Arham Hameed

arham.hameed@minerva.kgi.edu

Abstract

Discounted Cash Flow (DCF) is the most popular technique for a firm's valuation. However, conventional DCF valuation was created for mature stable companies that yield stable growth and returns, with long standing financial history and data. Thus when we talk about DCF valuation in the context of young growth companies one of its biggest weaknesses is that it does not account for the uncertainty and the lack of financial or operational data available for these firms. The goal of this paper is to build a probability- based approach towards young growth company valuation that uses Monte Carlo (MC) Simulation to integrate uncertainty and randomness.

Author's Note

After careful consideration of the feedback received in the last class and assignment I realized that I was focusing too much on my simulation code rather than the analysis and detail of the theory behind my simulation. So I started from scratch, fleshed out the details as was asked so that I can receive feedback on the theory. I start by presenting my question, which is to find a way to use DCF valuation on young growth companies. Why is conventional not appropriate for these companies? And what characteristics of these companies make them hard to value?

After that I present my own method to a simulated DCF approach that finds the key variables that impact the company value the most, and finds the most relevant probability distribution for those variables. And run the simulation and present the results in a histogram.

In this paper I am mostly focused towards the theoretical part of the simulation and the underlying bare bones of the project that makes up the practical aspects of the simulation. What I am thinking of going forward from here is to build case studies of different companies and valuing them based on my methods. I have yet to add more graphs, visualizations, figures, and results in this assignment. However, provided the feedback I received I was asked to first flesh out the details of where I am going with my simulation idea. So indeed of focusing on visualizations and figures, I focused on the theory and literature that is present out there and incorporated it in my theoretical analysis.

Introduction

Valuing growth companies is a major challenge faced by most investors (Damodaran, 2001).

These companies tend to have little or no revenues and operating losses. The ones that have might not have a long history to support any future growth predictions thus making the future potential of the firm highly uncertain (Maya, 2004). Conventional DCF approach was devised to cater to traditional companies' valuation, with stable growth rates and long standing revenues and earnings history. It assumes that future cash flows will be stable and predictable (Mun, 2002). DCF valuation aggregates the future cash flows in one single estimate, uses a risk adjusted interest rate to discount it to today's value, thus giving us an expected value. This presents a variety of drawbacks when we try to use it for growth companies. One major one is tackling the uncertainty that characterizes the future cash flows of growth companies (Booth, 2003). In such a volatile and uncertain environment, we cannot predict the cash flows to be a single value, but rather we will need to assume a range of multiple outcomes that will be derived by multiple possible values (Mun, 2002). In such stochastic situations, using conventional models such as deterministic DCF approach can lead to flawed valuation of growth companies (Booth, 2003; Damodaran, 2001).

In order to tackle the uncertainty, and account for this drawback in conventional DCF valuation method, financial analysts started performing sensitivity or scenario analysis to compliment the DCF approach (Savvides, 1994). This helped the analysts understand among a myriad of variables, which variables have the greatest impact on the DCF value, and characterize these variables based on their significance on the impact of the DCF value they have (Ragsdale, 2004). Even though sensitivity analysis helped the analysts understand the importance of different variables and their impact on the DCF value, it still did not account for the correlation among different variables. Sensitivity analysis did not account for the interdependencies between variables since the ceteris paribus assumptions made when changing one variable at a time is rarely realistic (Kelliher and Mahoney, 2000). Hence forthe, analysts started performing scenario analyses where we construct alternative scenarios based on different variable values. Even though this did account for interdependencies of different variables and heed analysts analyze different scenarios, it still did not provide them with the probabilities of occurrence of a particular scenario (Goldman and Emmett, 2003).

In order to account for these uncertainties and risks, this paper proposes a new method of performing DCF valuation for growth companies. This method is based on stochastic or Monte Carlo (MC) simulation. Monte Carlo simulation uses pseudo random numbers which can help us solve deterministic problems (Law & Kelton, 2000). It is a proven technique that considers risks and uncertainties, which allows analysts to assign different probability distributions to different variables which account for the range of possible values for each variable (Powell and Baker, 2004). Monte Carlo simulation uses random sampling from these probability distributions to perform hundreds of thousand of scenario analysis. A distribution of these several scenarios is thus created and decisions can be made with the knowledge of the whole distribution rather than one estimated aggregate value (Winston, 2004). Monte Carlo simulation was first used for Capital Budgeting in finance in the 1960's to evaluate risks and uncertainty inherent in investment decisions (Kelliher and Mahoney, 2000). This paper will be using a Monte Carlo simulation approach that could be used to grow the company's valuation.

In this paper we will be looking towards a specific subset of growth companies, in the technology industry. We will first describe what constitutes a growth company in the technology space first. After that we will propose a DCF model to value these subset of companies. After that we will be examining how our model incorporates the uncertainties in the DCF analysis using Monte Carlo Simulation. Lastly we will be evaluating the results and summarizing the empirical analysis.

Growth Companies in economy

Why are they important?

Even though young growth companies tend to be small in size and represent only a small part of the overall economy. Their importance and impact on the economy is disproportionately high due to the following reasons:

Employment Opportunities

The National Federation of Independent Businesses estimates that two-thirds of the new jobs created in the recent years have been created by these young growth companies. That means a lot of our economy's employment rate is dependent on these companies doing well financially.

Innovation

Clayton Christensen coined the term disruptive innovation. Disruptive innovation is an innovation that creates a new market and value network and eventually disrupts an existing market and value network, displacing established market-leading firms, products, and alliances (Clayton Christensen, 2015). This innovation was unlikely to come from well established firms but rather from the startups that will boost the innovation and explore new avenues for economic growth. For example: the online retail industry was established by a new startup, Amazon.com rather than a well established firm.

Economic Growth

Startups, even though they are small, they play a big role in economic growth. They not only increase employment as mentioned above but they also play a major role in economic dynamism (Ahmad Fahim Dar, 2000). This means they spur innovation and boosts the economy to grow through bridging new ideas in the economy and promoting entrepreneurial competition. The US was able to generate a more rapid growth than the Western Europe during the 1990s. This was primarily due to the growth of small, new technology companies (Damodaran, 2004).

Characteristics of Young Growth Companies

It is important for us first to describe what constitutes a young growth company in the technology industry. Even though young companies are diverse, they share some common characteristics (Damodaran, 2004). This section will be looking into these shared attributes of young growth companies in the technology industry and how these traits pose valuation problems for analysts and investors.

Little or no history

As described above the biggest issue with conventional DCF valuation is that it assumes that the future cash flows are certain and stable. However, these companies have very limited histories. Most of these companies have one to two years of financial data available on operations (Damodaran, 2004).

Little or no revenues/ operating income

Another challenge we face in implementing conventional DCF valuation for these companies is that the revenues or operating income provides little or no details. So even though companies that might have short financial histories, that data is rendered useless by the fact that the revenues and income/ losses have little operating details in them. In most cases the revenues are small or unavailable for young growth companies, and the expenses are often for setting up the business and kickstart generating revenues (Damodaran, 2004). Thus we cannot use these figures to forecast the data for future revenues/ operating income.

Dependant on Private Equity

Another common characteristic among these young growth companies in the technology sector is that these companies are dependent upon equity from private sources, rather than public markets (Damodaran, 2004).

Uncertain Survival

The US Small Business Administration found that on average, 39.8% of the new firms survive six or more years. This is equivalent to a failure rate of three out of five firms failing within the first five years (Phillips & Kirchhoff, 1989). A study of 5196 start-ups in Australia found that the annual failure rate was around 9%. And furthermore along the lines of failure rate of Phillips & Kirchhoff's study, 64% of the new businesses failed in a ten year period (John Watson & Jim Everett, 1996). In 2005 Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW) performed a census containing information on more than 8.9 million US businesses in both the public and private sector. Knaup and Piazza used this data to conclude that only 44% of all businesses that were founded in 1998 survived 4 years and only 31% made it through all seven years (Knaup, Amy, Piazza, 2007). In the context of DCF Valuation this poses a problem as to how to account for the risk of survival and control for it. Therefore, we have to account in the probability that the business will not survive into the discount rate (Damodaran, 2004)

Valuation Issues

We have listed some common characteristics among young growth companies. The fact that they have short or no financial history, are dependent upon financing from private sources (private equity) and are susceptible to failures in their early life makes it harder for us to account for all these uncertainties, limited data, and risks. Which eventually makes it more difficult to value these companies.

We will be analyzing how these problems play their role in making DCF valuation harder. There are four pieces that make up the DCF valuation puzzle - the cash flows from existing assets, the expected growth from new investments and improved efficiency on existing assets, the discount rates that involve risk assessments, and the terminal value that assesses when the firm will have stable growth (Damdodaran, 2004).

Existing Assets

In conventional DCF approach we take the value of existing assets from the current financial statements of the company. We then estimate the value of these existing assets using the history and anticipated future cash flows generated from these assets to attach a value to them.

With young growth companies, especially in the technology sector, these existing assets are either so small compared to the overall value of the firm that it does not make sense to estimate their value based on past or future estimations. Or there is not much historical data available for the analysts to predict the value of these assets. Having little background data available means that we cannot be sure that the revenues from existing assets were influenced by macro economic trends or some other confounding variable. The lack of data makes it harder for analysts to understand the effect of change on macro economic trends on the revenues generated from these existing assets.

Similarly, unlike traditional well established companies, young companies expenses also do not report a very clear picture of cash flows. It is not unusual to see Selling, General, and Administrative (SG&A) expenses at some young growth companies to be three to four times larger than revenues (Damodaran, 2004). This can be because of multiple reasons. A new company is trying to penetrate into a new market, they are trying to increase their customer base, so the expenses incurred right now are being used for lining up future customers. Because of these reasons it gets harder to differentiate between the genuine operating expenses from these expenses. And in order to value existing assets of young growth companies we need to be able to distinguish between them.

Growth Assets

Most of the young growth company's value comes from the growth assets (Damodara, 2004). The reason why conventional DCF valuation poses a problem here is that we are uncertain with the future value of these growth assets which are of immense importance to value these firms. The reason why we have problems estimating these growth assets are firstly, absence or lack of history of revenues. This means that either these firms are not revenue generating yet, and if they are then the history is too short to make a predictable forecast from the data. That means we have to rely on the company's own estimations for their future revenues that can be biased.

Similarly, even if we estimate the revenues of these forms, we will still be unsure as to how earning will evolve with the growth of revenues. As we explained above that it is hard to differentiate between the genuine operating expenses versus the actual expenses. Also, young growth companies tend to incur losses at the start, that makes it harder to predict what the future profit margins will look like and value them accordingly.

Lastly, we also have to take into account the quality of the growth as well. Growth by itself can be constructive or destructive. To assess the quality we will have to look at how much the firm has reinvested in future growth projects and whether or not the returns on those reinvestments are greater than the cost of capital invested in them. The reason why this is an issue for conventional DCF valuation is because young growth companies have little investments in the past that we can use that data to predict return on capital. Furthermore, current return of capital, which can be used as a starting point for estimating future return, is generally negative for young growth companies (Damodaran, 2004).

Discount Rate

Discount rates assess the risk in a company. The standard way of calculating discount rates is by using a regression model that estimates the beta for equity on a stock against the return on a market index and cost of debt by looking at the prices of publicly traded bonds (Damodaran, 2004). With young growth companies that is not the case. Firstly, most young companies are not publicly traded. That means that we cannot runa regression of the past returns to get equity beta or use the interest rate of the market.

In conventional DCF approach when we account for risk we focus on market risk to estimate cost of equity. However, in the case of young growth companies, the equity is held by a myriad of different investors (founders, venture capitalists, etc) who have different perspectives towards risk for their investments. Because in young companies equity can be raised from multiple sources, each source will have a different risk attached to it. That means that there can be different costs of equities for different equity claims (Damodaran, 2004).

Terminal Value

The terminal value of a firm reflects the value of all expected future cash flows (Higson and John, 2000). It accounts for a very large proportion of a company's value. This value provides the investors an estimate as to how much potential there is to a particular firm. In the case of young growth companies this value poses a big problem. It is not uncommon for the terminal value of a young growth company to be 90%, 100%, or even more that 100% of the current value of the firm (Damdodaran, 2004). Therefore, assumptions that when the firm will reach stable growth, will the firm reach stable growth or what stable growth will look like financially for the firm is important to consider since it accounts for a very big percentage of our valuation for young growth companies.

We discussed above how young growth companies are more prone to failures. This estimation and probability associated with a firm's success rate is of importance when we have to account for will the firm will reach stable growth? And if yes then when the firm will reach stable growth? Finally it is not only the if and when the stable growth will be achieved for the firm. For young growth companies we also have to determine the effect and consequences of stable growth rate. At such an early life cycle of a firm it is hard to predict what this stable growth rate would yield. What would the risks and returns look like during a stable growth phase?

These estimations, probabilities, and judgements make it hard for analysts and investors to value any young growth firm with lack of historical data and uncertain future.

Why MC Simulation

When dealing with uncertainties simulations can help u understand different scenarios. Instead of just specifying expected values of different variables, we can specify different probability distributions for revenues, costs, margins, and growth rates. And based on these distributions we can simulate a range of scenarios that a company might face which can help us understand and calculate the probability of success or failure of a firm.

Monte Carlo (MC) Simulation, as a form of risk assessment, was developed in the early 1960s by Hertz (1964), who applied it to a capital budgeting decision in Harvard Business Review. Monte Carlo Simulation will allow us to assign key uncertain cash flows a probability distribution that will help us represent a range of possible scenarios with a variety of possible values of different variables (Powell and Baker, 2004).

My Approach to MC simulation

Step 1: Estimating Revenues Growth

Damodaran suggests that revenue growth can be estimated in three ways:

1. Historical Growth Rates
2. Analysts' Estimates

3. Growth as a function of quality of reinvestments

Estimating revenue growth rate is a key first step toward building our simulation model. This is a difficult task of predicting uncertainty in future technology, financials, development of the company's structure, and predicting management and markets (Brealey and Myers, 2018; Reilly and Keith, 2003). In our approach we will either build a probability distribution using the historical growth rates or Analysts's estimation approach. The technique will depend on whether or not the company is generating revenues or not.

Step 2: Estimating costs, earnings, and reinvestments

After our first step of estimating the revenues, the next crucial part is to estimate the costs, earnings, and reinvestments. The technique we have employed to estimate the costs, earnings, and reinvestments is called "*percentage of sales approach".* This approach is based on the assumption that the revenues are the driver of these costs and reinvestment needs (Brealey and Myers, 2018).

We can implement the following method in two ways. Firstly, we can rely on historical data and see the percentage of revenues being consumed as costs and reinvestments. From there we can forecast these values out of our estimated revenues we forecasted in the first stage. However, this technique has a big assumption that the historical trends of costs and reinvestments will continue to hold as our revenues change in the future, which is not a reasonable assumption (Brealey and Myers, 2018). The second approach is more reasonable as it uses regression to forecast the future trends of costs and reinvestments based on our revenues (Benninga, 2001). We will perform a simple regression that fits a straight line to a scatter plot of forecasted revenues with costs and see the trend as to how our costs and revenues are correlated. Thus we can forecast our costs and reinvestments based on this method.

Step 3: Estimating Cash flows

After estimating the revenues, costs, earnings, and reinvestments, we can now calculate the free cash flow (FCF) of our young growth company. In our case, the FCF of the company would be operating profits less taxes less investments the company makes for future growth or projects (capital expenditure).

$$FCF \ = \ EBIT(1 - t_{tax}) - (CapEx - D_p) - \Delta WC$$

Here:

$FCF \ = \ Free\ Cash\ Flows$

$EBIT \ = \ Earnings\ before\ Interest\ and\ Tax \ = \ Revenues \ - \ Cost\ of\ Revenue \ - \ Other\ Operating\ Expense$

$t_{tax} = \ Tax\ rate$

$CapEx \ = \ Capital\ Expenditure$

$D_p = \ Depreciation$

$\Delta WC \ = \ Change\ in\ Working\ Capital$

So using the forecasts of our revenues which is done by forecasts annual growth rates. Then forecasting costs out of our forecasted revenues we estimate our operating costs. And finally we forecast our reinvestments needs for future growth or CapEx (Fernandez, 2001).

Step 4: Estimating Discount Rates

As we mentioned above, the discount rate is the assessment of risk in a company. In DCF valuation context it is the opportunity cost of investment by an investor when investing into a company. The way we can understand this is by thinking of the value of a company as the sum of all future cash flows discounted at their required rate of return. And that required rate of return would be our discount rate. Copeland describes this opportunity cost that an investor bears as the weighted average cost of capital (WACC) (Copeland et al., 2000).

$$WACC = C_E\left(\frac{W_E}{W_E+W_D}\right) + C_D(1 - t_{tax})\left(\frac{W_D}{W_E+W_D}\right)$$

Here:

$WACC = Weighted\ Average\ Cost\ of\ Capital$

$C_E = Cost\ of\ Equity$

$C_D = Cost\ of\ Debt$

$t_{tax} = Tax\ rate$

$W_D = Weight\ of\ Debt$

$W_E = Weight\ of\ Equity$

From the equation above we can see that in order to calculate the weighted average cost of capital of a young growth company we will need to perform four estimation- cost of financing in the shape of either debt or equity and the relative weights of debt and equity (Higson and John, 2000).

Let's start with the cost of debt estimation. In the case of a young growth company, the cost of debt would be the interest rate charged to the firm if the firm wants to borrow, this will be adjusted for any tax benefits associated with borrowing (Fernandez, 2001). The cost of equity will be more complicated as it is the rate of return an investor expects on its initial investment, which for young growth companies can be highly unpredictable and uncertain. In order to estimate the cost of equity, we will be implementing a capital asset pricing model (CAPM) (Graham and Harvey, 2001). As described in the issues with discount rate section above, our capital asset pricing model will require three additional inputs- *risk free rate* and *market rate of return* and *beta* of the company, as shown below:

$$C_E = r_f + (r_m - r_f)\ \beta$$

Here:

$C_E = Cost\ of\ Equity$

$r_f = Risk\ free\ rate$

$r_m = Market\ rate\ of\ return$

$\beta = Company's\ beta$

The risk free rate is the return on the security that has no default risk and is not related to other securities in the economy (Higson and John, 2000). We will be using government issued security returns in our simulation.

The market rate of return less risk free rate, multiplied by the beta, is the opportunity cost an investor incurs by moving his investment from a risk free investment opportunity to a riskier investment. With that risk, the investor looks for premium on the return on investment to make up for the risk taken. Since it's the risk associated with the company, hence it is thus associated with the company's beta as well. Which is a relative measure of risk added on to a diversified portfolio, rather than total risk (Reilly and Keith, 2003). As we described above in teh issues with estimating discount rates section, we normally calculate discount rates by using a regression model that estimates the beta for equity on a stock against the return on a market index and cost of debt by looking at the prices of publicly traded bonds (Damodaran, 2004). In our case, we will be using a relative valuation for the *risk premium* which will be based on the regression model. However, in our case, the regression will be implemented on the data of similar young growth companies' risk premiums, rather than looking at returns on the market index.

Step 5: Estimating Terminal Growth Rates

In order to estimate the terminal growth rate of a young growth company, we will be using the constant growth model of Gordon. The Gordon growth model assumes that the company's growth will be stable and constant after a certain period in time, thus allowing us to discount it to infinity (Reilly and Keith, 2003).

$$TV = \frac{FCF_n}{WACC_n + (1-g)}$$

$TV = terminal\ Value$

$FCF_n = Free\ Cash\ flow\ at\ Year\ n$

$WACC_n = Weighted\ Average\ Cost\ of\ Capital\ at\ Year\ n$

$g = Constant\ growth\ rate$

The major concern for young growth companies as explained in the section of Terminal Value issues is that we do not know the time period when the constant growth will come and what the constant growth would look like. In order to account for this uncertainty, Monte Carlo Simulation will help us integrate distributed values of constant growth rates so that we build a range of different scenarios based on probability distributions.

Step 6: Building a Discounted Cash Flow (DCF) Model

After calculating all these values, we are going to add the discounted value of free cash flows (FCF) and terminal value (TV).

$$V = \sum_{n=1}^{n} \left(\frac{FCF_n}{(1+WACC)^n}\right) + \left(\frac{TV}{(1+WACC)^n}\right)$$

Here:

$V = Value\ of\ the\ company$

$n = Year/\ Time$

$FCF = Free\ Cash\ flows\ at\ period\ n$

$WACC = Weighted\ Average\ Cost\ of\ Capital$

$TV = Terminal\ Value$

The sum of the discounted Free cash flow and terminal value will give us the estimated overall valuation of the company.

If we want to take further to get the stock value, which currently we are not going to do, we will subtract company's liabilities and debts to get Value to Common Equity, and divide it by current outstanding shares to get share price or stock price (Damodaran, 2001)

The next part of the model is to model for uncertainty in our DCF valuation using Monte Carlo Simulation. The way we will be going about it is by including following steps in our simulation model described by French and Gabrielli (2004):

1. Determining the variables that are uncertain and random, and match their uncertainty (Damodaran, 2001)
2. Identifying the key variables that are affected heavily by uncertainty and have large impact on the output (Maya, 2004)
3. Understanding the analyses of the results and effects on uncertainty on the overall value (Damodaran, 2001)

We have identified cash flows as the key variables in our model, which has the biggest impact on the final resulting output valuation. This means that volatility in our cash flows accounts for the most significant impact on our value while other uncertainties might have little or minimal effect on our firm's company's value (Ragsdale, 2004).

In the method we proposed above on how to calculate the Free Cash Flows (FCF) of our company we see that there are a number of variables being estimated that can lead to a different FCF value. This causes a major issue as employing a variety of probability distributions will make our model less predictable and transparent. Not only this, it will create inconsistent scenarios because of correlations among different variables. Also, spending too much computational and analytical resources on determining the perfect distributions for those variables that have little to no effect on the valuation have more costs than benefits. So we have to account for this as well.

Understanding the fact that there is not a single rule that tells us which variable should be stochastically distributed and which ones should be derived from the others, we have simplified this model by taking into account already done research by M. Ali et al, 2010. Sensitivity analysis is necessary to account for the importance of these variables and to determine precise probability distributions (Savvides, 1994).

The graph below shows how different estimations we make during calculating our Free Cash Flows have an impact on our final value. The Tornado chart is a deterministic sensitivity analysis where we change a single variable while keeping others controlled and see how change in that particular variable has an impact on our final value. This is important because we need to identify those key variables that will impact our final value mostly because of the reasons explained above.

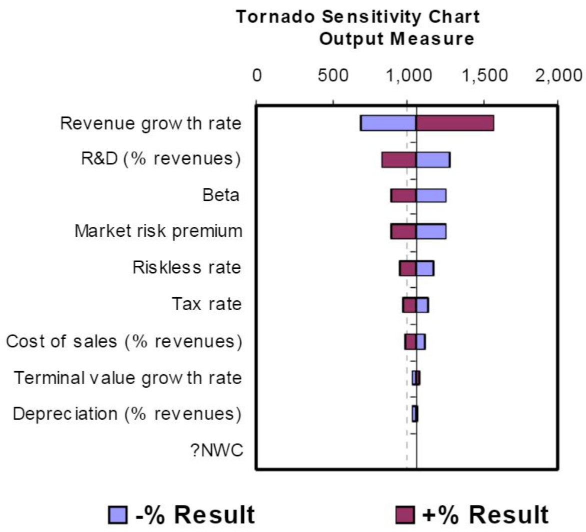

Figure: Taken from M. Ali et al. Will be using my own once the simulation code is completed. Maybe for me different variables might be more important based on the assumptions, however, looking at the graph I believe objectively I will also have these variables in the same order.

The graph above shows us that our valuation output is influenced the most by revenue growth rate, research and development (R&D) expense, company beta, market risk premium. From here we can see that company beta and market risk premium can be calculated to some degree precision based on comparables in the market. Thus we can focus on the probability distributions of the other two variables.

Step 7: Specifying probability distribution

After we identify the key variables that impact our final output valuation the most, we can analyze their probability distributions more indepthly. Starting with the revenue growth rate of the company, we can either use historical data of the growth rate or in case we do not have that available or if historical growth rates are not representable of the future, we can use comparables from the market of similar companies to estimate the distributions. Here using probability distributions give us room and advantage to be more accurate and precise. Since we are not estimated one predicted value that can either run our company value very accurately or very inaccurate, choosing from a range of values gives us the room to be able to make mistakes and learn from them.

Step 8: Run the simulation

After the key variables have been identified, the data has been imported, and the probability distribution has been analyzed, the computer takes over. Once all these assumptions have been inputted the computer takes random values from teh probability distributions and input them to calculate the value of the company. After that it will repeat these steps hundreds of thousands of times to generate many random valuation paths (Seila, 2004).

After calculating the value of the company thousands of times, on each iteration this value is stored. Since we are taking random value out of the described probability distributions, we get a different final value of the company. We can then show the final results inthe form of a histogram that we can use to analyze the likelihood of the company’s valuation.

Step 9: Analysis of the simulation results

Interpretation of the final result is very important. It's the final step in getting the value of the company probabilistic correct. Having a histogram as the output of the company valuations allows us to associate probabilities with different ranges of valuation of a company. For example: we can find the 95% confidence interval of our histograms and analyze how likely it is that 95% of the time the value of the company will fall under this range of value. We can calculate the mean value of the company and analyze how volatile the valuation is and how sure we can be that the fluctuations are either large or small enough for us to be confident in the final valuation result.

References

Ali, M., El-Haddadeh, R., Eldabi, T., & Mansour, E. (2010). Simulation discounted cash flow valuation for internet companies. *International Journal of Business Information Systems*, 6(1), 18-33.

Benninga, S. (2001) *Financial Modeling*, Second edition, The MIT Press, Cambridge, London

Booth, L. (2003) 'Discounting expected values with parameter uncertainty', *Journal of Corporate Finance*, Vol. 9, No. 5, pp.505–519.

Brealey, R. A., Myers, S. C., Allen, F., & Mohanty, P. (2018). *Principles of Corporate Finance, 12/e* (Vol. 12). McGraw-Hill Education.

Christensen, C. M., Raynor, M. E., & McDonald, R. (2015). What is disruptive innovation. Harvard business review, 93(12), 44-53.

Copeland, T., Koller, T. and Murrin, J. (2000) *Valuation: Measuring and Managing the Value of Companies,* John Wiley and Sons, New York, NY

Damodaran, A. (2002) 'Dealing with distress in valuation', Working paper, Stern School of Business, New York University, available at http://pages.stern.nyu.edu/~adamodar/.

Damodaran, A. (2001) *The Dark Side of Valuation: Valuing Old Tech, New Tech, and New Economy Companies*, First edition, Prentice Hall, Upper Saddle River, NJ.

Damodaran, A. (2001) *Investment Valuation*, preliminary second version, available at www.damodaran.com.

Damodaran, A. (2004). Valuing Young, Start-up and Growth Companies: Estimation Issues and Valuation Challenges. Retrieved December 11, 2020, from http://people.stern.nyu.edu/adamodar/pdfiles/papers/younggrowth.pdf

Dar, A. F. (n.d.). Role of Startups in Economic Prosperity. Retrieved December 12, 2020, from https://www.startupgrind.com/blog/role-of-startups-in-economic-prosperity/

Goldman, L. and Emmett, H. (2003) 'Crystal ball for six-sigma tutorial', in *Proceedings of the 2003 Winter Simulation Conference*, New Orleans, LA, pp.293–300.

Fernández, P. (2001). Valuation and value creation in Internet-related companies. *Available at SSRN 265609.*

French, N., & Gabrielli, L. (2004). The uncertainty of valuation. Journal of Property Investment & Finance.

Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: Evidence from the field. *Journal of financial economics*, 60(2-3), 187-243.

Higson, C., & Briginshaw, J. (2000). Valuing internet business. *Business Strategy Review,* 11(1), 10-20.

John Watson and Jim Everett, 1996, "Do Small Businesses Have High Failure Rates?" *Journal of Small Business Management*, v34, pg 45-63.

Kelliher, C. F., & Mahoney, L. S. (2000). Using Monte Carlo simulation to improve long-term investment decisions. *The Appraisal Journal*, 68(1), 44.

Knaup, Amy E. and MC. Piazza, September 2007, Business Employment Dynamics Data: Survival and Longevity, *Monthly Labor Review*, pp 3-10.

Law, A. M., Kelton, W. D., & Kelton, W. D. (2000). *Simulation modeling and analysis* (Vol. 3). New York: McGraw-Hill.

Maya, C. (2004) 'In search of the true value of a start-up firm: creative destruction and real options approach (CD-ROM)', in *Proceedings of the 8th Annual International Conference on Real Options*, Montréal Canada, pp.200–268.

Mun, J. (2002) *Real Options Analysis: Tools and Techniques for Valuing Strategic Investments and Decisions*, Wiley Finance, New York, NY.

Phillips, B. D., & Kirchhoff, B. A. (1989). Formation, growth and survival; small firm dynamics in the US economy. Small business economics, 1(1), 65-74.

Powell, S. G., Baker, K. R., & Lawson, B. (2008). A critical review of the literature on spreadsheet errors. Decision Support Systems, 46(1), 128-138.

Powell, S.G. and Baker, K.R. (2004) *The Art of Modeling with Spreadsheets*, Wiley, Hoboken, NJ.

Ragsdale, C.T. (2004) *Spreadsheet Modeling and Decision Analysis*, Southwestern, Mason, OH.

Reilly, F. K., & Brown, K. C. (2011). *Investment Analysis and Portfolio Management (Text Only)*. Cengage Learning.

Savvides, C.S. (1994) ‘Risk analysis in investment appraisal’, *Project Appraisal*, Vol. 9, No. 1, pp.3–18

Seila, Andrew F. "Spreadsheet simulation." *In Proceedings of the Winter Simulation Conference*, 2005., pp. 8-pp. IEEE, 2005.

Winston, W. L., & Goldberg, J. B. (2004). *Operations research: applications and algorithms* (Vol. 3). Belmont^ eCalif Calif: Thomson/Brooks/Cole.

Appendix

Code

This algorithm is incomplete and currently does not simulate the DCF valuation. However, it does perform DCF analysis and calculates the share price of any publicly traded firm based on the growth rates, terminal growth rate, and discount rate the user enters.

The idea behind this was that I have a functional calculator of FCF, I just have to integrate csv type files imports so that instead of requesting from API that gives Public company data, I get private company data on which i can perform analysis based on the approach I described.

Since the main part of the feedback I received was that my paper is lacking in theory and clarity, I mostly worked on fleshing out my question and analysis. I hope I am able to incorporate the feedback and my idea is clear now

Code Link: https://gist.github.com/arhamhameed/1c47903266295bf7471189f3965864e3