MA615 Final Project

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Introduction

Covid-19 can be said to be the most widely spread, and the most serious public health emergencies. The pandemic has caused economic recession in United States and the rest of the world as well. In March, the stock market has plunged several times in a short period. However, the stock market has recovered after that. It is reported that the S&P 500 experienced its best 100 day trend in history, due to optimistic expectations of economic recovery and fiscal stimulus. These factors will drive the market up sharply. And many investors believe that people will soon return to work and production, and the economy will recover soon. Moreover, industries in certain fields of expertise had a increasing trend during pandemic. For example, technological stocks benefits from this event since more and more people chose working and studying online. And medical stocks also went up with a great demand for medical resources during pandemic.

Objective

Our goal is to compute an efficient portfolios. For a given target expected return, investors would only choose the lowest risk portfolio for a given return. The minimum variance portfolio refers to the feasible portfolio with the lowest standard deviation. Minimum variance portfolios trace the set of Efficient Portfolios. The theory is based on Modern Portfolio Theory(MPT) by Harry Markowitz (https://en.wikipedia.org/wiki/Modern_portfolio_theory). We will use data from 1st May to 30th June to compute the weights and use that weights for our transaction. We set an initial position of $250000 in cash for the portfolio starting on 1st July 2020. And track the portfolio from 1st July 2020 to 1st Dec 2020. In this report we will choose 5 stocks, Apple, Amazon, Google, NIO and Tesla as an example.

Method and Results

We first download the price data by quantmod.

```
# Download price from Quantmod

# options("getSymbols.warning4.0"=FALSE)
# options("getSymbols.yahoo.warning"=FALSE)
 a <- getSymbols(c("AAPL","AMZN","GOOG","NIO","TSLA"), from = '2020-05-01',
        to = "2020-12-01",warnings = FALSE,
        auto.assign = TRUE)
```

```
## 'getSymbols' currently uses auto.assign=TRUE by default, but will
## use auto.assign=FALSE in 0.5-0. You will still be able to use
## 'loadSymbols' to automatically load data. getOption("getSymbols.env")
## and getOption("getSymbols.auto.assign") will still be checked for
## alternate defaults.
##
## This message is shown once per session and may be disabled by setting
```

```
## options("getSymbols.warning4.0"=FALSE). See ?getSymbols for details.
```

Separate the data set into two parts, which are from May to June and from July to December 1st. And combine the closing prices of each stock.

We then calculated the matrix rate of everyday return and get it demeaned and devided by root number of days. And use the matrix to compute its inverse of covariance. Vector r is the mean of rate of everyday return. After that, calculate the MPT parameter A, B, C and D, where

$$A = 1' \sum{}^{-1} 1$$

$$B = 1' \sum{}^{-1} r$$

$$C = r' \sum{}^{-1} r$$

$$D = AC - B$$

```
##          A        B         C        D
## 1 5934.581 20.10086 0.3613838 1740.617
```

We now calculate the weights using MPT parameters we have just got. We take the risk free rate in United States as 0.2 in our computation. The weights are

$$weights = \frac{\sum{}^{-1} r - r_f 1}{B - A r_f}$$

```
##          AAPL       AMZN      GOOG          NIO       TSLA
## 1 -0.02579247 0.8011653 0.3086772 -0.006028044 -0.078022
```

This chart indicates how much money we should distribute on each stock in this portfolio so that maximize the expectation of returns. Then we put 250000\$ in this portfolio on 1st July 2020, and hold it until 1st Dec 2020. And draw a plot to trace our balance everyday in this period.

```
##    ReturnRate  Balance
## 1 -0.01049091 247377.3
```
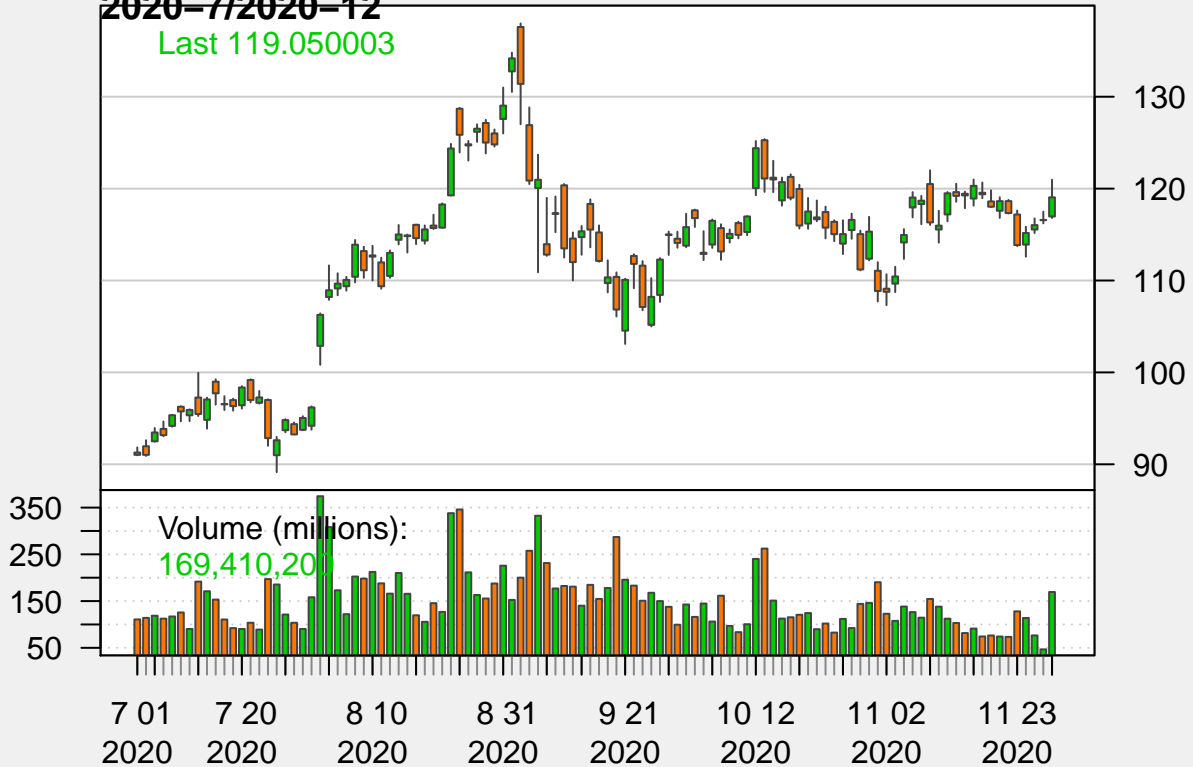
Oops, it seems this portfolio plan is not making us money. Actually, we lost 2622.7 USD in this transaction. Now let's look at the variation of everyday balance based on the stocks' closing price.
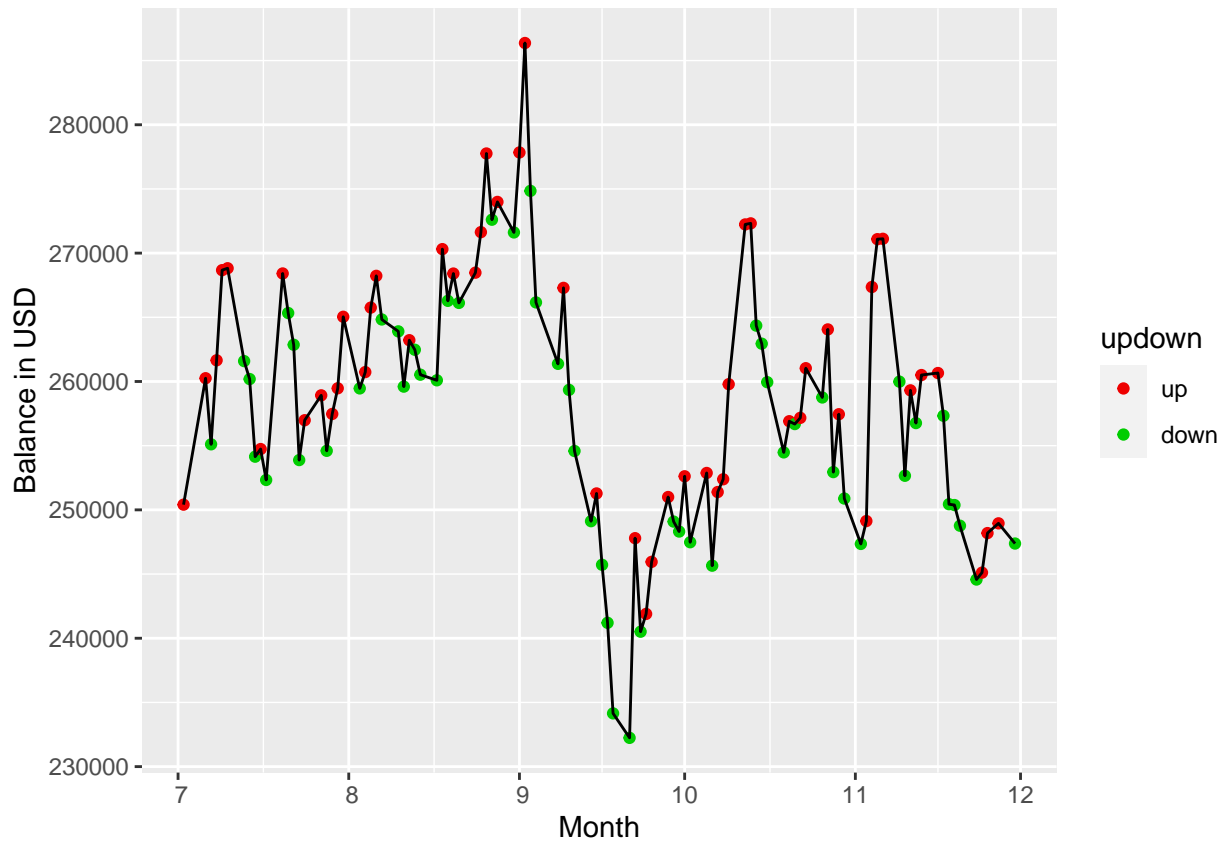
From this chart we can see clearly how our money goes. If the balance is more(red dots) than yesterday or less(green dots). And we also draw the candlestick chart as an appendix to see the performance of each of 5 stocks we've chosen.
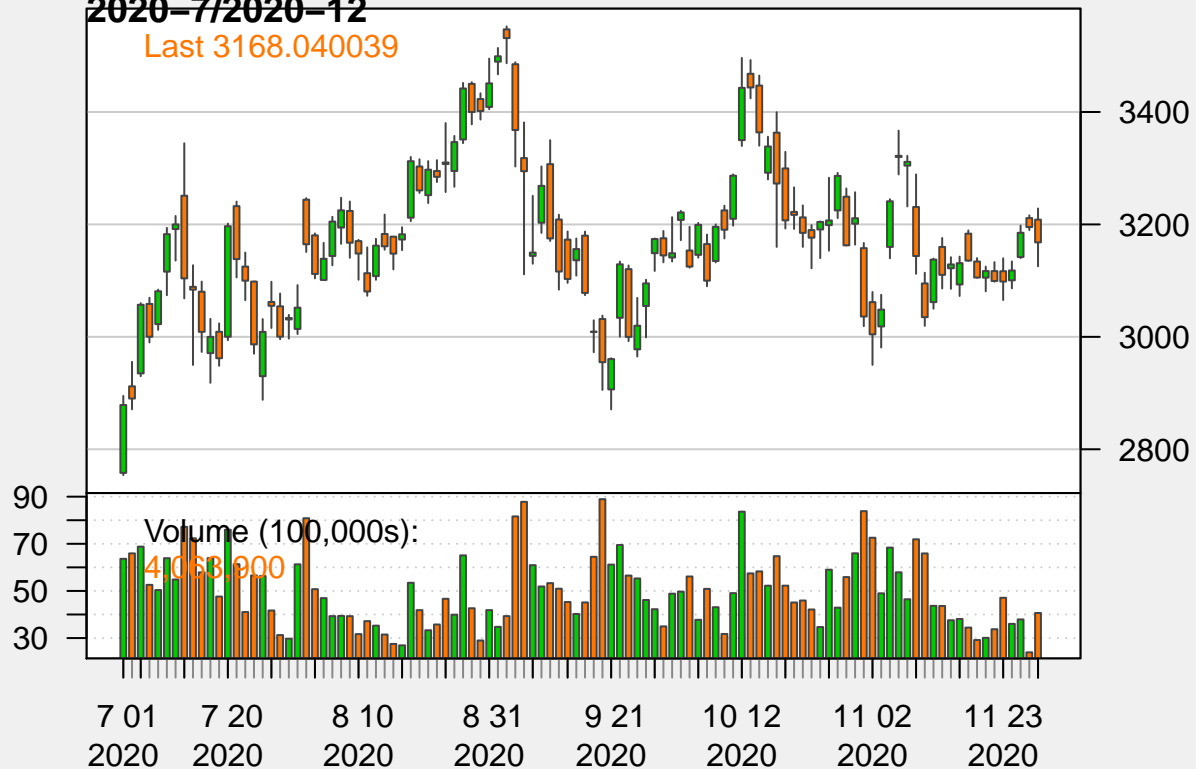
AAPL
2020−7/2020−12

[2020−07−01/2020−11−30]

Last 119.050003

130
120
110
100
90

Volume (millions):
169,410,200

350
250
150
50

7 01 / 2020
7 20 / 2020
8 10 / 2020
8 31 / 2020
9 21 / 2020
10 12 / 2020
11 02 / 2020
11 23 / 2020

AMZN
2020−7/2020−12

[2020−07−01/2020−11−30]

Last 3168.040039

3400
3200
3000
2800

Volume (100,000s):
41,063,000

90
70
50
30

7 01 / 2020
7 20 / 2020
8 10 / 2020
8 31 / 2020
9 21 / 2020
10 12 / 2020
11 02 / 2020
11 23 / 2020

4

GOOG
2020−7/2020−12
[2020−07−01/2020−11−30]

Last 1760.73999

Volume (100,000s):
1,823,800

NIO
2020−7/2020−12
[2020−07−01/2020−11−30]

Last 50.529999

Volume (millions):
179,765,400
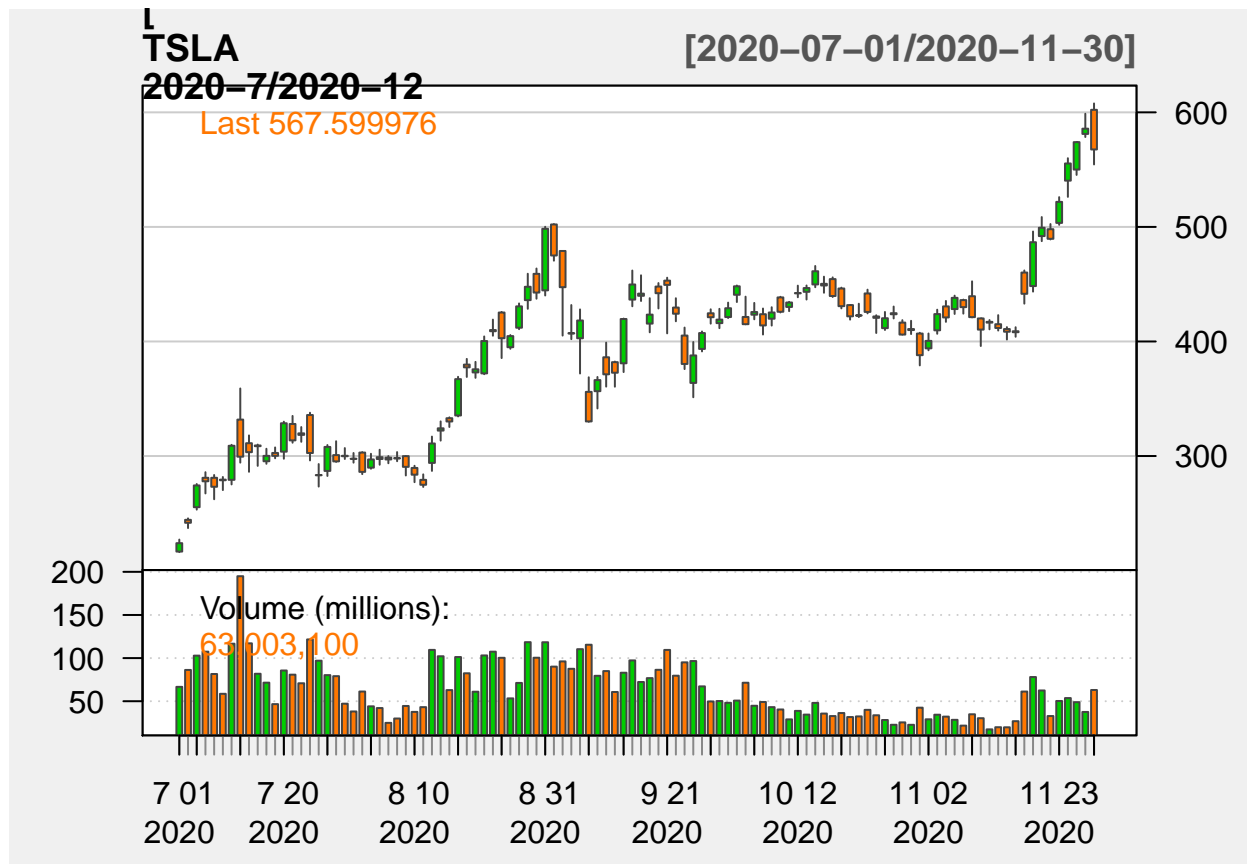
Conclusion

The example we choose shows that this portfolio is not profitable, because efficient portfolio takes historical data to predict the future without taking factors like variation of market fluctuation into consideration. Instead of being a economic method, it is more like a quantitative method. In this case, we have $247377 after transaction on 1st Dec 2020. The portfolio tends to go upwards before September, but experienced a sharp plunge during September. Though it recovers after that, we still lost money by the time we finished trading on 1st Dec 2020.

However, there's no theory that guarantees investors that they will 100% make money. The contribution that Markowitz has made is extraordinary.This theory did us the portfolio with the same risk but the highest expected return. The optimal portfolio is an effective portfolio selected by an investor and has the greatest utility. It has also greatly helped investors to decide their asset allocation before every investment.