze where the peak(s) are located. There is where we find concentrations of possible price targets that are included in our final summary. This process is done in exactly the same way for all 3 growth cases. Once all of the data has been processed, it is loaded (by reference) into the model summary page and displays a the possible ranges of the stock's value within the next 5 years.

	Perpetuity Model 94.66				
Sensitivity Analysis	Min	Max	Median	Average	Ex. Outliers
G vs. WACC	60.58	201.91	97.88	104.24	103.0880806
WACC vs. FCF_5	55.31	176.82	94.66	101.09	100.4526633
Debt vs. Equity Struct	77.54	118.71	94.66	96.00	95.60936231
Rm vs. Beta	39.40	256.61	99.42	110.40	108.7996644
G vs. Beta	60.25	229.84	95.84	109.29	107.7713022
CCE vs. LT Debt	91.05	98.10	94.35	94.60	94.60181084
Averages:	64.02	180.33	96.13	102.60	101.72

	Growth Model - 1 79.29				
Sensitivity Analysis	Min	Max	Median	Average	Ex. Outliers
LT Debt vs. EBITDA_5	64.06	95.36	79.29	79.45	79.43596176
WACC vs. EBITDA_5	46.16	149.25	79.29	84.84	84.29050354
Averages:	55.11	122.30	79.29	82.14	81.86

	Growth Model - 2 97.09				
Sensitivity Analysis	Min	Max	Median	Average	Ex. Outliers
LT Debt vs. EBITDA_5	79.32	115.96	97.09	97.30	97.28176962
WACC vs. EBITDA_5	56.78	182.40	97.09	103.87	103.1980575
Averages:	68.05	149.18	97.09	100.58	100.24

Growth Model SA_Major					Ex. Outliers
Sensitivity Analysis	Min	Max	Median	Average	
		133.29	81.40	81.80	81.91129059

Figure 12: Sensitivity Analysis Table output - organized

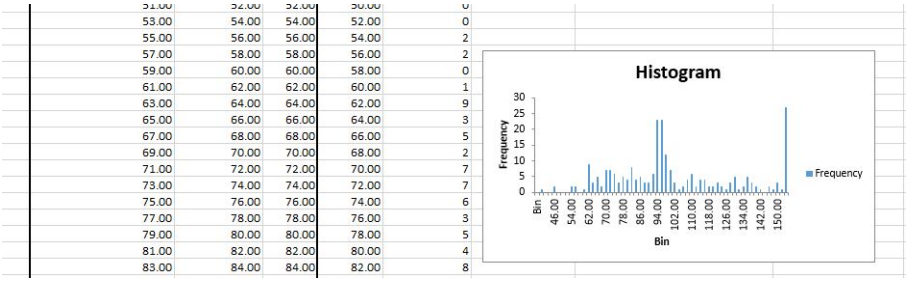


Figure 13: Histogram of Sensitivity Analysis results

6 Complimentary Analysis

The PWDCF model, while being the core valuation model and including multiple measures to account for error and change, only looks at the company valuation from one set of assumptions. Complimentary models are required to add depth to the assumptions and account for other possible growth drives that are not included as input for the PWDCF. For this, I have incorporated 3 additional models with their own sensitivity and error checking measures as well. These outputs not only add to the aggregate data pool but also add different perspectives and assumptions as well. All graphics for this section can be found in the appendix, and they will be clearly referenced in the report as well.

6.1 Comparable Analysis

Comparable Analysis consists of looking at relevant competitors or firms that exist further along the evolutionary pipeline or that have similar risk, revenue or other characteristics. The purpose of this model is to take the multiples of the these firms, weighted for time and company relevance, and apply them to the target company's current metrics. The resulting outputs are potential target prices that are derived directly from market participant's, and these comparable firms act as proxies.

The data needed for this model is market price and financial statement entries for the previous 5 years. The multiples are calculate for revenue streams, costs, cash balances and the value of assets and

debt as well as other components. The EV/EBITDA multiples are closely examined (Appendix: Figure 15) because they can directly imply a comparable EV for the target company. This calculation can be converted into equity value in the same way it was converted in the PWDCF model. The comparable companies represent the industry as a whole from rivals to partners, so their multiples play a very significant role in assessing market potential.

In addition to this multiple analysis, all of the multiples calculated in the beginning across the companies' financial and book values are compiled and compared through weighting. The time frames are weighted relative to holding period and those values are then re-weighted relative to how well the companies are correlated. They are then added by their value and weight, just like beta, kd and rf. All of these multiples are then applied to the target firm's current financials and asset values to extract potential market prices based on the theory that if a pool of comparative companies are in the same business or have the same characteristics, markets should price these assets similarly. The final resulting prices are filtered by their percentage increase or decrease being beyond a certain level of standard deviation relative to the rest of the data, no matter what direction the changes are in. (Appendix: Figure 16) The resulting output is constructed into 2 ranges for 2 tests performed and added to the aggregate analysis.

6.2 Dividend Discount Model

The dividend discount model (DDM) calculates the target equity price by forecasting the growth in a companies dividends. If a firm either (1) has no dividends, (2) has very low or decreasing dividends or (3) is taking out debt to pay for the dividends, this model will not be applicable. Assuming the target company has dividends and they are viable with some degree of growth, this model will calculate the equity price value those dividends indicate. (Appendix: Figure 17) The dividends are observed on a yearly basis and the average growth rate and CAGRs are calculated for varying time periods. Then, the averages of those time periods are taken and used to asses the growth rates to apply to the bear, neutral and bull cases we have already established. The DDM can help influence probability weightings by adding into the analysis the perspective of dividend seeking investors. To calculate the equity price, the following formula is used:

$$SharePrice = div_f 1/(1 + WACC) - (1 + pgr_d iv)$$

where f1 stands for the first forecast year and pgr_div refers to the perpetual growth rate of the firm's dividends per year.

The test concludes with the weightings of the cases and the summing up of the outcomes. The resulting price is the DDM's target equity price. In addition, the individual model is verified with a sensitivity analysis test using the same matrices as before with slightly altered values. These tests are compiled and graphically displayed on the summary page.

6.3 Credit Analysis

The final complimentary analysis performed is a credit test calculating the "O" and "Z" score of default probability and financial stability. The Z score, invented by Edward Altman, is used to preduct bankruptdy within 2 years. It is calculated by the 5 factor formula

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$$

where

$$X_1 = (workingcapital)/(totalassets)$$
$$X_2 = (retainedearnings)/(totalassets)$$
$$X_3 = (EBIT)/(totalassets)$$
$$X_4 = (marketcap.)/(totalliabilities)$$
$$X_5 = (revenue)/(totalassets)$$

and the thresholds used to evaluate the score are

$$"SafeZone" = Z > 2.99$$

$$"GrayZone" = 1.81 < Z < 2.99$$

$$"DistressZone" = Z < 1.81$$

The O (Ohlson) score, invented by James Ohlson, is used to predict financial distress. This 9 factor model formula is

$$T = -1.32 - 0.407log(TA_t/GNP) + 6.03(TL_t/TA_t) - 1.43(WC_t/TA_t) + 0.0757(CL_t/CA_t) - 1.72X - 2.37(NI_t/TA_t) - 1.83(FFC$$

where _t is the current time period and

$$TA = totalassets$$

$$GNP = GrossNationalProductpriceindexlevel$$

$$TL = totalliabilites$$

$$WC = workingcapital$$

$$CL = currentliabilities$$

$$CA = currentassets$$

$$X = 1 if TL > TA, else 0$$

$$NI = netincome$$

$$FFO = funds from operations$$

$$Y = 1 if there is a consecutive NI loss for 2 years, else 0$$

and the threshold here is that any results greater than 0.05 suggest a higher default within 2 years.

These models differ primarily in their accuracy ratings, where the Z score is anywhere from 70% - 90% accurate and the O score is generally higher. The model compiled the relevant data inputs for up to 10 years, calculates the score and plots the data as well as reports the scores to the summary table (Appendix: Figure 18).

7 Real-World Results

I created this model as a senior equity analyst in the Stevens Student Managed Investment Fund (SSMIF). We originally used a standard Discounted Cash Flow template as a base for our equity valuations but it was too shallow an analysis to capture the entire potential story of a firm. I began to do my research and built this model, trying to incorporate as much analysis as I could and make the inputs and assumptions be as dynamic as possible. This model was used to pitch 3 successful positions: D.R. Horton (DHI), American Outdoor Brand Association (formerly Smith and Wesson, AOBC) and Align technologies (ALGN). This model was also used for Hain celestial (HAIN) and CVS Corp. (CVS), but those positions were not incorporated into the portfolio. We worked in teams of 2 to 3 analysts to identify undervalued opportunity in the markets (Value investing) and used cash flow modeling as our core modelling technique.

DHI is a homebuilder in the U.S. and we pitched it as a buying opportunity when it was priced around $26/share. This model was much less evolved at the time but the core techniques were being developed and tested. I calculated as output the price range to be be in the interval $[34 : 41]$ with an investment horizon of 5 to 6 years. The stock is currently trading at $50.25, showing a %90 price appreciation in the last 1.5 years.

AOBC was the first company this model was fully tested on. We pitched this company as becoming diverse in its business segments and found strong catalysts for growth for most of their industries. The pitch was made at $19/share with a price target of just below 30 over 2 to 4 years. Within 6 months the price was almost passing $27 (42% return), but shortly after major headwinds caused a steep drop in price. I realized the model needed to be enhanced further to account for such risks, though the price ranges were accurate.

ALGN was a good investment based in risk to reward trade-offs. This firm makes, almost exclusively, invisalign brace technologies. They had patented this methodology and were positioned strongly in a niche market. We saw untapped potential in terms of value for this firm, and this model output in the bull case a price target of $125/share. At the time, the share price was $87. The additional sensitivity analysis and comparable models helped justify a large valuation for such a small firm, giving us confidence that there was large upside potential. We initiated the position and today it is trading at $233/share (168% return).

As for CVS and Hain, those positions are yet to reach the price forecasts modeled. The model has been tested and continues to be improved upon. The model used as an example throughout this paper is the one used to forecast the value of CVS. The model's ability to incorporate large ranges of tests make it possible to make safer assumptions and conclusions about a target company's price point. The model, tested in the field, has shown that the dynamic analysis potential is greater but needs to be improved upon.

8 Continuing Work

I am continuing this project to improve the model's accuracy and functionality. The next step will be to leverage a more powerful computational environment such as c++ and/or R to run more thorough and data-intensive tests. I also hope to expand the automation of the model to allow for more time doing research as opposed to tedious data collecting on empirical data sets. I also plan to incorporate more macro-economic analysis for seasonal and cyclical trend following. This probability weighted discounted flow analysis model is a strong base for equity modeling and price target setting. As it improves I will incorporate it into my own trading analysis and test it with my "skin in the game".

References

(1) Investment Banking, 2nd Edition, Rosenbaum and Pearl, Wiley Publishing Company
(2) Damodaran on Valuation, 2nd Edition, Aswath Damodaran, Wiley Publishing Company

Model Figures - Appendix

Simple Multiple Method

Company	Price	SO	MC	Debt	Cash	EV	EBITDA	EBITDA Mult	Weights	MxW
CVS	79.00	1,061.00	83,819.00	27,489.00	3,371.00	107,937.00	12,813.00	8.42		
WBA	84.03	1,080.70	90,810.83	18911.00	11,822.00	97,899.83	7,262.00	13.48	40.00%	5.39
RAD	3.80	1,052.27	3,998.62	7252.23	220.03	11,030.82	1,104.64	9.99	30.00%	3.00
ESRX	66.46	605.50	40,241.53	14846.00	3,077.20	52,010.33	7,242.40	7.18	15.00%	1.08
UNH	171.16	962.10	164,672.38	33,901.00	19,352.00	179,221.38	15,819.00	11.33	15.00%	1.70
			-			-				
			-			-				
			-			-				

Average =	10.49	Weighted Avg =	9.47
Excl. Outlier =	10.49		

EBITDA	12,813.00	EBITDA	12,813.00
EV =	134,465.51	EV =	121,280.26
Debt	27,489.00	Debt	27,489.00
Cash	3,371.00	Cash	3,371.00
Equity Value =	110,347.51	Equity Value =	97,162.26
SO:	1,061.00	SO:	1,061.00
VALUATION:	**104.00**	**VALUATION:**	**91.58**

Debt/Equity	74.63%		55.59%
Debt/Cash	815.46%		
Debt/TotCap	24.63%		
Debt/EBITDA	214.54%		
10578.00	1078	9.812615955	

PURE-PLAY Equal Weight Match

Ticker	EBITDA Mult	Weight	MxW
WBA	13.48	50.0%	6.74
RAD	9.99	25.0%	2.50
ESRX	7.18	25.0%	1.80
		SUM:	**9.24**
		IMPLIED PRICE:	**88.82**

Figure 14: EV/EBITDA multiples comparisons

Averages:	Adjusted:	Min:	Max:
84.23	84.23150767	75.8083569	92.654658
138.83	138.8318544	124.9486689	152.71504
54.29	54.28994971	48.86095474	59.718945
105.77	105.7711844	95.19406597	116.3483
328.18	-	-	-
87.01	87.00643727	78.30579354	95.707081
88.77	88.77225607	79.89503046	97.649482
49.60	49.59632751	44.63669476	54.55596
131.14	131.1410661	118.0269595	144.25517
766.04	-	-	-
83.11	83.11088264	74.79979438	91.421971
120.82	120.8220618	108.7398556	132.90427
54.29	54.28994971	48.86095474	59.718945
90.99	90.99020123	81.89118111	100.08922
286.81	-	-	-
82.07	82.07347389	73.8661265	90.280821
74.02	74.01985105	66.61786595	81.421836
49.60	49.59632751	44.63669476	54.55596
82.80	82.80262293	74.52236064	91.082885
724.58	-	-	-

Figure 15: Financial Metrics multiples filter and final selection

TimeFrame	CAGR	AVG
3yr:	15.62%	9.21%
5yr:	21.20%	10.63%
7yr:	25.33%	10.66%
10yr:	22.21%	10.40%
20yr	14.67%	5.95%
30yr	7.05%	3.06%
Average:	17.68%	8.32%

Growth Rates...		PRICE	Weights	Sums
Bull	4.00%	135.5605	25%	33.89
Steady	3.00%	78.13534	60%	46.88
Bear	2.50%	64.47841	15%	9.67

Calibrate

PRICE	90.44

Figure 16: Dividend Discount Model case weighting and summary target price

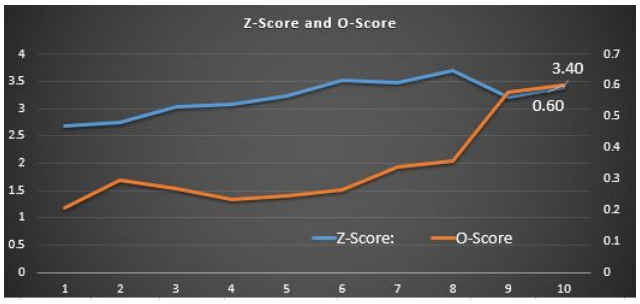


Figure 17: Credit analysis plot