Financial Modeling Notes

Investors' Association at NC State
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Overview

What is financial modeling?

Most generally, financial modeling is the art of estimating future values based on a set of assumptions.

What does that even mean and why is it useful?

Financial modeling can be extremely simple. Building a budget could be considered a common form of financial modeling. The person building the budget is using previous expenditure data as well as some assumptions about future needs to forecast future expenditures. They then compare that with expected income so that they can verify that the sum of the two is positive. If the result is too far from their expected value, they can adjust the assumptions (i.e. add income or decrease expenses) to rectify the result. In the corporate world, companies do the same expect on a much larger scale. They also do so across a much larger range of metrics including earning, margins, cash flow, inventories, etc.

How does one construct a model?[1]

1. Gather historical data
    a. Recommended at least 3 years, but 5-10 usually gives a better picture
    b. Take special care to account for any changes in reporting standards or other structural changes that would appear to affect the data
2. Calculate ratios and metrics
    a. Examples: ROI, ROA, P/E, turnover, margins, growth rates
3. **Build Assumptions**
    a. Forecast the data and metrics into the future
    b. Goal: Create a reasonable approximation of future metrics that does **not** overestimate them
4. Valuation
    a. With the forecasted metrics, compute the present value of the company/stock/entity

Common Models

Top 10 Most Common Models[1]

1. Three Statement – Predict values across Income Statement, Balance Sheet and Cash Flow Statement in a unified model
2. **Discounted Cash Flow (DCF)** – Determine the present value of a firm using predicted free cash flow
3. Merger – "determine pro forma accretion/dilution of a merger or acquisition"
4. Initial Public Offering (IPO) – Predict the value of a company if it were to go public
5. **Leveraged Buyout** (LBO) – Models value of a debt driven acquisition
6. Sum of Parts – Uses several different models that may exclude certain items and sums them together to build a final value
7. Consolidation – Models the effects of merging several business units into one
8. Budget – Forecasts company budget over the next month/quarter/year/etc.
9. Forecasting – Often used as a separate model the compares to the budget

10. **Options Pricing** (binomial tree and Black-Scholes) – Used to price options based on a set equation

Leveraged Buyout Model[2]

What is a leveraged buyout?

An acquisition funded primarily by debt. After purchase the debt/equity ratio will be greater than one.

Who uses them?

LBOs are especially common in private equity and investment banking.

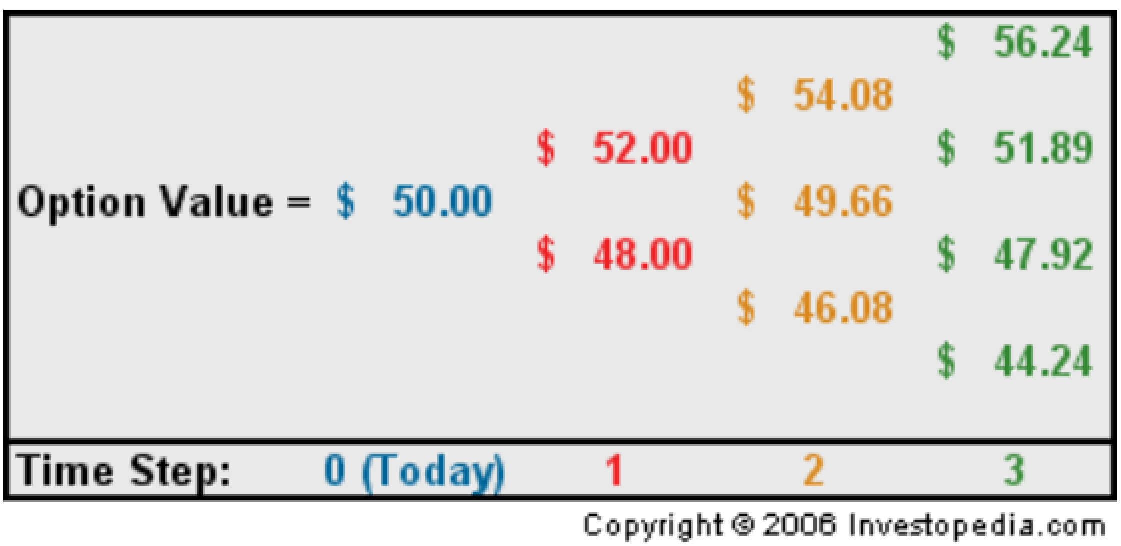
What might a basic LBO model do?

1. Determine a fair value of a target
2. Estimate expected returns if the target is taken private and then sold or taken public
3. Model the effect of recapitalization of a target
4. Determine the ability of a target to repay debt obligations from current cash flows

Binomial Tree Options Pricing[3]

What is a binomial tree model?

In a binomial tree model, each time step is represented as a set of possible prices. As time progresses, the model assumes that there are two possibilities in the next step: the price of the underlying security goes up or down. After some number of timesteps, we can see a range of values for the option.



When is it useful?

The Black-Scholes Model is strictly relevant to European options that cannot be exercised prior to expiration. However, American options can be exercised at any point in time, so the model does not work well. A binary tree mode, in comparison, can iterate over multiple time steps so it takes this into account implicitly.

How might one determine the value of an option with a binary tree model?

> For simplification purposes, assume that an investor purchases one-half share of stock and writes or sells one call option. The total investment today is the price of half a share less the price of the option, and the possible payoffs at the end of the month are:
>
> - **Cost today** = \$50 - option price
> - **Portfolio value** (up state) = \$55 - max (\$110 - \$100, 0) = \$45
> - **Portfolio value** (down state) = \$45 - max(\$90 - \$100, 0) = \$45
>
> The portfolio payoff is equal no matter how the stock price moves. Given this outcome, assuming no arbitrage opportunities, an investor should earn the risk-free rate over the course of the month. The cost today must be equal to the payoff discounted at the risk-free rate for one month. The equation to solve is thus:
>
> - **Option price** = \$50 - \$45 x e ^ (-risk-free rate x T), where e is the mathematical constant 2.7183.
>
> Assuming the risk-free rate is 3% per year, and T equals 0.0833 (one divided by 12), then the price of the call option today is \$5.11.

Source: Investopedia

Discounted Cash Flow Model

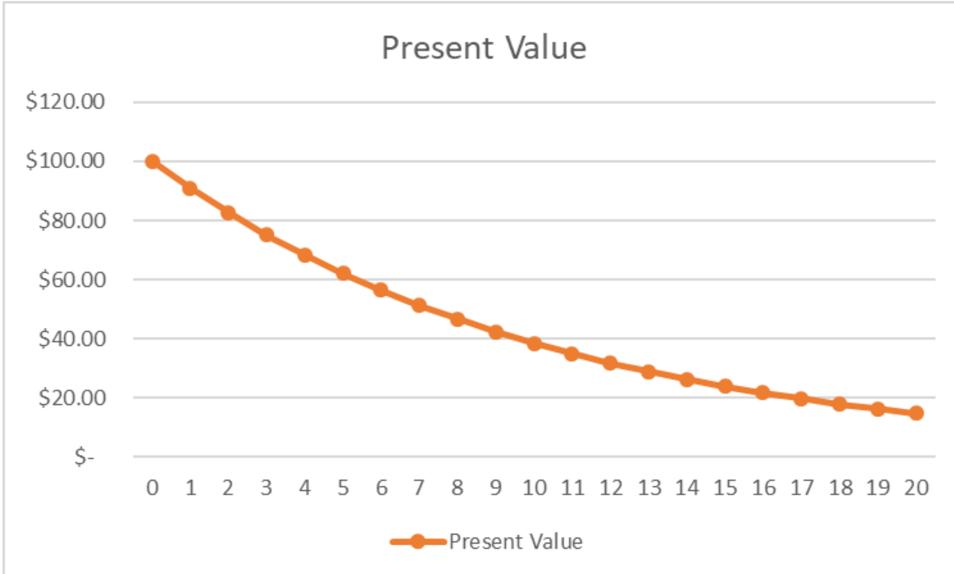
DCF Definition

The DCF Model states that the value of a firm/entity is the present value of all future expected cash flows. The key point here is that the value reflects the **present value** of future cash flows. So, in order to understand the model, we need to understand what this means in practice.

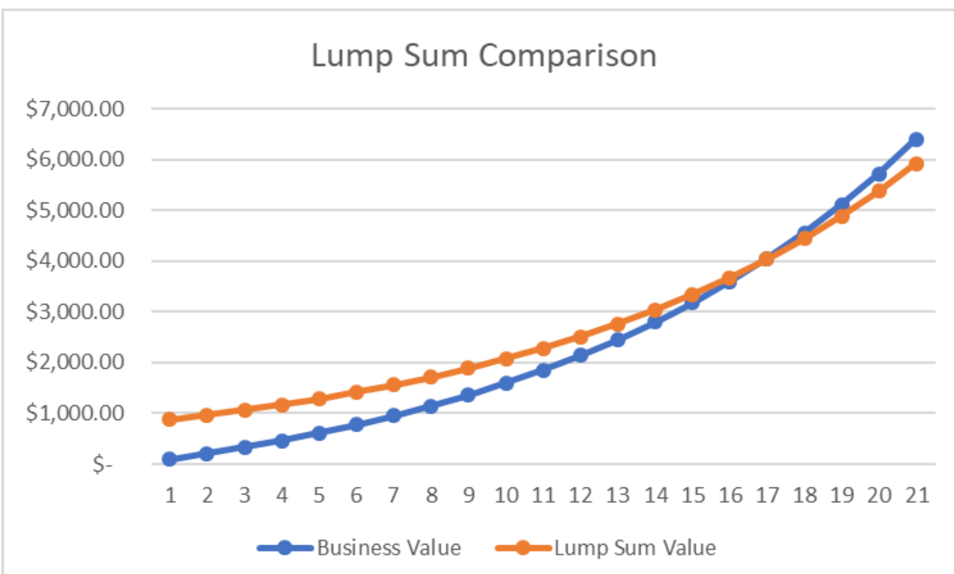
Present Value "Theory"

Discount Rate

The discount rate determines how much less future cash flows are worth in today's dollars. You can also think of it as the expected rate of return of an investment made today, although it is slightly different in practice. Below is an example that shows the present value of \$100 discounted at 10% per year over the next 20 years according to the equation: $PV = \frac{CF}{(1+D)^t}$, where CF is the future cash flow, D is the discount rate and t is the number of time periods (years) from now when the cash flow will be realized.

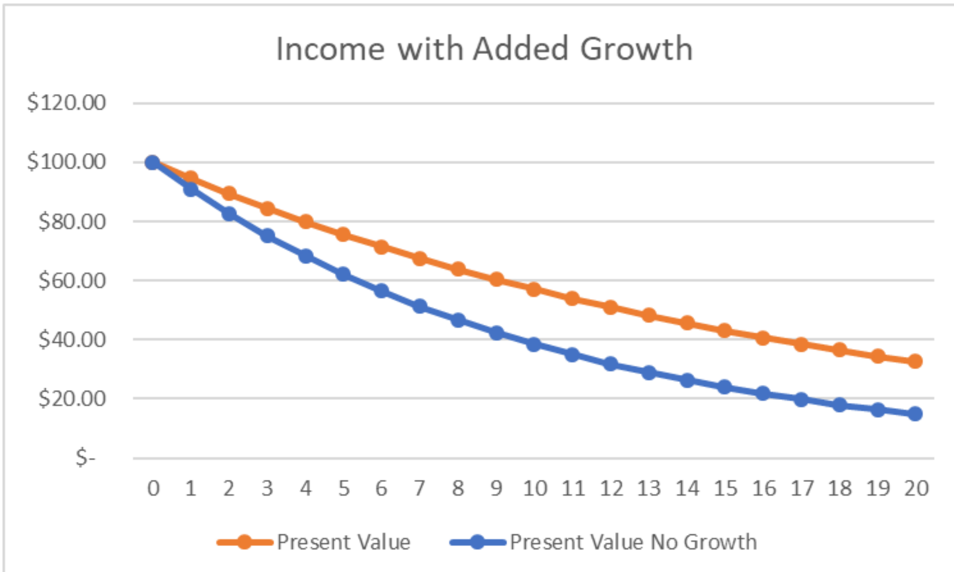


This simple model tells us that $100 dollars realized 20 years from now is only worth $14.86 in today's dollars. So, let us suppose that this was the expected income from a business we owned. If we were offered a lump sum of $925 dollars during year 0 for 100% ownership in the business, would that be a good offer? In this case, using a 10% discount rate, it is a low offer, because the present value of all the future cash flows (the area under the curve or the integral over time 0-20) is equal to $951.36. We can prove this another way by looking at the possible future value of the lump sum compared the future value of the income stream. If we were to invest the lump sum and receive a 10% annual return, then after 20 years we would have $5920.20, whereas if we kept the business and reinvested the yearly income (at the same 10% annual return), we would have $6400.25 as shown in the figure below.



Growth Rate

In our previous example, we assumed that future cash flows were constant, which is practically useless for a business for obvious reasons. Therefore, the next piece that we include is expected growth (or decline) of cash flow over time. Let's revisit our previous example except we will assume that our company does well and grows at 4% per year. The image below shows the new business, with a total present value of $1268.79, versus the old one. The growth rate directly counters the discount rate and you should be able to simply subtract the two to get a final "total rate". If the growth rate and discount rate were the same, the present value of the next years' cash flow would be the same as the current years'.



That is the entirety of a single stage discounted cash flow model. With that foundation, we can look a little more at the math that is needed to formulate a DCF calculation.

Maths

Single Stage DCF

The math for the DCF model is relatively simple and I already presented some of it in the previous section. While we are exploring the math, we will stick to a simple one-stage model that assumes constant growth throughout the lifespan of the company. The first thing we need to do is take our starting Free Cash Flow and estimate it out into the future while simultaneously discounting it. Rather than give some large proof that even I do not really understand, I will show you the formula and then prove to you that it works.

$$TV = FCF * \frac{1+g}{D-g}$$

In this equation, FCF is our starting Free Cash Flow, g is the annual (or periodic) growth rate and D is the discount rate. This equation will give us the Terminal Value of our cash flow, which is sum of all the future cash flows discounted back to today (sounds familiar doesn't it). It is important to note that the discount rate and growth rate cannot be equal, because that would leave a 0 in the denominator. Now in order to prove that this works, we have to revisit and expanded version of our example from the last couple of sections. If we were to extend the example out for another 80 years, the total present value of all the **future** cash flows would be $999.93 (it is really $1000, which you might realize is due to the fact that it is discounted at 10% i.e. 0.1). Now if we use the formula for Terminal Value we get:

$$TV = \$100 * \frac{1+0}{0.1-0} = \$100 * \frac{1}{0.1} = \$100 * 10 = \$1000$$

And as expected, they match showing that the equation and our method of discounting using the formula are equivalent (minus some rounding errors in Excel). I bolded the word future because the terminal value formula does not include the current year's value. In our example this is the first $100. If you were to sum every value from year 0 to year 100 you would get $1100 in the manual excel sheet. However, the terminal value excludes the first value. Just be aware of this when constructing terminal value calculations.

The Terminal Value represents the total value of the firm which is known as Enterprise Value. However, usually, we are interested in the value of the firm's equity. Therefore, we subtract out the current value of the debt and add back cash and cash equivalents, which are both found on the balance sheet. The result gives the total value of equity, which would be divided by the number of shares outstanding to yield a per-share value of the firm.

Multi-Stage DCF Models

In the next section, we will discuss multi-stage DCF models, but the math behind them is similar expect we have more than one growth rate, where each one corresponds to some time range. A common example is a two-stage model with five years of "short term" growth and "long term" growth following. Using the Terminal Value formula does not work for defined periods, so we must adjust things slightly. For the periods with a defined time period, we estimate and discount these manually using the formula below:

$$PV = FCF_{-1} * \frac{1+g}{1+D}$$

For each year in the short term, we manually estimate each year's cash flow (PV) from the previous (FCF_{-1}). Once we have forecasted each period with a fixed length, we use the terminal value formula to forecast the remaining time. If this short explanation made little sense, see the attached two-stage model. You can examine the excel formulas used at each step to calculate the final value. The model splits up the growth and discounting (numerator and denominator) parts into separate columns, but it results in the same end value.

Assumptions and Estimates

Discount Rate

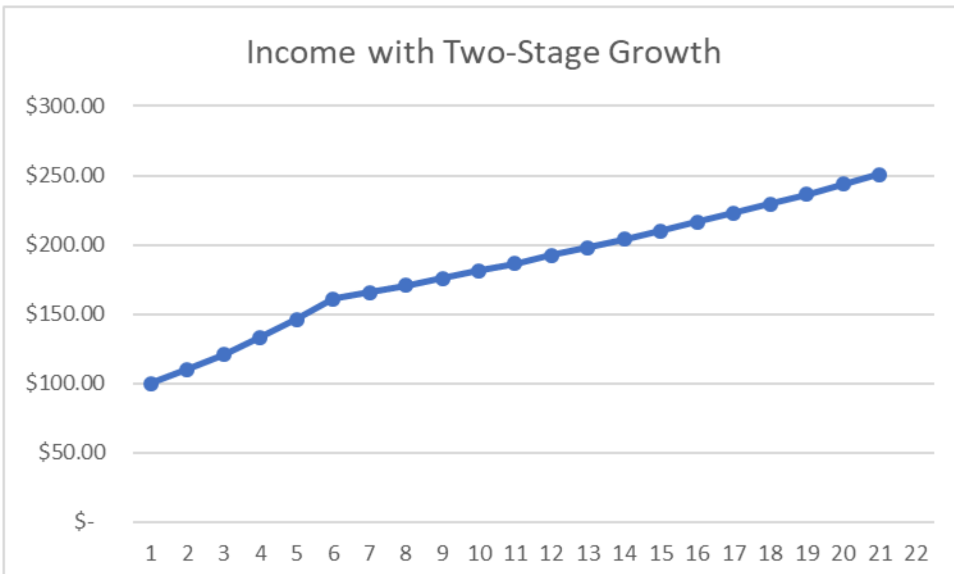
The discount rate plays the largest role in determining the final value of the model so we will start there. In a discounted cash flow model, the discount rate is usually a **weighted average cost of capital (WACC)**. The WACC gives the cost of maintaining the capitalization structure of a firm, which is comprised of two pieces: equity and debt. Each case can also be viewed as an investor as the rate of return required to compensate them for taking the risk. If the cost of capital is too high a business may not invest in new projects that have rate of return lower than the cost. Alternatively, if the rate of return is too low, an investor may seek to invest in another firm with a higher expected return.

In my experience, reasonable WACC values tend to range somewhere between 7-12%, but that is just a guide. If the company has a high debt/equity ratio then the WACC can be much lower as debt is cheaper to maintain than equity, but that structure has other problems. Determining an appropriate WACC is really an art form, but in Bell Tower Capital Management we tend to rely on the Bloomberg Terminal

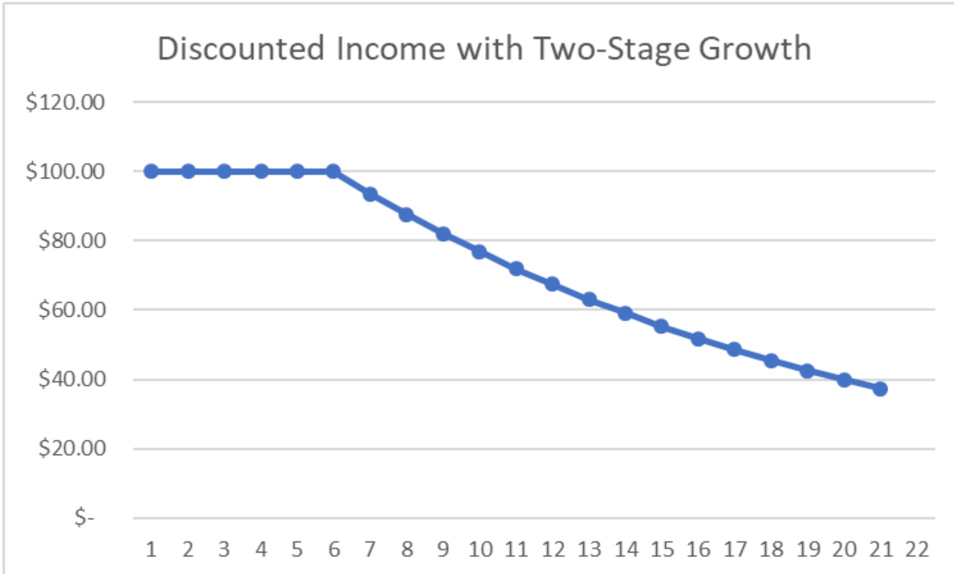
WACC function. This function will give the current WACC as well as the metrics and formulas used to calculate it. If you do not have access to a terminal, then gurufocus.com also has a reasonable calculator.

Growth

Our simple model assumed growth was constant over a 20-year span. I have never seen a company achieve that level of consistency regardless of how aggressive the growth was, so a single-stage model is not very common. Instead, the two-stage DCF model is used and accounts for some period of high growth followed by an indefinite period of low growth (or rarely vice versa). In theory, each year of the model could have a different growth rate, which is doable for the first few years using analyst estimates. However, doing so after about 5 years is very difficult so even in a more complex model, a terminal growth rate is often used to model growth in perpetuity. At this point let's revisit our fake company and assume that we heavily invested in projects in year 0 that will spur growth for the first 5 years. After that, we may or may not continue to invest so the growth will be lower. Such a proposition leads to the following results:



We can see that growth is exponential in each segment, but there is a clear distinction in the short- and long-term growth regions. This fits a typical companies growth trajectory much better than a single exponential curve would. The next step is to apply the discounting to see how this affects the present value.



After applying the discount rate, the two sections become even more visible. In this case, I set the short-term growth rate to be equal to the discount rate, so the first five years see no decrease in the present value. We could integrate over these years to obtain the present value of the company just like before and we would have a simple two-stage DCF.

As I stated earlier, the model could incorporate more than two stages, but each additional stage introduces added uncertainty. Put simply, it is much easier to justify one growth rate sustained over the next five years than to justify 5 different growth rates for each year. The result may be the same, but the effort and work required are often not necessary or productive. Using analyst estimated growth rates can help mitigate this effort, but the model creator would still need to justify why those growth rates seem acceptable.

There is one caveat with growth that should be addressed. Long-term growth should not exceed long term expected GDP growth, expect in rare circumstances. Here is why. If a firm grew at a growth rate higher than GDP **forever** (the long-term growth rate implies an indefinite period) then that company would grow to be 100% of GDP after a long time, which is completely irrational (given if the difference is only 1-3% it takes a long time, like 200-1000 years long, for this to happen). Now, the discounting of cash flows will mean that by the time a company reaches that stage the present value is basically zero, but the idea is still valid. The general rule for long term growth is 2% for a dividend paying company and 3% for a non-payer for a starting conservative estimate. In rare cases, the company could be expected to mature long in the future, meaning that a higher long-term growth rate makes sense (e.g. AAPL in 1985), but the uncertainty involved in that would render the model relatively meaningless in my opinion.

Example Two-Stage DCF Model in Excel

Bell Tower Capital Management

General Information

Company Information		
Ticker	CTSH	
Share Price	$ 63.38	DES
Market Capitalization ($mil)	$ 34,707.00	DES
Shares Outstanding	547601767.1	
Beta	0.930	BETA
Dividends Per Share	$ 0.80	DVD
Dividend Yield	1.26%	
WACC	7.80%	WACC
Cost of Equity	8.10%	WACC
Cost of Debt	1.90%	WACC
Short Term Debt ($mil)	$ 9.00	FA 3
Long Term Debt ($mil)	$ 736.00	FA 3
Total Debt	$ 745.00	
Cash and Cash Equivalents	$ 4,511.00	FA 3
Enterprise Value ($mil)	$ 30,941.00	
Tax Rate	24.96%	FA 5

Macroeconomic Factors		
Risk Free Rate	1.831%	CRP
Expected Market Return	8.54%	CRP

Model Results	
Discounted Cash Flow	
Fair Value	$ 80.50
Margin of Safety	21.27%
Dividend Discount Model	
Fair Value	85.68
Margin of Safety	26.03%

Bell Tower Capital Management

Discounted Cash Flow Model

Year	Free Cash Flow ($mil)
Y0	$ 1,914.00
Y1	$ 1,345.00
Y2	$ 2,123.00
Y3	$ 2,215.00
TTM	$ 1,868.00

Short Term Growth Rate (5Y)	5.00%	EEO
Long Term Growth Rate	2.50%	EEO

Note: EEO gives analyst estimates for a variety of company metrics and growth numbers. It is important to do your own research before accepting any numbers given by analysts.

Gordon Growth Model	
Estimation of Future Cash Flows	
Y0 Cash Flow	$ 1,961.40
Y1 Cash Flow	$ 2,059.47
Y2 Cash Flow	$ 2,162.44
Y3 Cash Flow	$ 2,270.57
Y4 Cash Flow	$ 2,384.09
Terminal Value	$ 46,107.48

Discounted Cash Flow Model	
Current Value of Estimated Future Cash Flows	
Y0	$ 1,819.48
Y1	$ 1,772.22
Y2	$ 1,601.29
Y3	$ 1,812.50
Y4	$ 1,637.68
Terminal Value (adj.)	$ 31,672.15
Enterprise Value ($mil)	$ 40,315.32
Value of Equity ($mil)	$ 44,081.32
Shares Outstanding	547,601,767.12
Value/Share	$ 80.50
Margin of Safety	21.27%

The example DCF model is taken from the Bell Tower Capital Management model and is available at www.ia-ncsu.com/stock-valuations. This model was designed to use the Bloomberg Terminal and has the relevant terminal commands listed beside the fields. This model is a two stage DCF with 5 years of short-term growth followed by an indefinite period of long-term growth. The Trailing Twelve Month (TTM) free cash flow is used to estimate the future cash flows, which are then discounted using the WACC. The sum of these values gives the enterprise value which also includes debt, cash and cash equivalents. After removing these, the model gives a per-share value as well as the margin of safety (See Appendix A).

Common Pitfalls and Mistakes

There are several common mistakes that one can make while constructing a DCF model that have to do with the assumptions and estimates used.

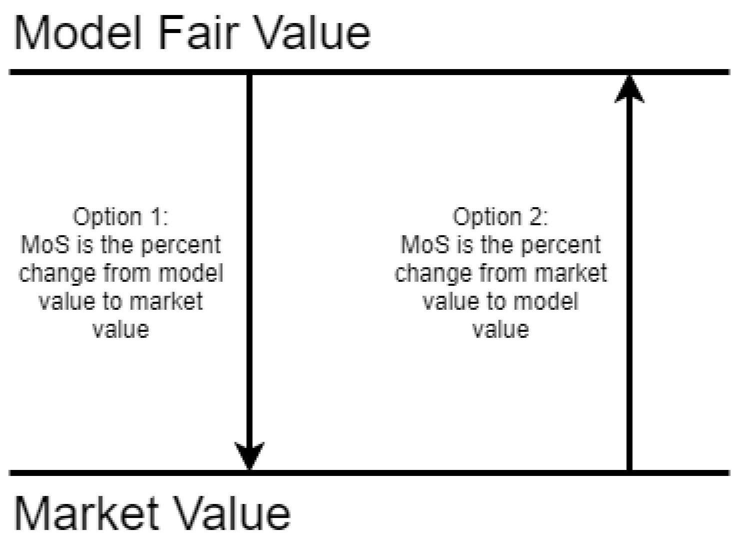
1. Growth rates are too high or too low – Estimating the future growth of a company is extraordinarily difficult and professional go to great lengths to attempt to predict those numbers and yet most predictions even for next quarter will be inaccurate at best. So, what then should the analyst do in order to make a fair prediction? Be reasonable but not aggressive. Models are always wrong, but sometimes useful. In order to make a useful model, we prefer it

to be as close to realistic as possible with room for some error. For example, if we believe that a company could grow at 15% per year the next 5 years and that gives a value slightly above the current value, then what happens if we are wrong by 30% and it grows at 10%. Likely, we lose money are make very little. On the other hand, if we think the company can grow at 15% but our model predicts that even at a 10% growth rate the company is worth slightly more than it is currently valued at, we will most likely make some money and it is very unlikely we lose money. Now of course, that was all a big simplification, but it should show the idea. Modeling is not about creating an accurate prediction of the future, it is about assessing our expectations and comparing them to the market's. For that reason, it is much better practice to prove that the business is unlikely to perform worse than your model then to attempt to show the best possible scenario for performance.

2. Using one metric to estimate another – This one seems stupid because who would use revenue growth to estimate cash flow growth or earnings growth. The answer is most of the people in Bell Tower at some point or another including myself. It is entirely possible to model future cash flow growth using revenue or earnings predictions, but it requires extra steps that adjust those rates back to cash flows. It is incorrect to say, "revenue has shown solid 4% YoY growth for 10 years so I think cash flow will follow the same trend over the next 5." It may turn out to be the case, but it is much more useful to look at cash flow growth where it is entirely possible cash flow has seen negative, zero or positive growth over the same period. Company capitalization and cost structure determines how cash flow and revenue interact so you would need to model those as well in order to calculate cash flow estimates (note: this is what some analysts get paid to do on a daily basis).
3. Not understanding all of the model inputs – Does an increased tax rate increase or decrease a firm's value according to a DCF model? Does a higher debt/equity ratio increase or decrease a firm's value in a DCF (typically)? These are extremely easy questions for anyone that is familiar with a DCF and knows how the model works. If you cannot answer them, then you need to study it more thoroughly. The inputs to a model are all important and affect it in some way. If you put your name on a model you are responsible for all of those inputs whether you pulled the number from someone else or not. In addition, if you are aiming to provide what amounts to a little better than the worst-case scenario then you need to understand what that scenario entails. If you don't understand how tax rates affect a DCF, you may be inclined to raise it in order to make a more conservative estimate, but you would see that you then raise the value of the firm as well, which makes little sense at first. Why would a higher tax rate result in a higher value? This is left as an exercise for the reader, but it has to do with the WACC.
4. Not exploring the model – Formally this could be considered a sensitivity analysis, but the reason you built a model was so that you could quickly and easily predict various scenarios. What if growth is lower than expected, what if it is higher. What if interest rates rise suddenly, what if they fall. These are questions that are easily answerable in a DCF model and they can be presented in a table or graph relatively easily. The model was not built to do on computation, it was built to do many so that the analyst can glean a better picture of the possible future scenarios.

Appendix – Margin of Safety

Margin of safety is a concept that was introduced in Benjamin Graham's famous guide to investing, *The Intelligent Investor*. It measures the possibility that a model may be wrong. Benjamin Graham (to the best of my knowledge and memory) did not specify a formal equation or method for calculating a margin of safety, but I have adopted a specific measure which I will call deviation from expected value (or fair value). This measure gives the percent change from the value a model produces to the current value. It would be equally beneficial to use the percent change from the current value to the predicted, but I see this as having a singular drawback. With this secondary method, it is incorrect to say, “my model has to be wrong by x% in order for a loss to occur.” Instead, the second definition gives rise to this explanation “my fair value is x% above the current market value,” which is fair in its own right, but less useful in my opinion than the first quote. Defining the margin of safety from the model value to the market value allows us to use the first quote which aligns more closely with the spirit of the margin of safety. The image below shows the two definitions side by side for comparison. This section has also assumed that the model presents a value greater than the market value, but the same would apply if the value gave a value lower than the current market price. In that case, the margin of safety would still be calculated as the percent change from the model value to the current value. Lastly, this measure is only useful for a security or instrument with a market value. If the model were being used to predict the value of a private firm, this measure would be useless generally.



References and Additional Resources

[1]https://corporatefinanceinstitute.com/resources/knowledge/modeling/financial-modeling-for-beginners/
[2]http://www.streetofwalls.com/finance-training-courses/private-equity-training/basics-of-an-lbo-model/
[3]https://www.investopedia.com/terms/b/binomialoptionpricing.asp

Excel Templates and Self-Study
https://www.macabacus.com/learn

Real Estate Modeling
https://www.adventuresincre.com/library-real-estate-excel-models/#library

Various Learning Resources
https://corporatefinanceinstitute.com/resources/knowledge/modeling

Financial Modeling Course (This one has some paid features, but it looks like you can access the course itself without paying.)
https://www.asimplemodel.com/default.aspx