

Risk Analysis Assignment 2

Group 3

Authors

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Introduction

For our analysis we have chosen the companies Microsoft (MSFT), Intel (INTC), Apple (AAPL), Coca Cola (KO) and Walmart (WMT) as given in the assignment. We proceed by answering the questions given by the assignment.

1. Derive the mean of log stock returns of the companies and comment on your results.

Stock name	Mean log return
Apple	0.0010
Microsoft	0.0008
Intel	0.0003
Walmart	0.0003
Coca Cola	0.0002

Figure 1: Table of mean log returns

After calculating the log returns in R, we see in Figure 1 that Apple has the highest mean log stock returns at 0.001. After that follows Microsoft at 0.0008 and then Walmart, Intel and Coca Cola which have less than half mean log returns at 0.0003, 0.0003 and 0.0002 respectively. Considering just the mean, Apple is the best stock and Coca Cola is the worst. However, we also must consider the standard deviation.

2. Derive the standard deviation of log stock returns of the companies

Stock name	Standard deviation log returns
Apple	0.0177
Microsoft	0.0158
Intel	0.0180
Walmart	0.0118
Coca Cola	0.0110

Figure 2: Table of standard deviation of the log returns

3. Create a data frame for the 5 companies with each company's average log return and standard deviation and compare their stock performances. Which stock (among these) would you buy, why?

Stock name	Mean log return	Standard deviation log returns
Apple	0.0010	0.0177
Microsoft	0.0008	0.0158
Intel	0.0003	0.0180
Walmart	0.0003	0.0118
Coca Cola	0.0002	0.0110

Figure 3: Table of mean log returns and standard deviation of the log returns

The data frame is given in **Figure 3**. We would buy the Apple stock here because it has the highest expected return. Another stock to consider is the Microsoft stock because the mean log return is similarly high and it has a lower standard deviation, therefore lower risk.

We believe that all the other stocks are worse in comparison. For example, Coca Cola (KO) has a five times lower log mean return and one and a half times lower standard deviation than Apple (AAPL). We assume that the lower risk does not balance out the lower expected return, something that we will also demonstrate with a Monte-Carlo Simulation for our solution in problem 7.

4. Make a risk analysis of the stock's performance with a chart series (subset 2020) for the companies. You may also consider Bollinger bands.

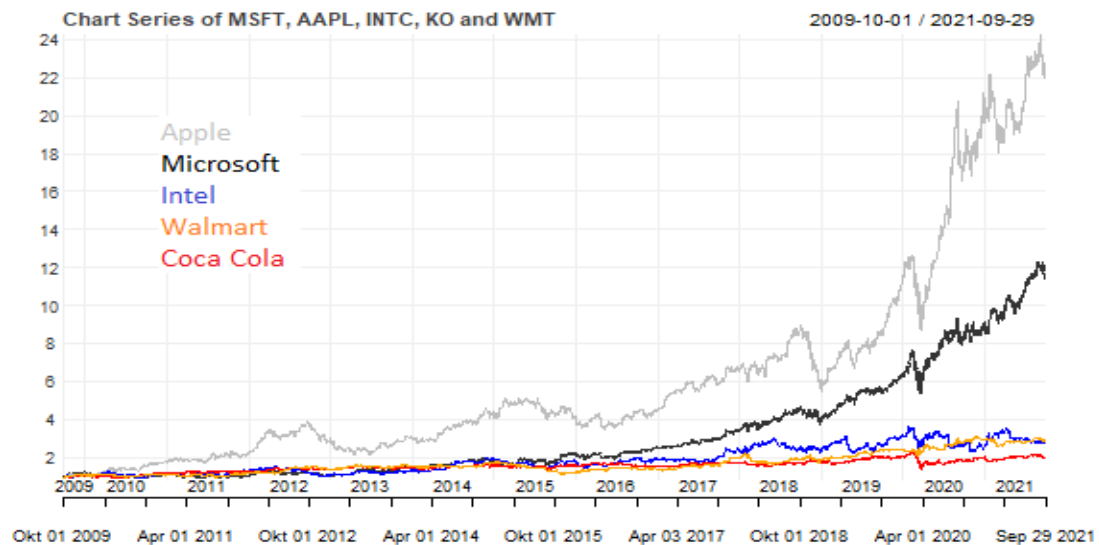


Figure 4.1: Chart Series of all five stocks. The prices have been normalized meaning that all prices have been divided by their starting price on the 2009-10-01 to make for a better comparison. Therefore, every stock starts at a price of 1.

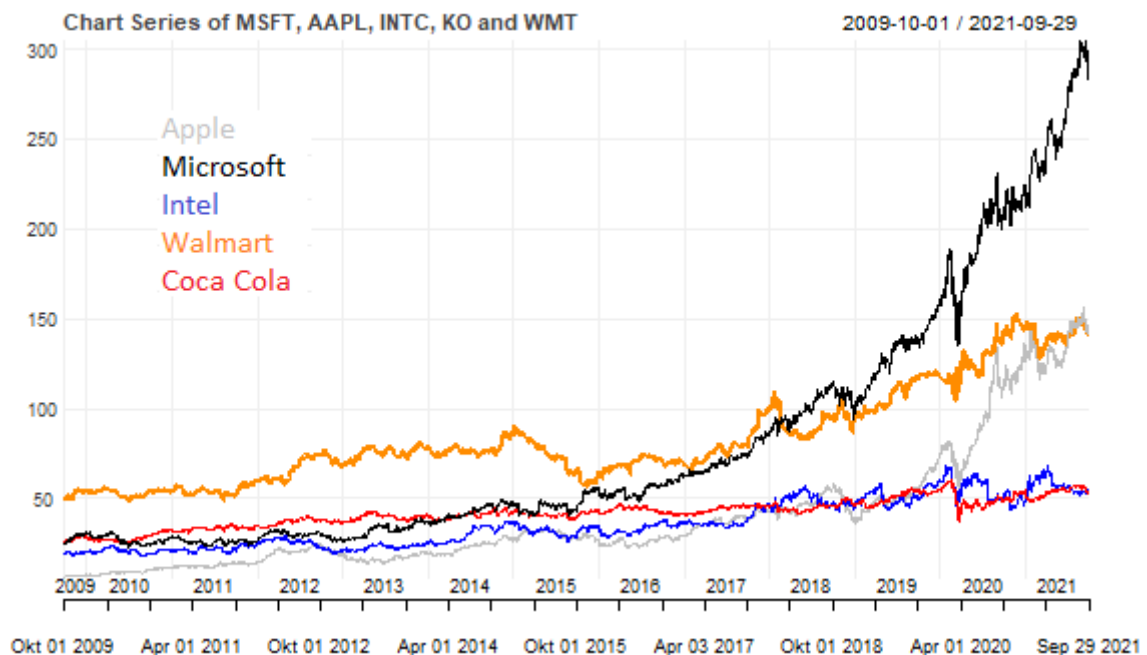


Figure 4.2: Chart series all five stocks

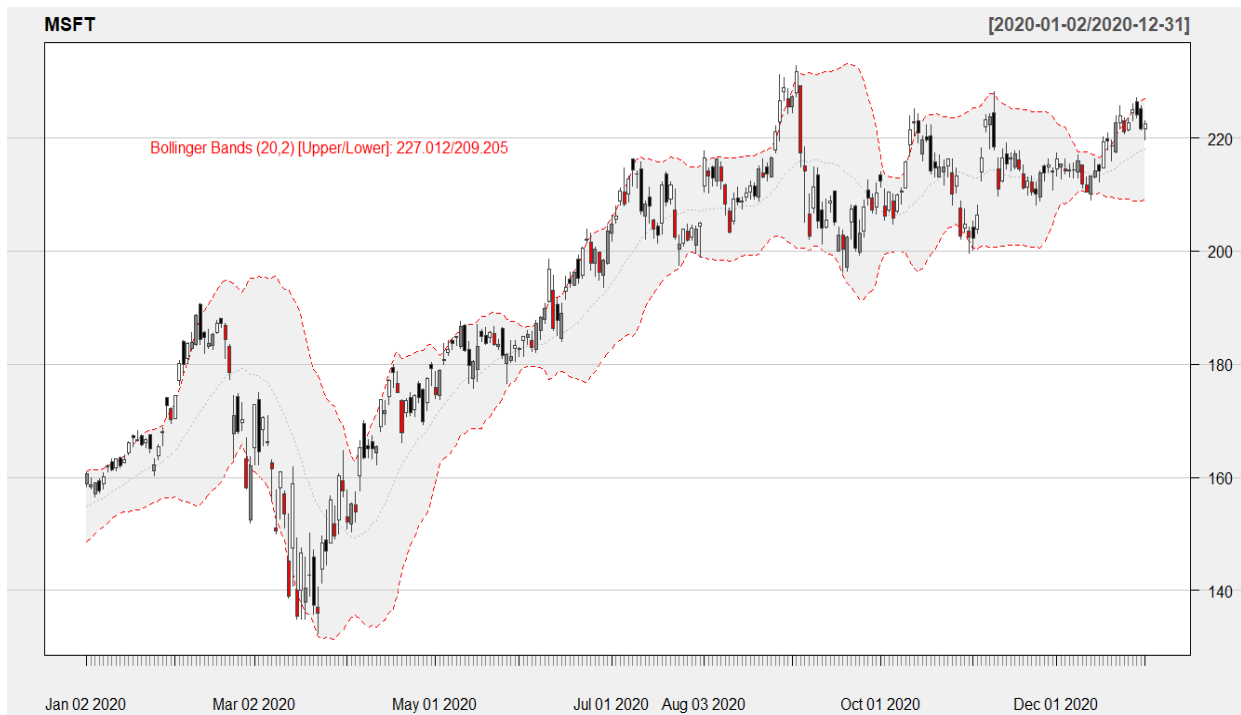


Figure 4.3: Microsoft stock Bollinger band for the year 2020

As we can see from **Figure 4.1** and **Figure 4.2**, from 2009 to 2014 the stock remained steady without showing any serious fluctuation. In 2014 a small but steady growth started which lasted until the first three months of 2020. To analyze this more deeply we look at the Microsoft Bollinger band for the year 2020 in **Figure 4.3**. In 2020, the pandemic seriously affected the stock market in general, thus leading to a steep decline of the stock's price. Specifically, we can see the width of the two bands getting smaller as the stock price declines after reaching a peak in March 2020. This would be the right moment for investors to get out of the trade or set a trailing stop loss as a security measure of their investment from the downward trend.

However, this decline lasted for less than two months, with the stock price dropping only to its late 2019 levels. After that, we can observe an extremely steep rise until June, when there was a small drop in the price level. Then the upward trend continued until the stock price reached its highest level of the year in mid-September 2020, which was again followed by a significant fall that lasted until the end of the month.

After that there was no serious fluctuation until the end of the year and the stock price in December was approximately 40% higher than in the beginning of 2020. Overall, the stock managed to recover efficiently from the financial turbulence that Covid-19 created in the market, reaching the end of the year with a much higher value.



Figure 4.4: Apple stock Bollinger band for the year 2020

As a comparison we also do a risk analysis of the Apple stock. As **Figure 4.1 and 4.2** show, after a period of low volatility and stability from 2009 to 2014, in 2016 the stock price entered a period of higher volatility. The 2020 epidemic had a significant impact on the stock market which we analyze in **Figure 4.4**. This epidemic results in a sharp drop in stock prices. The breadth of the two bands is widening as the stock price falls after peaking in March 2020, which at some points closes below the lower band with an indication of a downward trend. This will be a good time for investors to invest money, as the price is thought to be oversold and that indicates the buy signal. This collapse, however, lasted less than two months. Following that, we can see an exceptionally quick growth until June, when the price level dropped slightly. The increasing trend continued until mid-September 2020 and the band widened, but then followed a substantial fluctuation until the end of the year. As a conclusion, even though Covid- 19 had a huge impact on the company's stock price, the stock managed to recover within a few months.

5. Analyze the correlation of the company's stock and explain the risk of buying stocks from the same or different sectors.



Figure 5: Correlation between the different stocks

Assume the scenario where you buy two stocks. The price of the first stock we will call X and the price of the second stock we will call Y . This means that the value of the whole portfolio will be $Z = X + Y$.

We know that $Var(Z) = Var(X+Y) = Var(X) + Var(Y) + 2Cov(X,Y)$. Since the Covariance $Cov(X,Y)$ is dependent on the correlation Coefficient ρ , that means that a higher correlation coefficient results in a higher Variance. Note that the stocks from Apple, Intel and Microsoft all belong to the same (tech) sector and thus have a higher correlation with each other than Apple to Walmart for example. With the provided data we can assume that the Variance is expected to be higher when buying stocks from the same sector and lower when we buy from different sectors. This means that buying from the same sector will carry more risk than buying from different sectors.

6. Simulate for the next 4 years the stock prices of Microsoft Corporation using Monte Carlo (300 Monte Carlo simulations). Will you buy Microsoft's stock and why?

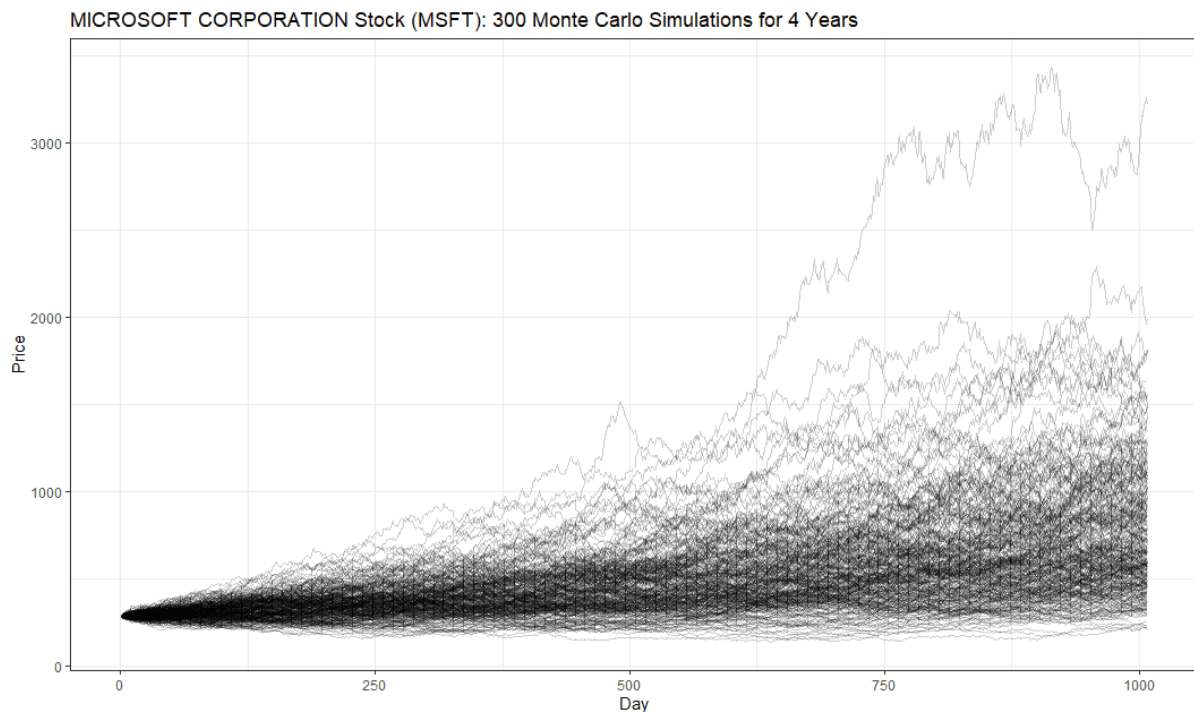


Figure 6.1: 300 Monte Carlo Simulations of the Microsoft Stock

We simulated 300 Monte Carlo Simulations of the Microsoft Stock assuming that the daily growth rate is normally distributed. The mean log stock returns and standard log stock returns have been calculated as presented in Figure 1. To analyze our results, we look at all the 300 different end prices and compare them to the starting price.

Starting price = 284

Min.	1st quantile	Median	Mean	3rd quantile	Max.
210.8	476.7	649.7	737.8	916.9	3224.2

Figure 6.2 This table helps us understand the distribution of the end prices. It shows us the minimum, first quartile, median, mean, third quartile and maximum value.

From Figures 6.2 and 6.3 we can see the general distribution of all the end prices after 4 years using a Monte Carlo simulation. We calculated the mean at 737.8 and the standard deviation at 370.12

To put this data into perspective we compare it with the starting value. The average profit of $mean(end\ Value) / startValue = 2.6$, which means that for every 1\$ we put in, we can expect to have 2.6\$ at the end of year 4.

To assess the risk of the investment we calculate the probability of making profit: $\#(endValue > startValue) / \#Simulations = 0.98$, which means that in 98% of all simulations we end up with more money than we started with.

Given this data we would always buy the Microsoft stock as there is no better alternative. An expected return of 2.6 times the investment with only a 2% chance of losing money is worth the investment.

7. Suggest your favorite trading strategy and provide an intuitive motivation for your strategy. Code your rule and assess your strategy (with respect to the risk that you take) using the Monte Carlo simulation (in 7).

As stated earlier we want to disregard the stocks for Walmart, Intel, and Coca Cola since we assume that the expected return will be significantly lower than that of the stocks of Microsoft and Apple. For this reason, we first do a Monte Carlo Simulation just for the Coca Cola stock. We chose Coca Cola as a demonstration since it has the lowest standard deviation, but it is representative of the other stocks, Walmart and Intel since their log returns are all less than half of Microsoft.

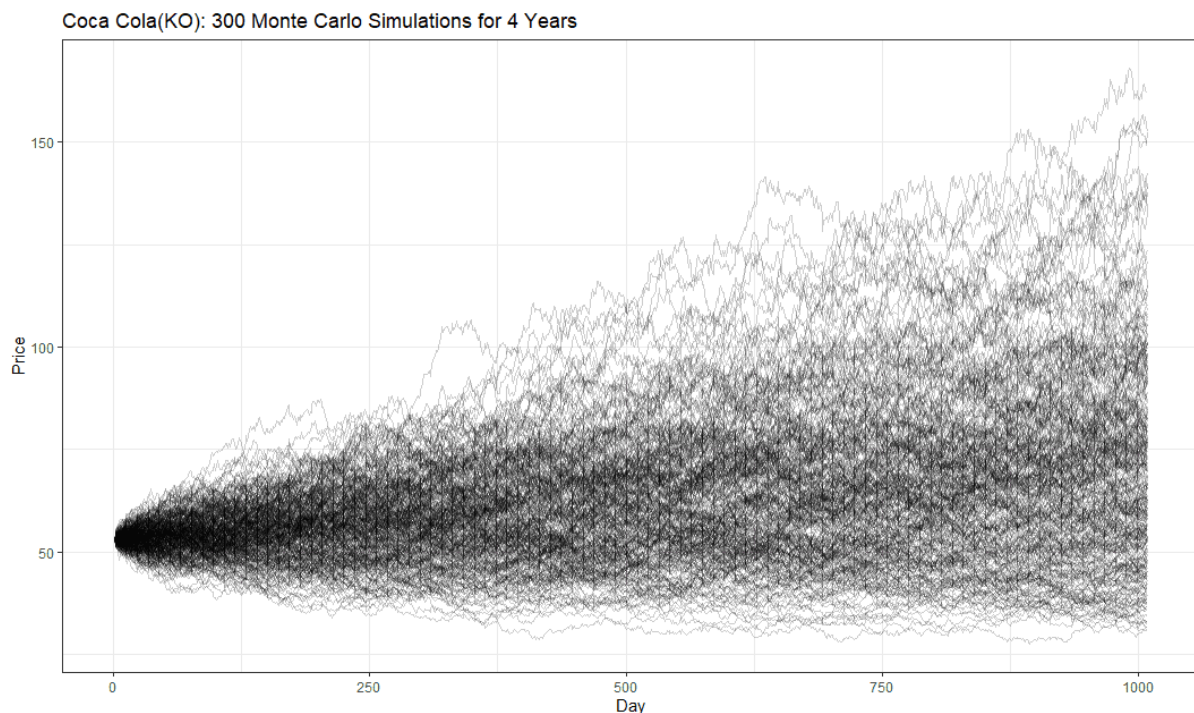


Figure 7.1 300 Monte Carlo Simulations of the Coca-Cola Stock

As we can already see in Figure 7.1 the lower log return of 0.0002 compared to Microsoft's log return of 0.0008 has already a significant impact on the long-term development of the stock. Doing the same analysis, we find that $\text{mean}(\text{endValue}) / \text{startValue} = 1.33$, which is much lower than the expected profit of 2.6 from the Microsoft stock. Since the expected return is so much lower, the lower standard deviation does not offset the actual risk. If we calculate the probability of making profit while investing in Coca Cola stock we see that $\#(\text{endValue} > \text{startValue}) / \# \text{Simulations} = 0.74$, which is also significantly lower than the probability of 0.98 of the Microsoft stock. We know that combining different stocks from different sectors lowers the variance of the whole portfolio (as shown in Question 5). However, we do not want to lower our average expected return by adding Stocks that perform significantly worse than the Microsoft stock.

Our Strategy:

Since Microsoft and Apple have the highest expected return, we want to invest in both. Even though they are from the same sector and therefore highly correlated, the variance of buying a portfolio is lesser than buying just one single stock. To maximize the risk-reducing factor of having two stocks, we do a 50-50 split of Apple and Microsoft. We call this split “portfolio Z”.

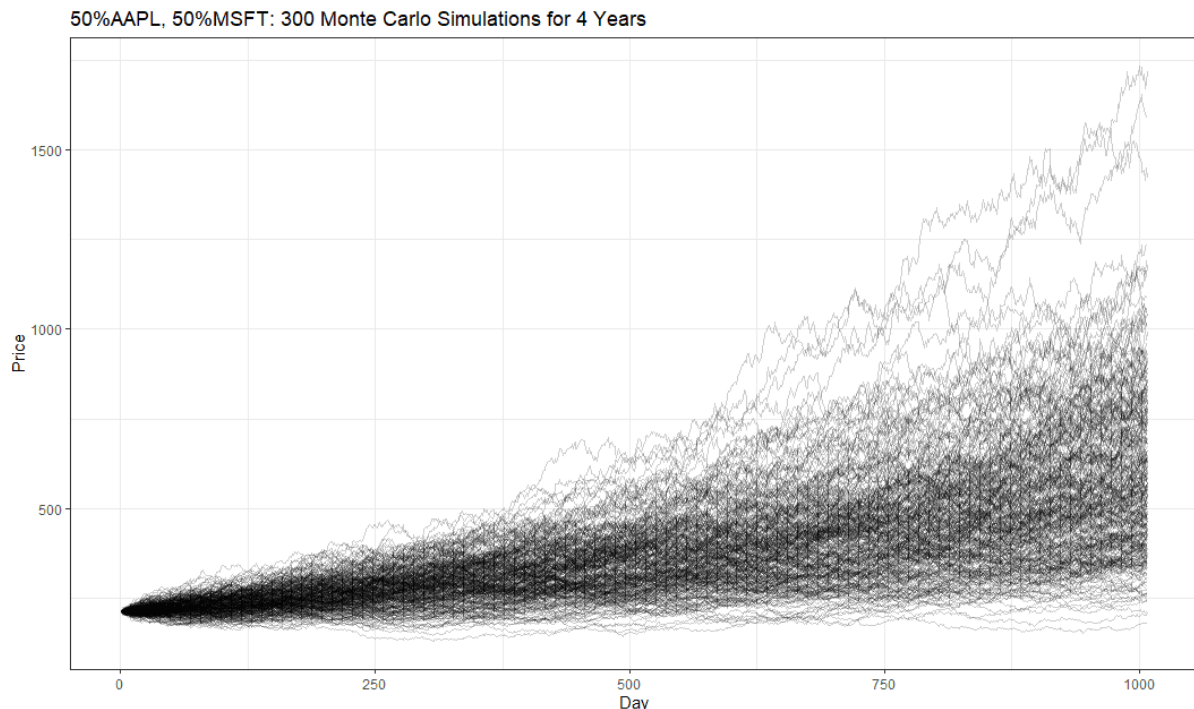


Figure 7.2 300 Simulations of a portfolio of 50% AAPL and 50% MSFT

The end prices of portfolio Z has a mean of 585.7 and a standard deviation of 231.6. Given the starting price of 213.4 our portfolio performs better than just the Microsoft stock in two ways. Firstly, $\text{mean}(\text{endValue}) / \text{startValue} = 2.7$, is greater than 2.6 which is the average we earn if we just invest in Microsoft’s stock. Moreover, the likelihood of making profit is also higher at $\#(\text{end Value} > \text{start Value}) / \# \text{Simulations} = 0.99$, which means our portfolio has even less risk of losing money. Given this argumentation we use a strategy where we buy a 50-50 split of Apple and Microsoft stocks.