

In step one, I generally set up three main functions

First one function `Stock_selection(date1 , cut_start , cut_length)`

It takes the specific date, BTM ratio category formed by cutting sorted BTM ratio as inputs

It can return the selected stocks according to BTM ratio category on the specific day

Second function `return_track (basket , date1 , duration)`

It takes the basket of stock and the start day and duration of interested time period

It returns a $M \times N$ matrix (M is the number of stocks in our selected basket, N is the interested period)

Third function `Return_portfolio(M1, money)`

It takes previous return Matrix and investment amount as inputs

It can track how the equal weighted portfolio according our selection will be along the interested period.

It gives back the a vector the dollar value of portfolio along the period

Using these three functions to build a function to track a specific strategy on sorted BTM ratios

`Strategy_performance =function(rebalance_cutoffs,rebalance_fre,
BTMcut_start,BTMcut_length,initial_investment_at_begin)`

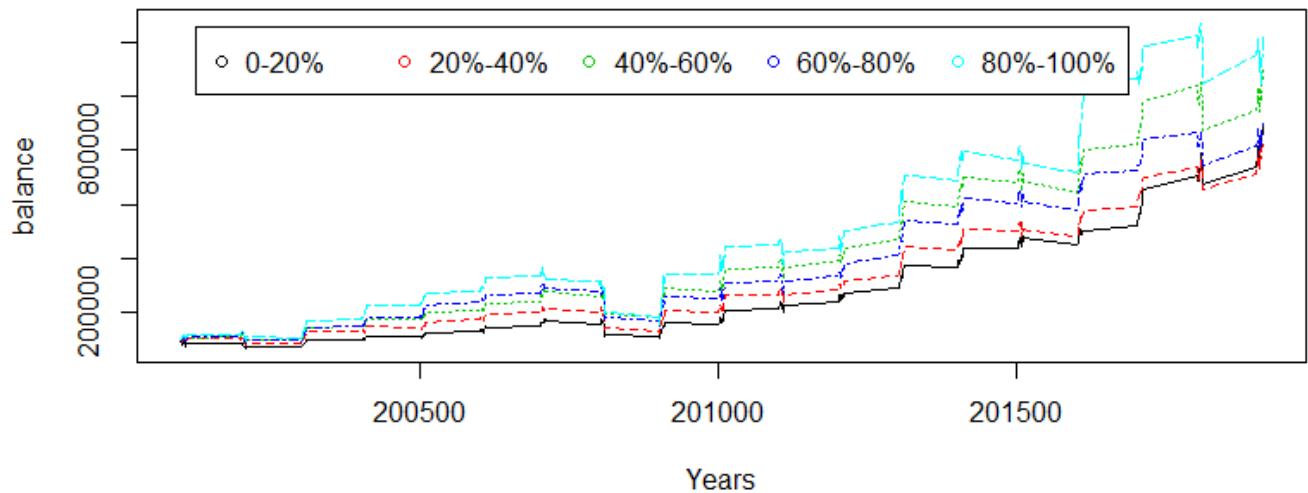
It takes the predefined rebalance cutoffs and strategy by the BTM cuts and the initial investment

It can return how a strategy perform along the period with rebalance at each rebalance period

The latter initial investment is the previous balance of last rebalance period

Step2:

Then write a for-loop on the BTM cuts to track how these five strategies perform along the time



```
> summary(value_paths)
```

0-20%	20%-40%	40%-60%	60%-80%	80%-100%
Min. : 65286	Min. : 77919	Min. : 90507	Min. : 87606	Min. : 96196
1st Qu.: 113130	1st Qu.: 145664	1st Qu.: 184482	1st Qu.: 190124	1st Qu.: 230528
Median : 175683	Median : 222172	Median : 305144	Median : 290002	Median : 377917
Mean : 289348	Mean : 324641	Mean : 433168	Mean : 388870	Mean : 513454
3rd Qu.: 450202	3rd Qu.: 502850	3rd Qu.: 684326	3rd Qu.: 609435	3rd Qu.: 781012
Max. : 897358	Max. : 842727	Max. : 1113482	Max. : 916952	Max. : 1271880

Turn dollar value into return matrix

```
> summary(return_paths)
```

0-20%	20%-40%	40%-60%	60%-80%	80%-100%
Min. :-0.16829	Min. :-0.18863	Min. :-0.16762	Min. :-0.21281	Min. :-0.21344
1st Qu.: -0.01144	1st Qu.: -0.01397	1st Qu.: -0.01254	1st Qu.: -0.01246	1st Qu.: -0.01076

Median : 0.01506	Median : 0.01458	Median : 0.01562	Median : 0.01358
Median : 0.01546			
Mean : 0.01074	Mean : 0.01056	Mean : 0.01178	Mean : 0.01105
Mean : 0.01260			
3rd Qu.: 0.03658	3rd Qu.: 0.03940	3rd Qu.: 0.03844	3rd Qu.: 0.03997
3rd Qu.: 0.03901			
Max. : 0.12183	Max. : 0.15954	Max. : 0.18160	Max. : 0.16614
Max. : 0.23576			

Step 3:

For the whole period

0-20% category according to BTM ratio, its annual mean is 12.88201 %
its annual sd also known as volatility is 15.60896 %
20%-40% category according to BTM ratio, its annual mean is 12.66918 %
its annual sd also known as volatility is 16.41366 %
40%-60% category according to BTM ratio, its annual mean is 14.13839 %
its annual sd also known as volatility is 16.3166 %
60%-80% category according to BTM ratio, its annual mean is 13.26565 %
its annual sd also known as volatility is 17.20889 %
80%-100% category according to BTM ratio, its annual mean is 15.1214 %
its annual sd also known as volatility is 19.02681 %

the two category 1 and 2 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.9674187
```

the two category 1 and 3 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.8088921
```

the two category 1 and 4 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.9427786
```

the two category 1 and 5 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.6924727
```

the two category 2 and 3 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.7825957
```

the two category 2 and 4 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.9131809
```

the two category 2 and 5 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.6714485
```

the two category 3 and 4 can not reject the null that the true difference in means is equal to 0

```
$p.value
```

```
[1] 0.8729033
```

the two category 3 and 5 can not reject the null that the true difference in means is equal to 0

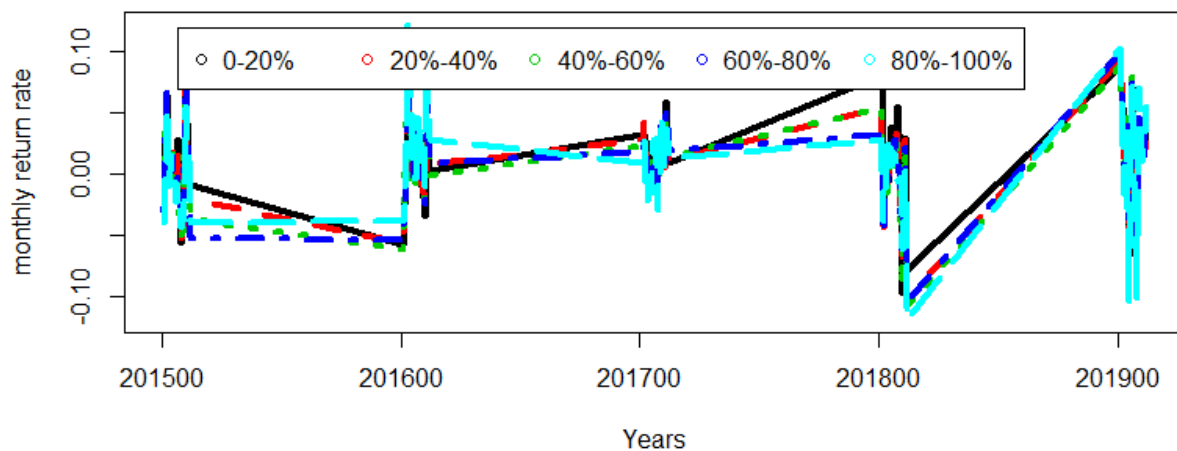
```
$p.value  
[1] 0.8646365
```

the two category 4 and 5 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.7532041
```

For the period of 2015-2020

0-20% category according to BTM ratio, its annual mean is 15.24972 %
its annual sd also known as volatility is 12.67726 %
20%-40% category according to BTM ratio, its annual mean is 10.86286 %
its annual sd also known as volatility is 12.64663 %
40%-60% category according to BTM ratio, its annual mean is 10.29151 %
its annual sd also known as volatility is 14.59899 %
60%-80% category according to BTM ratio, its annual mean is 8.687346 %
its annual sd also known as volatility is 13.78838 %
80%-100% category according to BTM ratio, its annual mean is 9.816546 %
its annual sd also known as volatility is 15.92002 %



the two category 1 and 2 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.5848634
```

the two category 1 and 3 can not reject the null that the true difference in means is equal to 0

```
$p.value  
[1] 0.5674804
```

```
the two category 1 and 4 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.4349596
```

```
the two category 1 and 5 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.5517265
```

```
the two category 2 and 3 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.9473771
```

```
the two category 2 and 4 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.7953179
```

```
the two category 2 and 5 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.9085932
```

```
the two category 3 and 4 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.8585377
```

```
the two category 3 and 5 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.9608687
```

```
the two category 4 and 5 can not reject the null that the true difference in
means is equal to 0
$p.value
[1] 0.9047797
```

From the p-value of 2 sample t test between any of these 5 categories, none of them can be distinguish with each other. I did not see the marked difference for the monthly return rate. Maybe it is caused by the high sd error

While from the cumulative effect perspective, its overall performance as long-run dollar balance for each strategy. There exists the difference. I definitely want to hold the 0-20% portfolio at 2015-2020 and 80%-100% at the whole period. And you see the best strategy according to BTM ratio also changes along time.

Step4:

Yes, BtM factor can definitely explain some part of stock return. Just like the FF 3 factor model, there is a factor called HML it is constructed by holding some value stock and short the low BtM stock. It is statistically significant. And this can be used to explain other anomalies such as why slow sales growth companies outperform than others. The slow sales growth companies actually has larger exposure on the HML factor and it behaves like value stock. This anomaly can be linked to the HML factor.

Fama mentioned that there exists an economic reason that most wealthy people work for or are close with the companies of the large and value stocks, for the risk sharing reason, they do not want to invest on these stocks, such bias selection will cause the value stock has weaker performance.

While in my view, it is a kind of change of investment preference. In 2000-2005, investors ran out of tech companies and most of them are in the low book to market category, these stocks' performance are seriously affected by the selling power, so they gained less profit than the value stocks. On the contrary, for the 2015-2020, investors are in favor of tech companies again, and they like the high-growth rate companies and keep chasing them even their BTM ratio are already very low.