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Homework 5

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DGGB/SDGB 7844

Statistical Methods and Computation I

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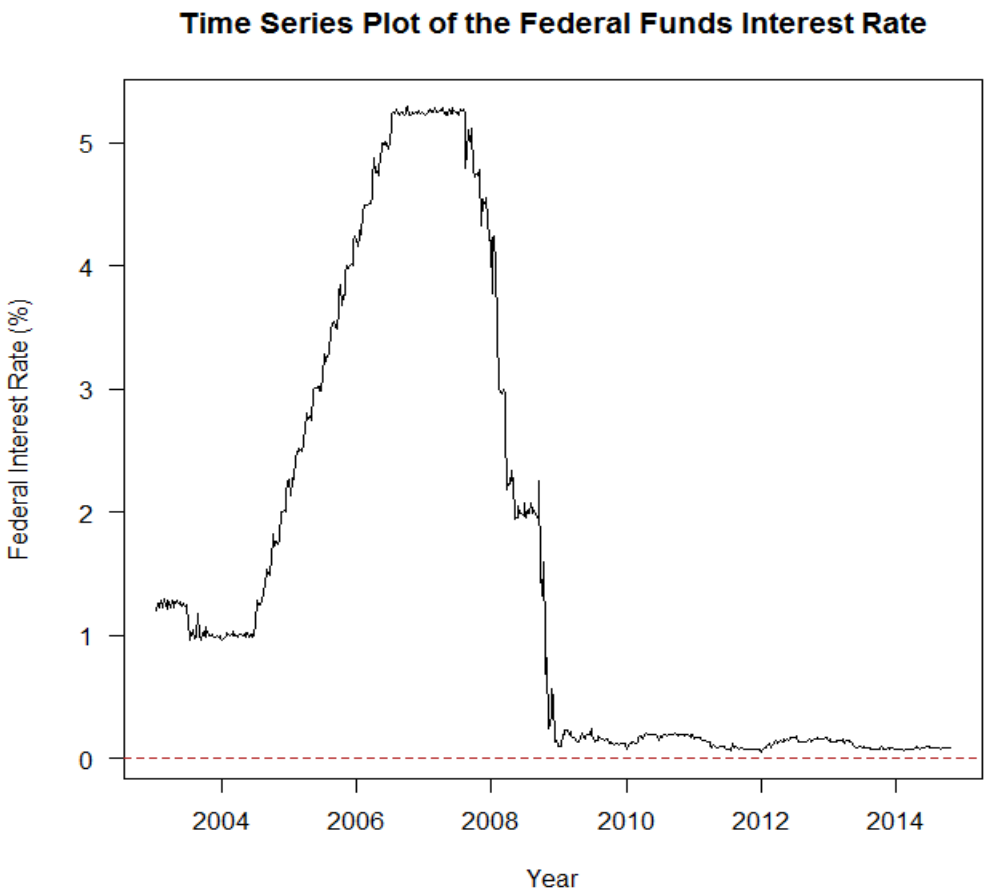
###Problem 1 ##

Solution:

1.In the reduced data set, the start date is 2003-01-08 and the end date is 2014-10-29.

2. Plot of the Federal Funds Interest Rate:



As we can see in the plot, there is a continuous surge of the broken line between the year of 2005 and 2007, which means the federal interest rate increased a lot during this period, from around 1% to over 5%. Then, there is a huge drop of the broken line between 2008 and 2009, in other words, the federal interest rate decreased a lot during this period, from over 5% to almost 0.

The huge decline of the federal interest rate between 2008 and 2009 is correlated to the subprime crisis in 2008. The financial crisis led to the descending of the economics of the US and increased the market risk because the market was unstable at that time. The return of capital dropped down and people were not willing to invest their money to the market during the period. Thus, the U.S. Federal Reserve Bank would lower down the interest rate and try to attract some investors back to the market. This behavior gave some confidence to the investors and stimulated the economics at some degree.

All in all, the huge decrease of the interest rate reveals that the economics affected by financial crisis was at a hard time then.

###Problem 2 ##

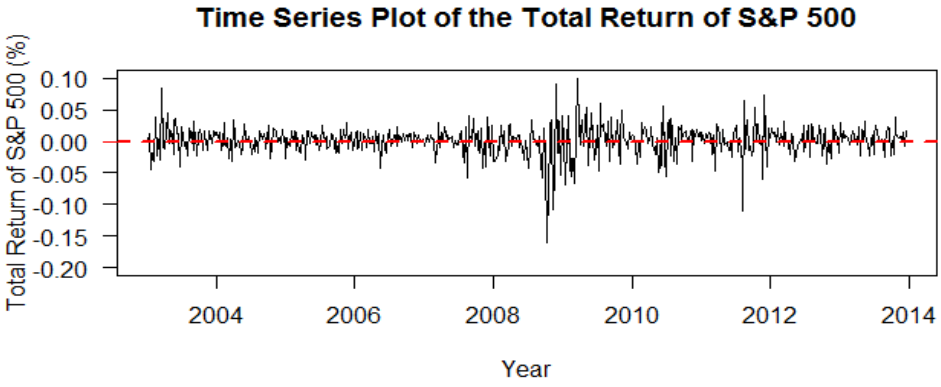
Solution:

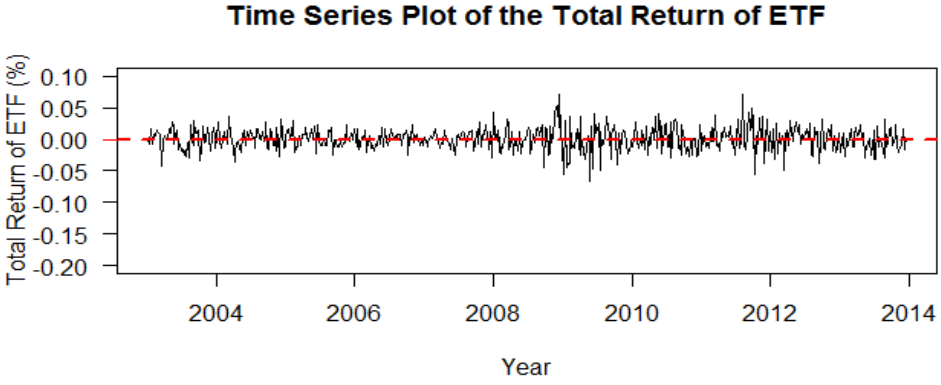
In training set, there are 570 observations.

In test set, there are 43 observations.

###Problem 3 ##

The two plots:



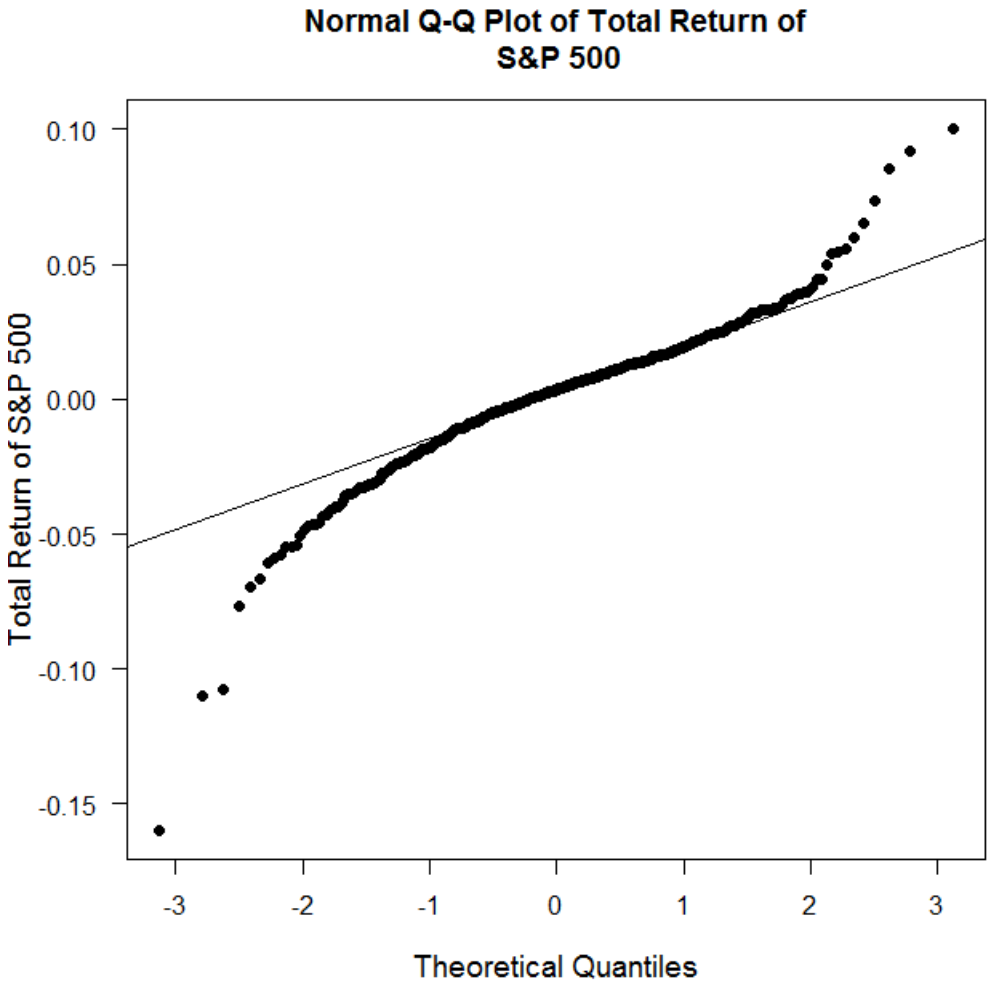


Firstly, as we can see, it appears that the fluctuation of the overview of the second plot (total return of ETF) is obviously less than that of the first plot (total return of S&P 500). Thus, the total return of ETF is more stable than that of S&P 500. This also implies that the variance or risk of ETF is less than the variance or risk of S&P 500.

Secondly, during the period of financial crisis between 2008 and 2010, the total return of S&P 500 shocked dramatically while the total return of ETF is stable, compared to that of S&P 500. It seems that ETF has better ability to resist the risk of financial crisis than S&P 500 based on these two time series plots.

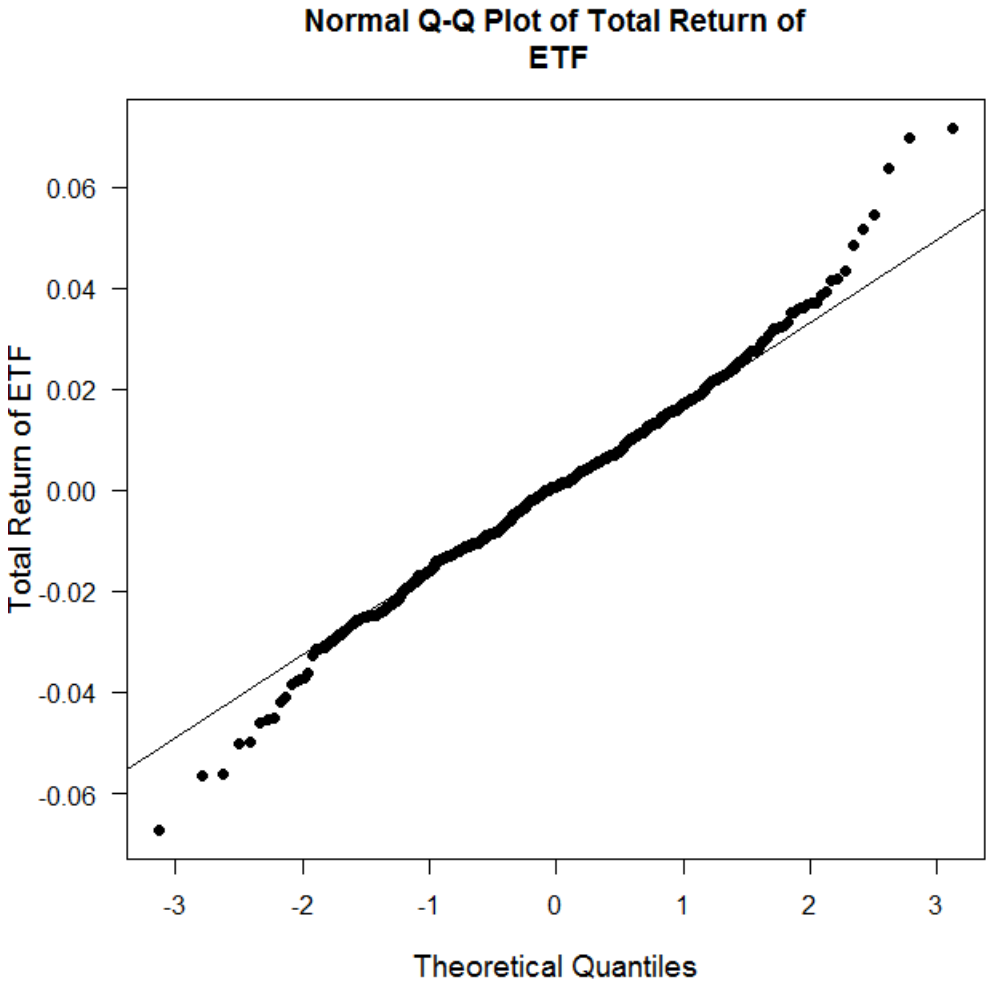
###Problem 4 ##

The normal quantile plot of total returns of S&P 500 :



Since the curve starts below the normal line, bends to follow it, and ends above it, this indicates the data long tails. It's not a normal distribution.

The normal quantile plot of total returns of ETF:



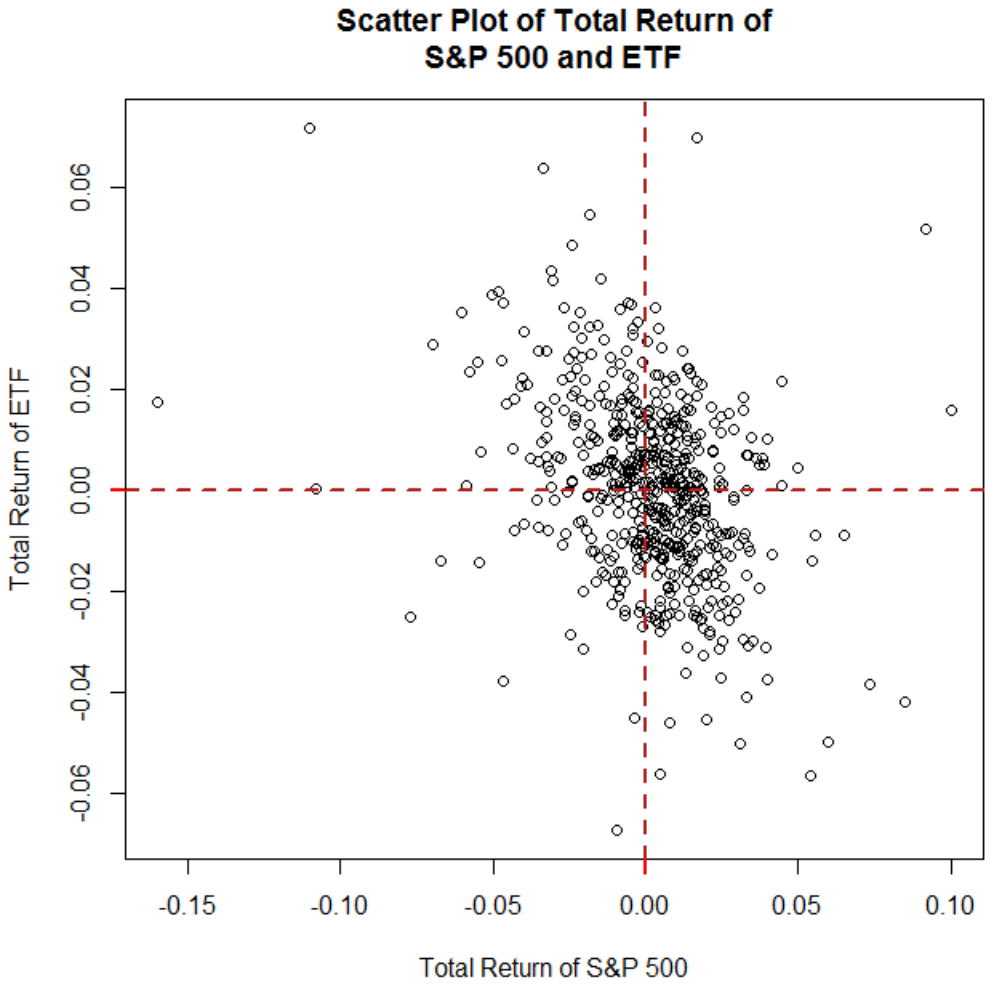
This indicates long tails, but not normal distribution.

###Problem 5 ##

Solution:

a)The correlation between the total returns of S&P 500 and ETF is -0.3439, which indicates that these two assets have negative linear relationship.

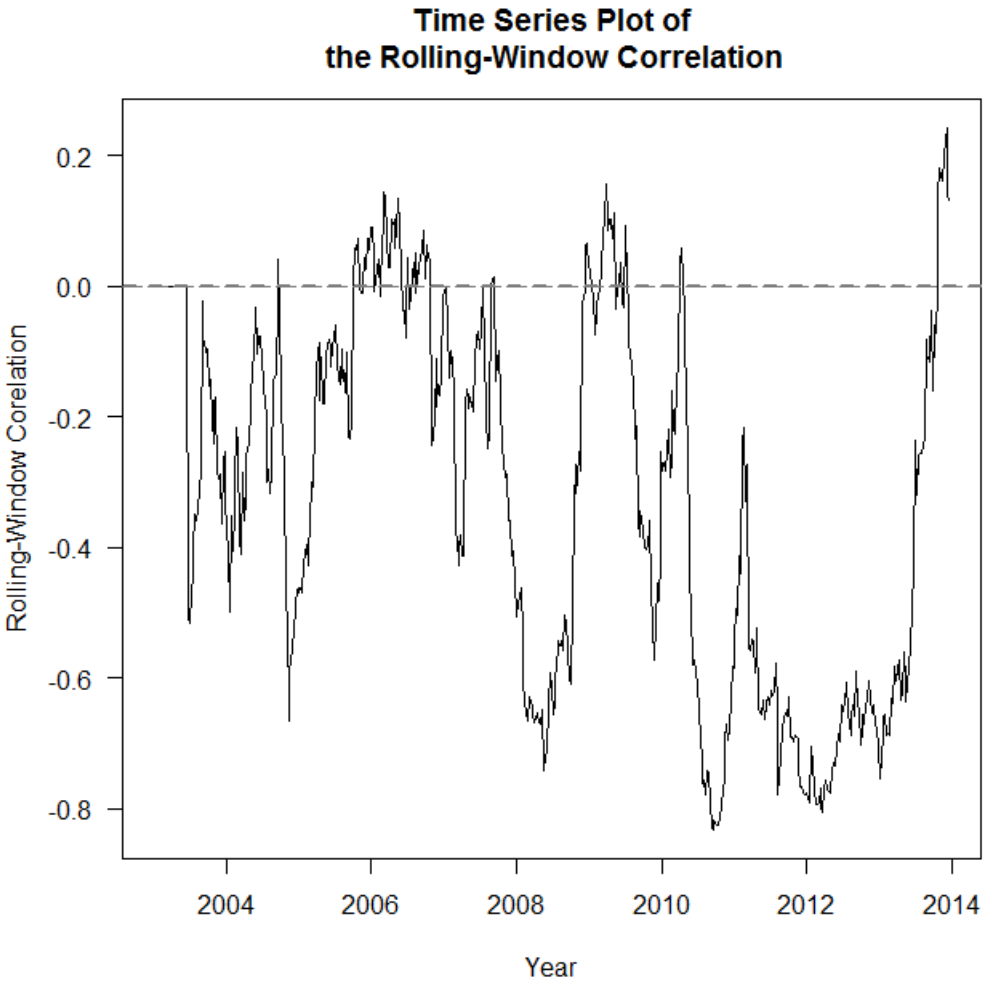
The scatter plot to interpret their linear relationship:



Correlation measures the strength of a linear relationship. Based on the scatter plot, the data form a negative linear trend and thus have negative linear relationship.

b)Rolling-Window Correlation:

Time series plot of the rolling-window correlations :



As we can see in the time series plot, there are some periods of the rolling-window correlation over zero and it means that not all the correlations are negative, which is obviously different from the conclusion we got from the common correlation at the previous part. The rolling-window correlation gives us a better overview and interpretation on the correlation between these assets.

Thus, the rolling-window correlation is a better way to describe the relationship between these two assets since it precisely reflects the correlation at different phases.

###Problem 6 ##

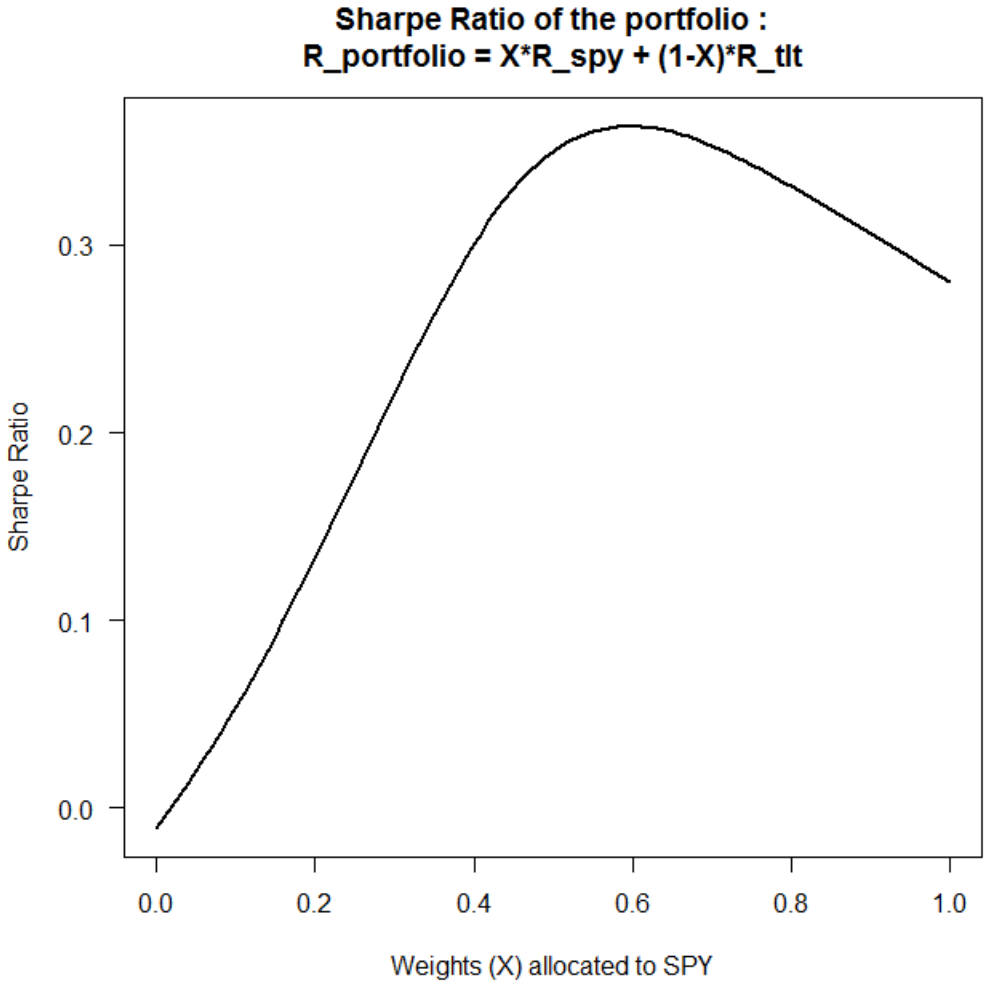
The Sharpe Ratio of SPY is 0.2807176;

The Sharpe Ratio of TLT is -0.01095925.

Since the higher the Sharpe Ratio value, the better the investment is considered to be. SPY should be a better investment.

###Problem 7 ##

The plot of Sharpe Ratio of the potfolio:



As we can see in the plot, there is a weight that produces the maximum Sharpe ratio in the plot.

###Problem 8 ##

a)

```
> optimize(rt.por, r.spy = data.training$tr.spy[2:570], r.tlt = data.training$tr.tlt[2:570],
+ r.fed = data.training$fed.rate[1:569], c(0,1), maximum = T)
$maximum
[1] 0.5958502

$objective
[1] 0.3634139
```

Thus, when X = 0.5958502, the Sharpe Ratio has the highest value, which is 0.3634139

59.585% of the funds should invest in SPY

1-0.59585= 40.415% of the funds should invest in TLT.

The Sharpe Ratio of the overall portfolio is 0.3634139

b)

In problem 6, we get the result:

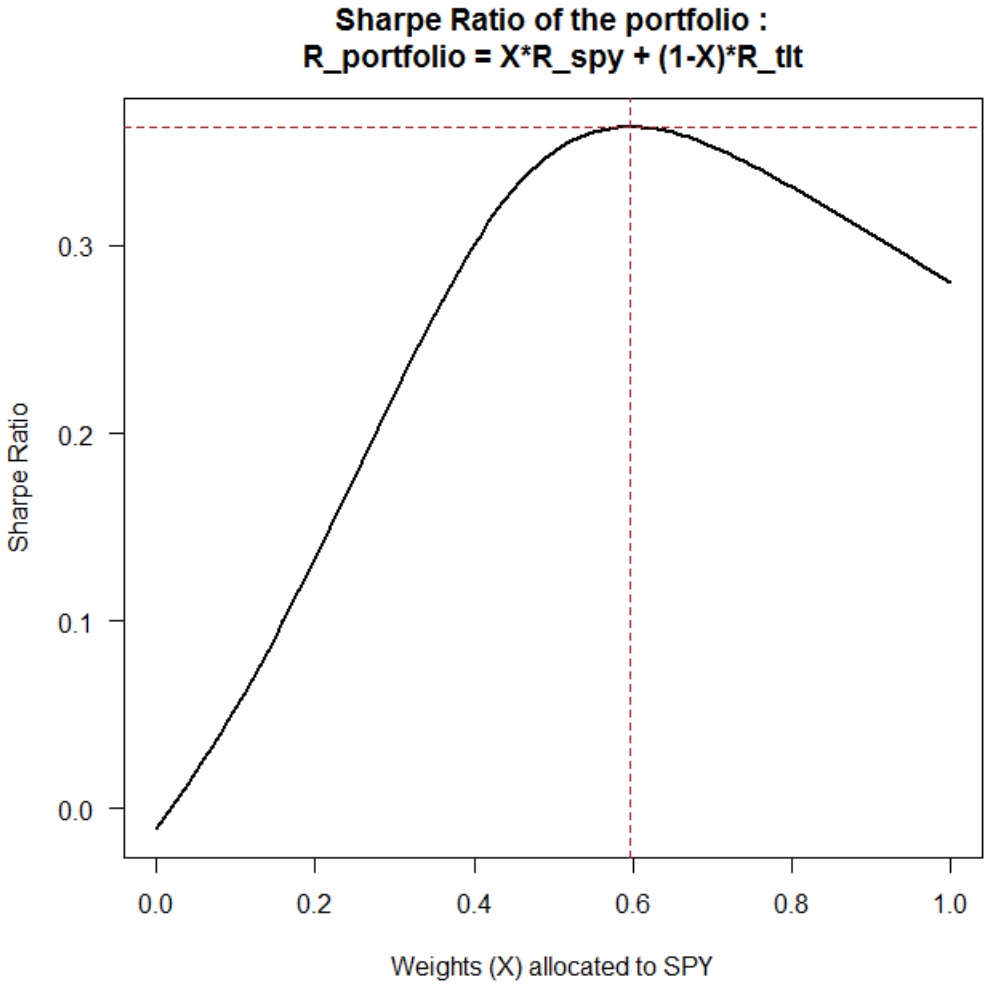
The Sharpe Ratio of SPY is 0.2807176 < 0.3634139

The Sharpe Ratio of TLT is -0.01095925 < 0.3634139

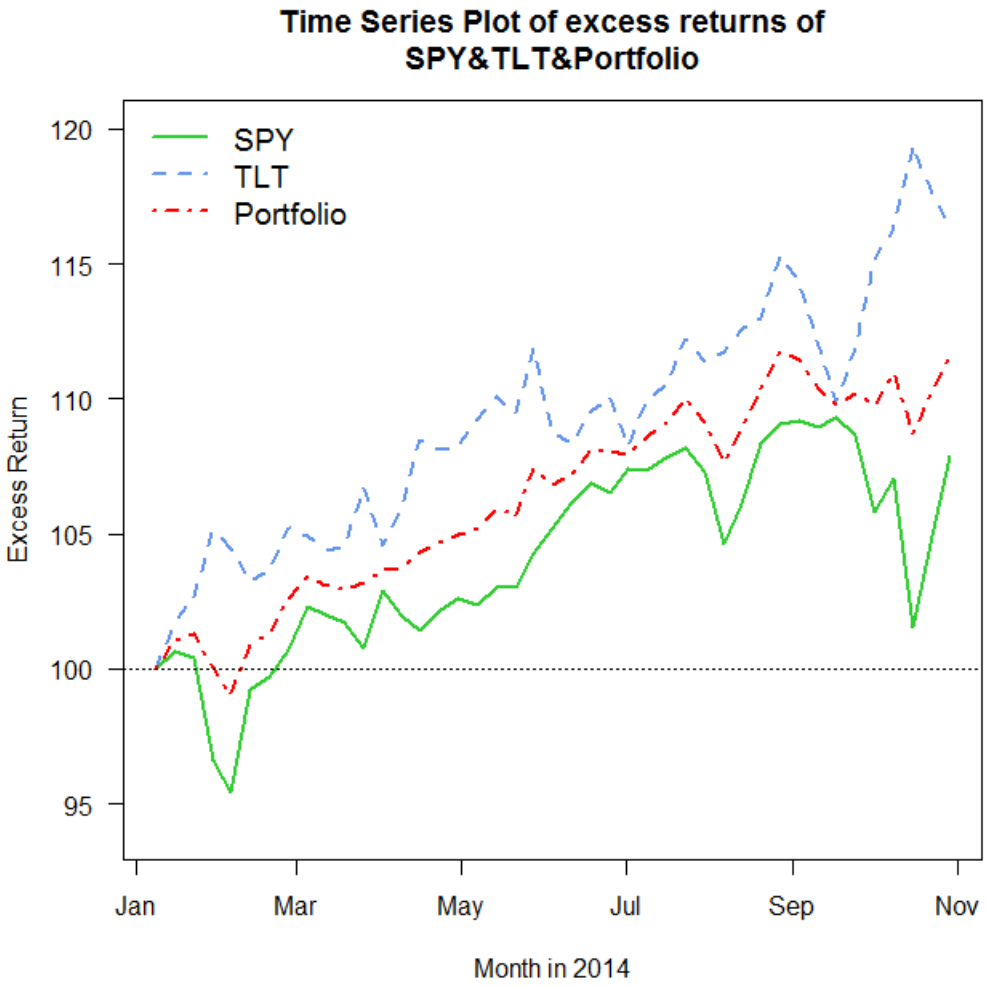
Thus, the Sharpe Ratio of the optimal portfolio is higher than either ratio of SPY or TLT.

It is better to invest in the optimally combined portfolio because the return would be higher.

Also, investing in a combined portfolio could reduce the risk of the investment in a way because the total risk would be dispersed, especially most of the time these two assets have negative correlation.



###Problem 9 ##



As we can see in the plot, the excess return of SPY is the lowest line in the plot, the excess return of TLT is the highest line in the plot, and the excess return of Portfolio is in the middle part of the plot.

Return: TLT > Portfolio > SPY

Stability: Portfolio > TLT > SPY

From Jan to Nov in 2014, all the excess returns of three assets are ascending overall.

Most of the time, the excess returns are greater than 100.

###Problem 10 ##

```
> data.test.temp[nrow(data.test.temp),c("ex.spy","ex.tlt", "ex.por")]
     ex.spy   ex.tlt   ex.por
43 107.8761 116.3758 111.6364
```

For SPY, I would have $107.8761

For TLT, I would have $116.3758.

For Portfolio, I would have $111.6364.

I think the portfolio performs well in the test set even though it only provides the medium return because it can lower the risk of the investment at some degree and make the return more stable than that of other two assets.