

Analyzing Stocks Using R

A general and technical analysis of Amazon (AMZN)'s stock and a price simulation using random walk and monte carlo method. Visualizations done with plotly and ggplot.



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Amazon (AMZN)'s stock experienced a 95.6% (+\$918.93) increase this past year, which makes Amazon (AMZN) a desirable choice for many investors. Many analysts also believe Amazon (AMZN)'s value will continue to increase in the upcoming years. While it sounds tempting to purchase the stock, an elaborate in-depth analysis should be done to avoid purchasing the stock based on speculation.

I implemented my knowledge in Statistics and R skills to analyze its performance from a technical side and predict its future price. I heavily relied on a packages frequently used in quantitative finance such as quant mod and xts to fulfill my goal.

Here is the complete list of packages I used:

```
library(quantmod)
library(xts)
library(rvest)
library(tidyverse)
library(stringr)
library(forcats)
library(lubridate)
library(plotly)
library(dplyr)
library(PerformanceAnalytics)
```

I started my analysis by obtaining the log returns of Amazon's stock beginning August 1st, 2008 to August 17th, 2018:

```
getSymbols("AMZN", from="2008-08-01", to="2018-08-17")

AMZN_log_returns<-AMZN%>%Ad()%>%dailyReturn(type='log')
```

The log returns doesn't make sense at this stage but it is actually the fundamental of my analysis. I will explain later.

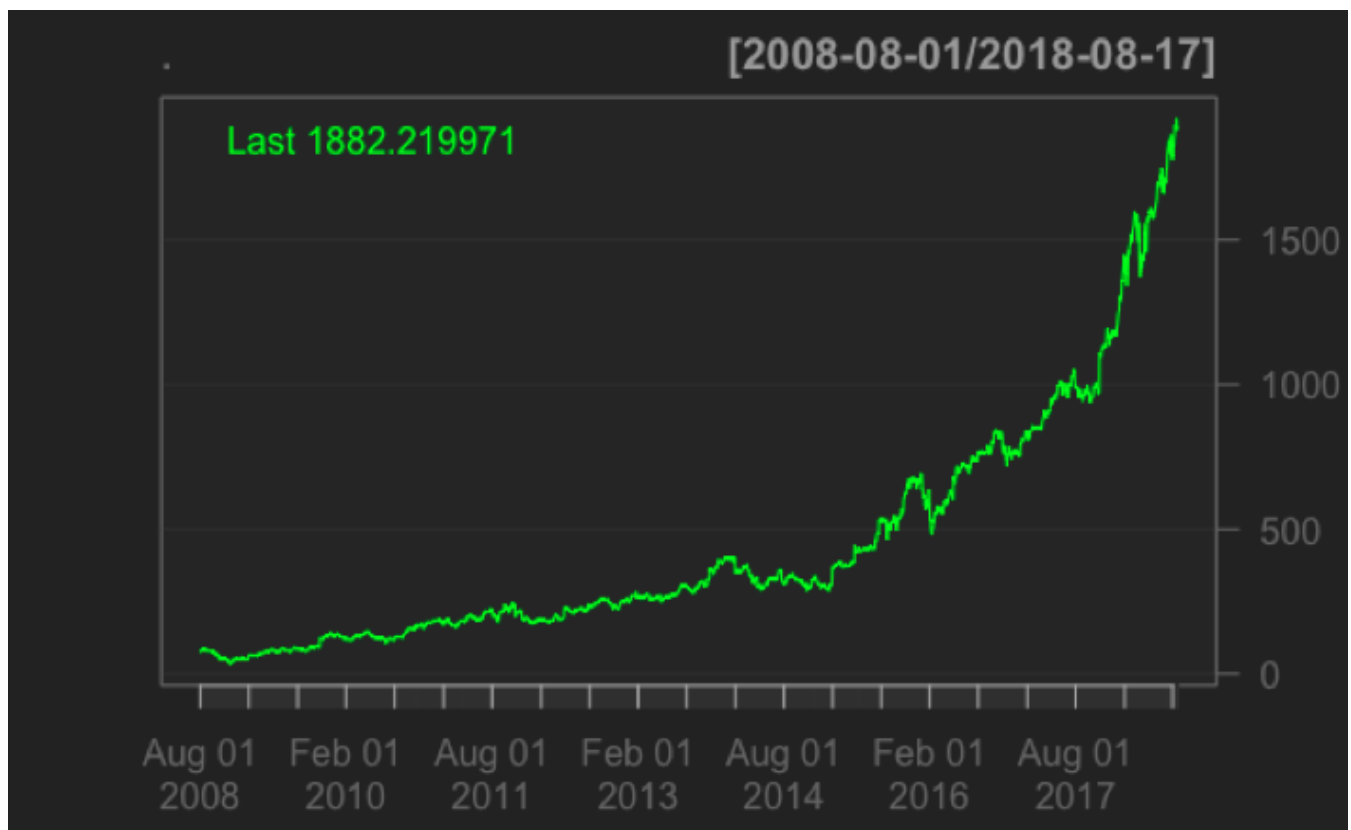
Technical Analysis

I started by doing a technical analysis of Amazon's stock:

```
AMZN%>%Ad()%>%chartSeries()

AMZN%>%chartSeries(TA='addBBands();addVo();addMACD()', subset='2018')
```

The first chart series graph is straightforward as it shows Amazon's price chart:



Price Chart

The second chart series show the Bollinger Band chart, % Bollinger change, Volume Traded and Moving Average Convergence Divergence in 2018 alone:



Technical Analysis

The moving average is important to understanding Amazon(AMZN)'s technical charts. It smoothes out daily price fluctuations by averaging stock prices and is effective in identifying potential trends.

The Bollinger Band chart plots two standard deviations away from the moving average and is used to measure the stock's volatility. The Volume chart shows how its stocks are traded on the daily. The Moving Average Convergence Divergence gives technical analysts buy/sell signals. The rule of thumb is: If it falls below the line, it is time to sell. If it rises above the line, it is experiencing an upward momentum.

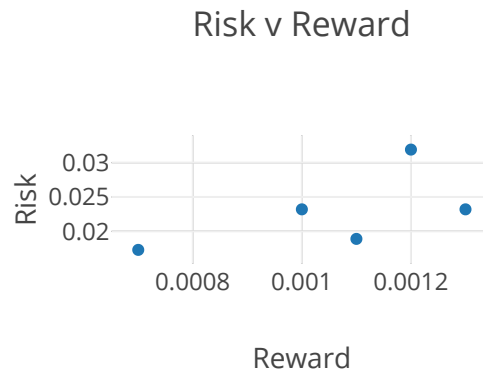
The charts above are usually used to decide whether to buy/sell a stock. Since I am not a certified financial analyst, I decided to do additional research to convince myself.

Comparisons

I implemented the underlying principle of public comparisons. I wanted to see how Amazon (AMZN) was doing in comparison to other popular technology stocks such as Facebook (FB), Google (GOOGL) and Apple (AAPL).

I first compared the risk/return rate of each stock. I took the mean of log return and standard deviation of log return. The mean is assumed as the consistent rate of return

while standard deviation is the risk that comes with purchasing the stock. I used plotly, an interactive visualization tool, to illustrate my findings.


[EDIT CHART](#)

Risk vs Reward chart

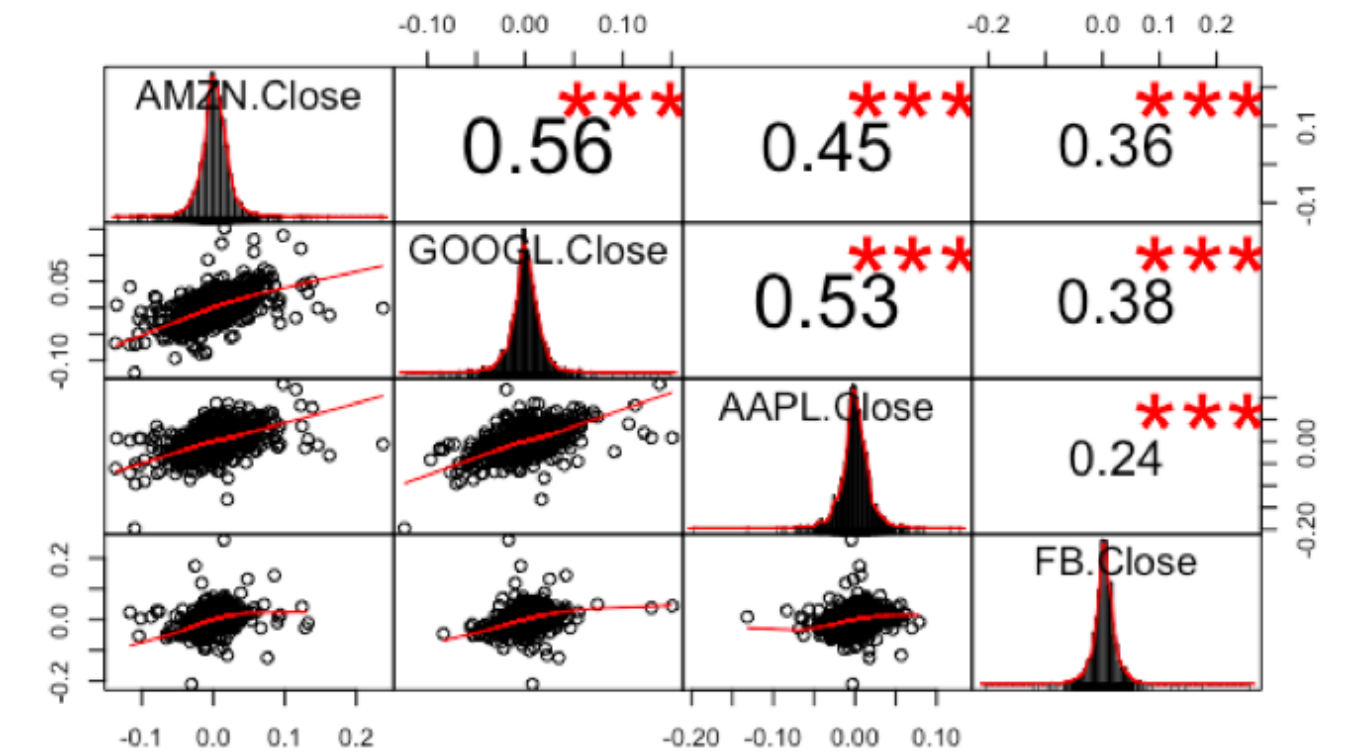
Google (GOOGL) stock has the lowest risk and the lowest return. Facebook (FB) and Amazon (AMZN) are equally as risky but the latter has stronger returns. If you are risk-inclined, Tesla (TSLA) is a good investment as it has high risk and high returns. But if you are risk-adverse, like me, Apple (AAPL) is the best choice.

A popular investing principle is to diversify your investments: do not put all your eggs in one basket. When purchasing stocks you should try to purchase stocks that share a small correlation because you want to maximize the total rate of return.

```
library(PerformanceAnalytics)
```

```
data<-
cbind(diff(log(Cl(AMZN))),diff(log(Cl(GOOGL))),diff(log(Cl(AAPL))),d
iff(log(Cl(FB))))
```

```
chart.Correlation(data)
```



Correlation Chart

Facebook (FB) and Apple (AAPL) have the smallest correlation of 0.24 while Amazon (AMZN) and Google (GOOGL) have the highest correlation of 0.56. The correlation between each stock is high because they are all technology stocks. It is better to purchase stocks from different sectors to truly minimize the risk and maximize rates of return.

Price Prediction

I went on to predict the prices for Amazon (AMZN)'s stock. I achieved this by the random walk theory and monte carlo method.

The random walk theory is suited for a stock's price prediction because it is rooted in the belief that past performance is not an indicator of future results and price fluctuations can not be predicted with accuracy.

I simulated the prices Amazon (AMZN)'s stock for 252*4 trading days (Since a year has ~252 trading days). That is 4 years worth of trading!

I generated the prices using the data I have earlier from log returns and used exponential growth rate to predict how much the stock will grow per day. The growth rate is randomly generated and dependent on the input values of mu and sigma.

```

mu<-AMZN_mean_log # mean of log returns
sig<-AMZN_sd_log # sd of log returns

price<-rep(NA,252*4)

#start simulating prices

for(i in 2:length(testsim)){
  price[i]<-price[i-1]*exp(rnorm(1,mu,sig))
}

random_data<-cbind(price,1:(252*4))
colnames(random_data)<-c("Price","Day")
random_data<-as.data.frame(random_data)

random_data%>%ggplot(aes(Day,Price))+geom_line()+labs(title="Amazon
(AMZN) price simulation for 4 years")+theme_bw()

```



Price Prediction with Random Walk

The chart above shows the simulated prices for ~1000 trading days. If you pay attention to my code I did not include a `set.seed()`. The simulated prices will change and is dependent on my seed. In order to come up with a stable prediction, the price simulation needs to use the monte carlo method, where the prices are simulated repeatedly for accuracy.

```

N<-500
mc_matrix<-matrix(nrow=252*4,ncol=N)
mc_matrix[1,1]<-
as.numeric (AMZN$AMZN.Adjusted[length (AMZN$AMZN.Adjusted),])

for(j in 1:ncol(mc_matrix)){
  mc_matrix[1,j]<-
as.numeric (AMZN$AMZN.Adjusted[length (AMZN$AMZN.Adjusted),])
for(i in 2:nrow(mc_matrix)){
  mc_matrix[i,j]<-mc_matrix[i-1,j]*exp(rnorm(1,mu,sig))
}
}

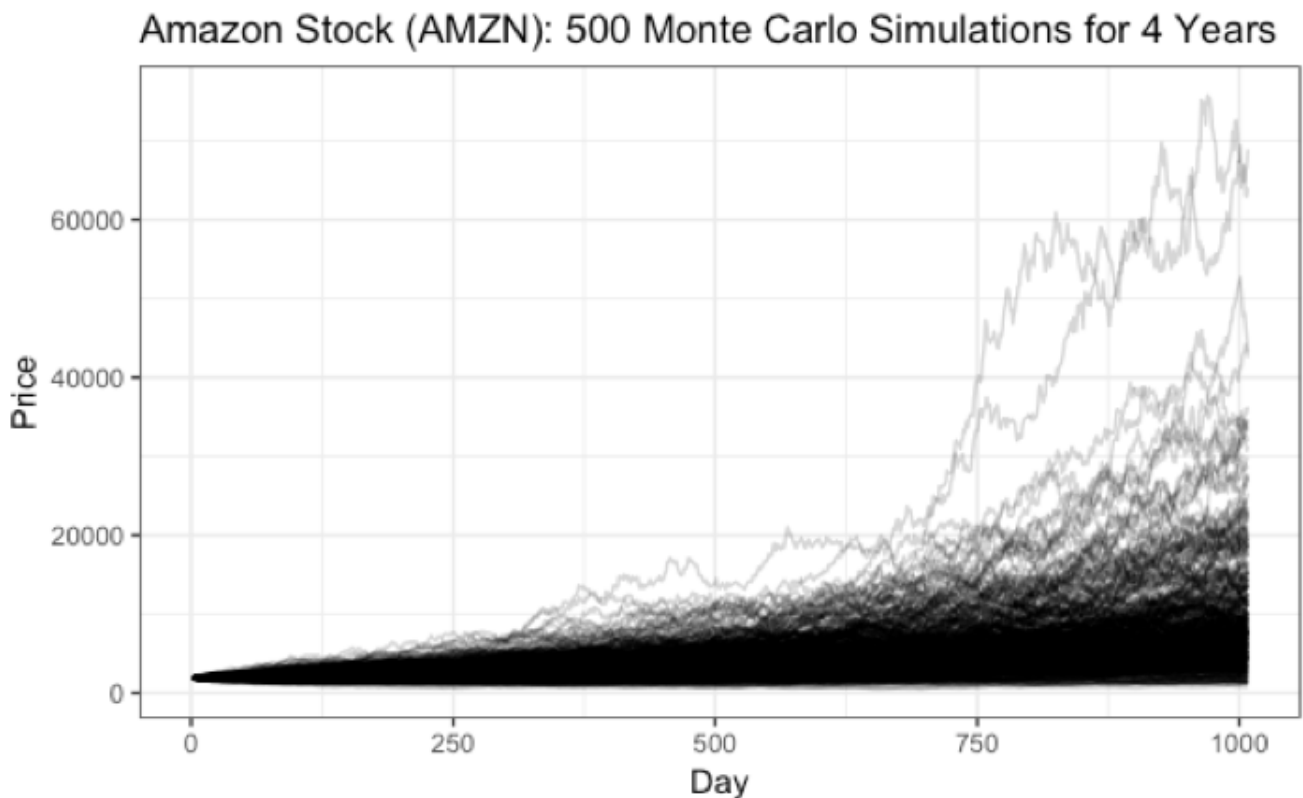
name<-str_c("Sim ",seq(1,500))
name<-c("Day",name)

final_mat<-cbind(1:(252*4),mc_matrix)
final_mat<-as.tibble(final_mat)
colnames(final_mat)<-name

dim(final_mat) #1008 501

final_mat%>%gather("Simulation","Price",2:501)%>%ggplot(aes(x=Day,y=
Price,Group=Simulation))+geom_line(alpha=0.2)+labs(title="Amazon
Stock (AMZN): 500 Monte Carlo Simulations for 4 Years")+theme_bw()

```



Price Prediction with Monte Carlo

The graph above isn't intuitive so I finalized my findings using percentile check the Amazon (AMZN)'s price after four years.

```
final_mat[500,-1]%>%as.numeric()%>%quantile(probs=probs)
```

0.5%	2.5%	25%	50%	75%	97.5%	99.5%
834.6	1212.1	2529.0	3487.2	4864.6	9287.8	11198.1

Don't take my word for it, but given from the result of my simulation, Amazon (AMZN)'s stock may reach the price of \$11198.10 in four years time or crash to a \$834.60 low. You can compare my findings with Amazon (AMZN)'s CAGR to determine if my finding makes sense. But if given the chance, I'd purchase the stock right away!

. . .

Thanks for reading! Let me know if you have any feedback/want to chat. You can reach me at

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You can look at my full code and references here.

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