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CMDA 4984 SS
Data Science for Quantitative Finance

Final Project:
Monte Carlo Simulation to Determine Equity Value of a Company

Introduction/Background and Impact:
The equity value of a company is the full intrinsic value of a company based on the company's shares and loans to the shareholders. However, the value that analysts give to a company can detour pure mathematics and statistics that give an exact value for the company. Other than exact stock price targets, there are a lot of random variables that are inputted into financial models, which make it difficult to retrieve a true intrinsic company value.

Using certain random variables, we can find the true market value of a company. Of the many variables and points of data that effect any aspect of a company on a trading sheet, the four variables that I will select to compute the firm's true value are the revenue Compound Annual Growth Rate (CAGR), the marginal Earnings Before Interest and Taxes (EBIT), the Weighted Average Cost of Capital (WACC), and the long-term growth rate of a company.

There is importance in determining a company's true value. Equity valuation of a company helps determine the fair market value for that company, which is vital in the whole stock market. This is because the market is just a cycle of cash flow and putting more money in one basket than needed can upset the flow of cash and cause problems to arise. The whole system of stock markets is based upon the idea of equity valuation. The stock markets have a wide variety of stocks to offer to investors, where those perceived market values change every minute because of the change in information that the market receives on a real time basis. Equity valuation therefore is the backbone of the modern financial system. It allows businesses with strong business models and financials to command a higher value in the market. On the other hand, it ensures that companies whose financials and models are weak to have a drop in their valuation.

Literature Review
1. https://www.ally.com/resources/pdf/invest/monte-carlo-methodolgy.pdf
2. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.348.5246&rep=rep1&type=pdf
3. https://www.irjet.net/archives/V7/i11/IRJET-V7I11202.pdf

The three sources above are some of many research papers all gearing towards proposing and proving the same goal: Using the Monte Carlo Simulation to find a certain aspect of returns to a company, whether it be the stock valuation, equity value, or compound returns.

The first link is from Ally, on their projection tool. The benefit of using Monte Carlo is that they can provide a comprehensive view of possible outcomes for a stock portfolio. The method not only tells you not only what can happen, but also the probability of each outcome. It provides a more realistic projection over a simple linear, compound return projection. The simulation is intended to show possible future portfolio values to illustrate the impact of different contribution decisions, investment time horizons, and portfolio allocations.

The second link from the Hvass Laboratories on their research of obtaining the financial valuation of a company using the Monte Carlo simulation. This paper uses the Monte Carlo simulation of a simple equity growth model with historical data to estimate the probability distribution of the future equity,

earnings, and payouts of companies, which are then used to estimate the probability distribution of the future return on the stock and stock options. The paper mentions that the Monte Carlo simulation is the use of computers to simulate numerous outcomes of a mathematical model to estimate the probability distribution. This is useful when the model cannot be studied analytically. There are several problems in finance where Monte Carlo simulation is useful, such as a simple equity growth model to simulate the future equity, earnings, and payouts of companies, based on historical data for the return on equity and the fraction of earnings retained in the past.

The third link is from the International Research Journal of Engineering and Technology. The purpose of their publication is to find the stock valuation of a company using the Monte Carlo simulation. They mentioned that the Monte Carlo simulation is a model used to foresee the likelihood of various results when the intercession of arbitrary factors is available. The Monte Carlo simulation help to clarify the effect of risk and uncertainty in expectation and anticipating models. A variety of fields utilize Monte Carlo simulations, including finance, engineering, supply chain, and science. The basis of a Monte Carlo simulation involves assigning multiple values to an uncertain variable to achieve multiple results and then to average the results to obtain an estimate. The Monte Carlo simulations assume perfectly efficient markets.

Data Description & Summary
For this simulation in determining true value of a company, I used the company Microsoft as an example. A free source for pulling financial data is **Yahoo Finance**, so I will be using the **yahoo_fin** python library. I also used the **Financial Modeling Prep** site as it includes calculations for certain input variables that I would need to use to power my simulations.

Below are the current (as of 04-25-2023) equity values for three very popular American corporations. I have selected three companies from different industries.

- Apple Inc. (APPL)
    - Equity Value: $2,640,322,000,000
- Tesla Inc. (TSLA)
    - Equity Value: $1,039,727,000,000
- Goldman Sachs (GS)
    - Equity Value: $108,060,000,000

After seeing these three companies, I will be reporting the Equity Value on Microsoft, using the Monte Carlo method:

- Microsoft Inc. (MSFT)
    - Equity Value: $2,153,016,000,000

The value of equity listed for Microsoft above is the value posted by analysts after their consideration of data points and trends. The value that I have received for the equity value of Microsoft (listed in Outputs section) was generated using the Monte Carlo simulation and parts of the data I researched, and thought was important to use.

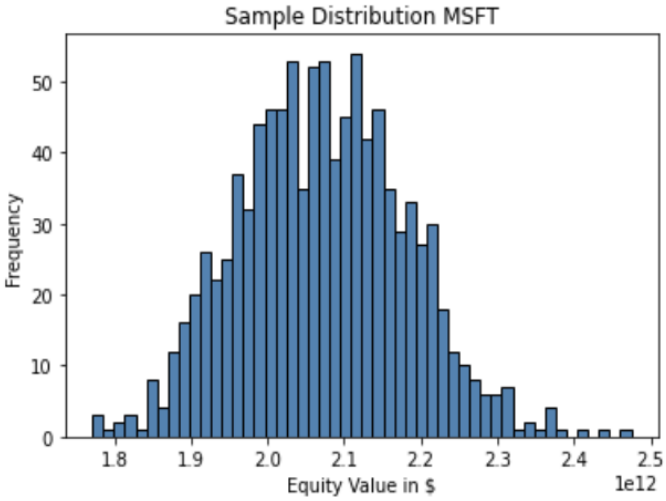
Methodology
First, I used Python to retrieve those four values/variables. Then, running a simulation like the Monte Carlo simulation to get a forecast of true mean values of the company's values. Finally, I would use statistics to gain the mean, standard deviation, and confidence intervals to get the values I think would best describe the true equity value of a company.

The idea of using the Monte Carlo simulation for this project seemed like a good idea because I would be taking random variables to find the true valuation value, and the Monte Carlo algorithm takes random

variable samplings and simulates them to obtain numerical values. It models different ranges of values based on those random variables. The model of the Monte Carlo simulation relates to the output that I would be receiving too. I received a range of values of which was very close to the equity value of the firm online.

Outputs

After going through iterations of my code, I have developed a range of possible equity values for Microsoft. The equity value, written by analysts for Microsoft is: $2,153,016,000,000. According to the bounds and sample distribution, it is very clear that the equity value that was outputted is very close to the value put out by analysts. To the right is a bar graph of the sample distribution of the equity value of Microsoft using my independent variables. Also listed below are the bounds I generated as well.

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MSFT
Avg Revenue CAGR:  0.11091608373093576
Avg Revenue EBIT Margin:  0.415948788729713
Equity Value:  ['$2,055,162,246,276.18', '$2,068,399,976,013.53']
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As you can see, the range of equity values I generated from Microsoft are between USD $2,055,162,246,276.18 and $2,068,399,976,013.56. This is very close to the equity value posted online.