STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY®

FE541 Portfolio Analysis with CAPM &Fama French Factors

Jiawei Lu, Yucan Li

2021.12.14

General description

What we did and will do:

- Find 15 stocks from 15 different industries with the top three market capitalizations to reduce covariance.
- Time choice: from 2018-03-01 to 2021-03-30
- Find the Optimal Portfolios
- Using the portfolio to calculate return, volatility and Sharpe ratio
- Compare with the market index (GSPC,XIC,DJI)
- Using CAPM and Fama and French Three Factor Model to do regression
- Estimate Alpha, Beta and Sharpe ratio

Selected industries

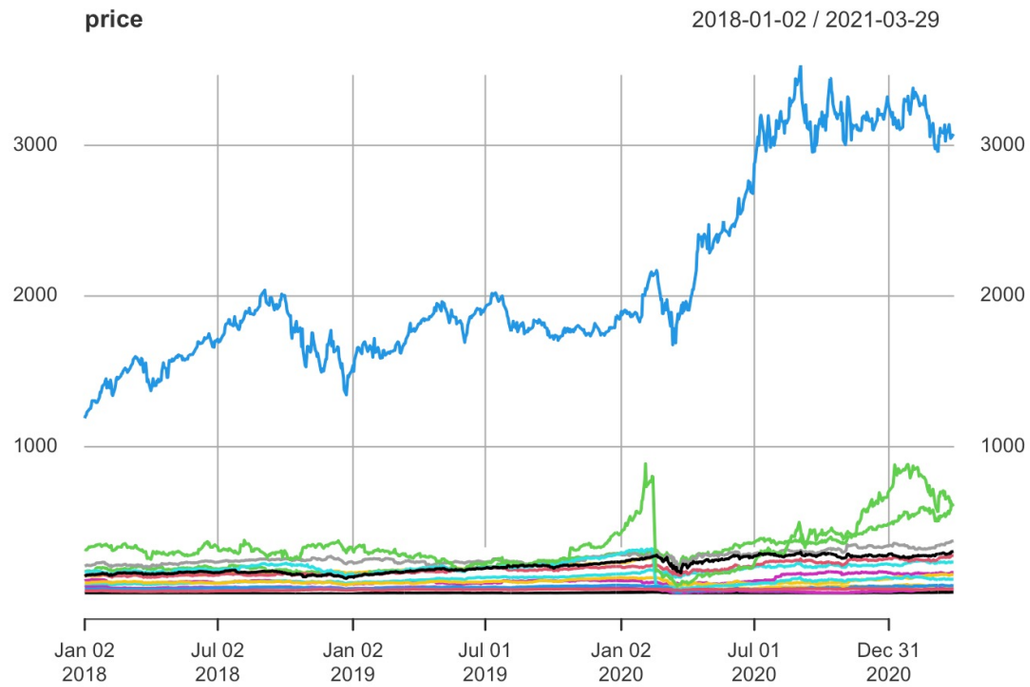
- Commercial Services, Communications, Consumer, Distribution Services, Electronic Technology, Energy Minerals, Finance, Health, Industrial Services, Process Industries, Producer Manufacturing, Retail Trade, Technology Services, Transportation, Utilities.

Reference : https://www.tradingview.com/markets/stocks-usa/sectorandindustry-sector/

Data collection

About our data choices

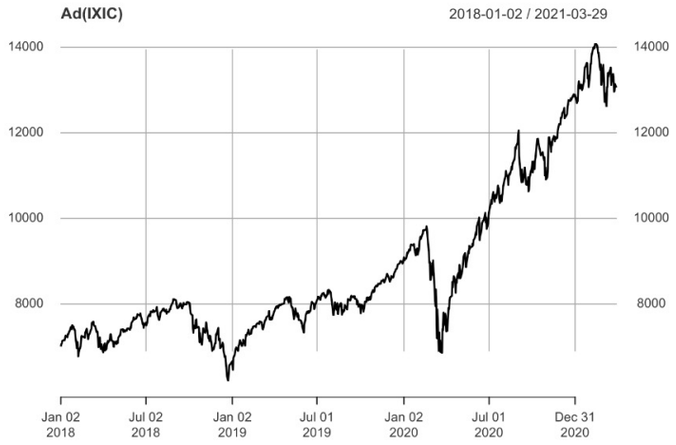
- Load the data
- Use the data between ‘2018-01-01: 2021-03-30'

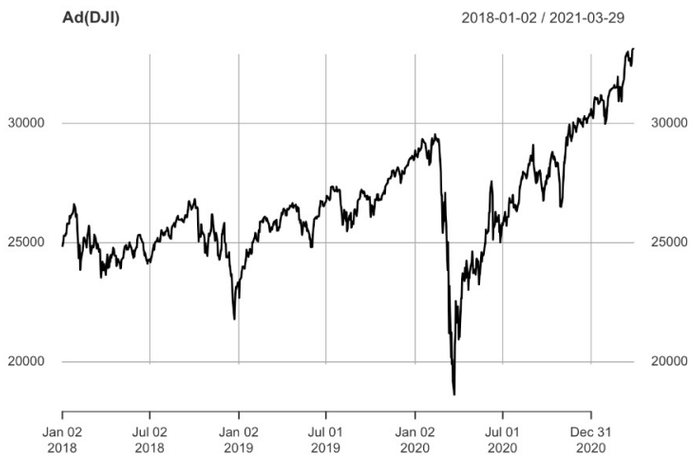


Graph : price of stocks

Data collection

S&P 500, Nasdaq index and Dow Jones Industrial Average.





Graph : price of index

the whole period:2018-01-01 to 2021-03-30

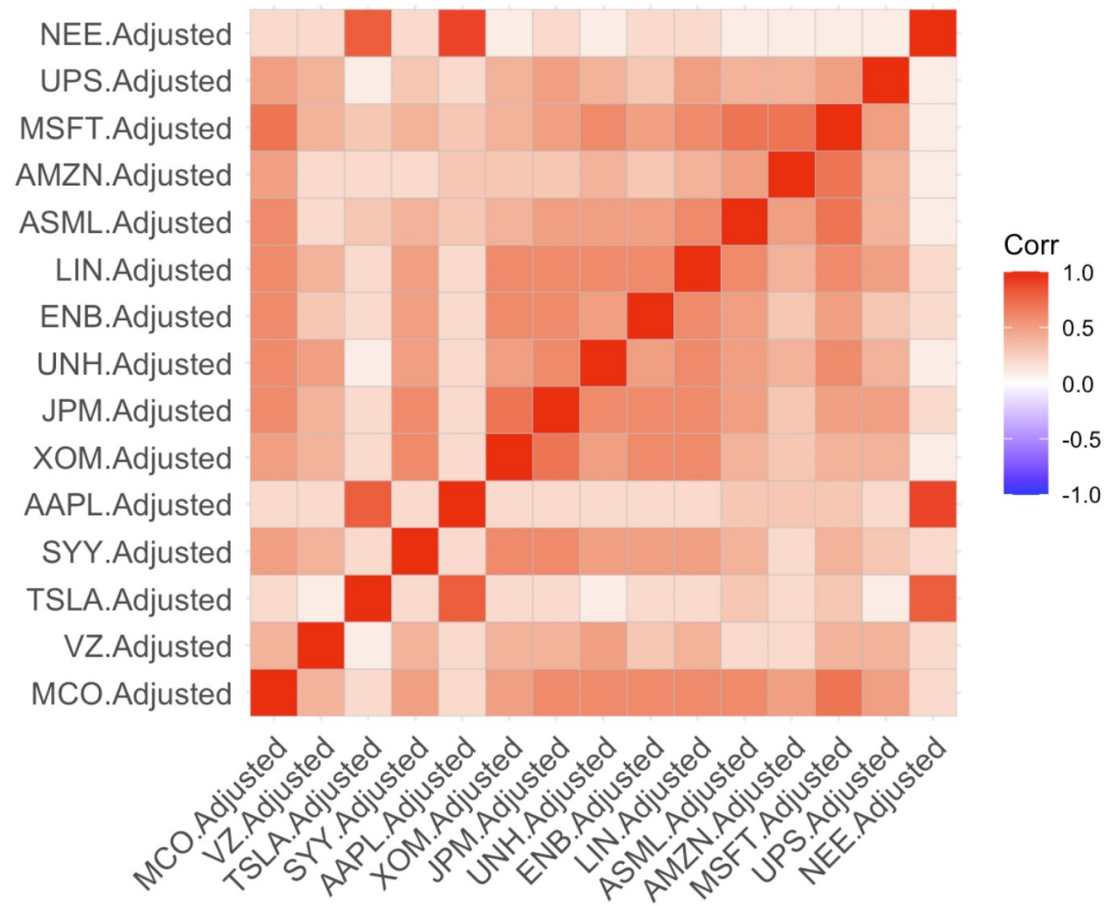
```
##       Index               MCO.Adjusted     VZ.Adjusted     TSLA.Adjusted
##  Min.   :2018-01-02   Min.   :126.1   Min.   :39.31   Min.   : 72.24
##  1st Qu.:2018-10-22   1st Qu.:165.7   1st Qu.:47.78   1st Qu.:247.76
##  Median :2019-08-15   Median :200.9   Median :51.87   Median :309.10
##  Mean   :2019-08-15   Mean   :210.5   Mean   :50.87   Mean   :345.67
##  3rd Qu.:2020-06-06   3rd Qu.:265.9   3rd Qu.:54.64   3rd Qu.:364.11
##  Max.   :2021-03-29   Max.   :305.4   Max.   :59.06   Max.   :887.06
##   SYY.Adjusted    AAPL.Adjusted     XOM.Adjusted     JPM.Adjusted
##  Min.   :29.72   Min.   : 55.4   Min.   :27.83   Min.   : 74.87
##  1st Qu.:57.64   1st Qu.:120.9   1st Qu.:42.34   1st Qu.: 96.40
##  Median :63.80   Median :172.5   Median :60.37   Median :101.50
##  Mean   :63.93   Mean   :168.1   Mean   :55.60   Mean   :105.59
##  3rd Qu.:70.32   3rd Qu.:203.5   3rd Qu.:65.22   3rd Qu.:109.76
##  Max.   :81.95   Max.   :323.2   Max.   :71.37   Max.   :154.90
##   UNH.Adjusted     ENB.Adjusted     LIN.Adjusted    ASML.Adjusted    AMZN.Adjusted
##  Min.   :189.9   Min.   :20.17   Min.   :133.1   Min.   :140.7   Min.   :1189
##  1st Qu.:232.4   1st Qu.:25.35   1st Qu.:151.8   1st Qu.:189.1   1st Qu.:1696
##  Median :250.6   Median :27.51   Median :180.1   Median :215.7   Median :1859
##  Mean   :262.7   Mean   :27.67   Mean   :186.5   Mean   :270.4   Mean   :2121
##  3rd Qu.:290.4   3rd Qu.:29.29   3rd Qu.:207.8   3rd Qu.:343.6   3rd Qu.:2511
##  Max.   :375.1   Max.   :35.89   Max.   :278.5   Max.   :622.2   Max.   :3531
##  MSFT.Adjusted      UPS.Adjusted      NEE.Adjusted
##  Min.   : 80.81   Min.   : 82.28   Min.   : 43.87
##  1st Qu.:103.37   1st Qu.: 96.95   1st Qu.: 73.14
##  Median :134.05   Median :105.66   Median :158.83
##  Mean   :144.96   Mean   :113.82   Mean   :142.77
##  3rd Qu.:184.94   3rd Qu.:114.63   3rd Qu.:183.47
##  Max.   :242.95   Max.   :171.77   Max.   :267.63
```

Graph : the summary of stocks

Investment Strategy

```
##                MCO.Adjusted VZ.Adjusted TSLA.Adjusted SYY.Adjusted AAPL.Adjusted
## MCO.Adjusted            1.0         0.4            0.2           0.5           0.2
## VZ.Adjusted             0.4         1.0            0.1           0.4           0.2
## TSLA.Adjusted           0.2         0.1            1.0           0.2           0.8
## SYY.Adjusted            0.5         0.4            0.2           1.0           0.2
## AAPL.Adjusted           0.2         0.2            0.8           0.2           1.0
## XOM.Adjusted            0.5         0.4            0.2           0.6           0.2
##                XOM.Adjusted JPM.Adjusted UNH.Adjusted ENB.Adjusted LIN.Adjusted
## MCO.Adjusted            0.5         0.6           0.6           0.6           0.6
## VZ.Adjusted             0.4         0.4           0.5           0.3           0.4
## TSLA.Adjusted           0.2         0.2           0.1           0.2           0.2
## SYY.Adjusted            0.6         0.6           0.5           0.5           0.5
## AAPL.Adjusted           0.2         0.2           0.2           0.2           0.2
## XOM.Adjusted            1.0         0.7           0.5           0.6           0.6
##                ASML.Adjusted AMZN.Adjusted MSFT.Adjusted UPS.Adjusted
## MCO.Adjusted             0.6           0.5           0.7           0.5
## VZ.Adjusted              0.2           0.2           0.4           0.4
## TSLA.Adjusted            0.3           0.2           0.3           0.1
## SYY.Adjusted             0.4           0.2           0.4           0.3
## AAPL.Adjusted            0.3           0.3           0.3           0.2
## XOM.Adjusted             0.4           0.3           0.4           0.4
##                NEE.Adjusted
## MCO.Adjusted            0.2
## VZ.Adjusted             0.2
## TSLA.Adjusted           0.8
## SYY.Adjusted            0.2
## AAPL.Adjusted           0.9
## XOM.Adjusted            0.1
```

Graph : correlation between 15 stocks


NEE.Adjusted
UPS.Adjusted
MSFT.Adjusted
AMZN.Adjusted
ASML.Adjusted
LIN.Adjusted
ENB.Adjusted
UNH.Adjusted
JPM.Adjusted
XOM.Adjusted
AAPL.Adjusted
SYY.Adjusted
TSLA.Adjusted
VZ.Adjusted
MCO.Adjusted
MCO.Adjusted
VZ.Adjusted
TSLA.Adjusted
SYY.Adjusted
AAPL.Adjusted
XOM.Adjusted
JPM.Adjusted
UNH.Adjusted
ENB.Adjusted
LIN.Adjusted
ASML.Adjusted
AMZN.Adjusted
MSFT.Adjusted
UPS.Adjusted
NEE.Adjusted
Corr
1.0
0.5
0.0
-0.5
-1.0

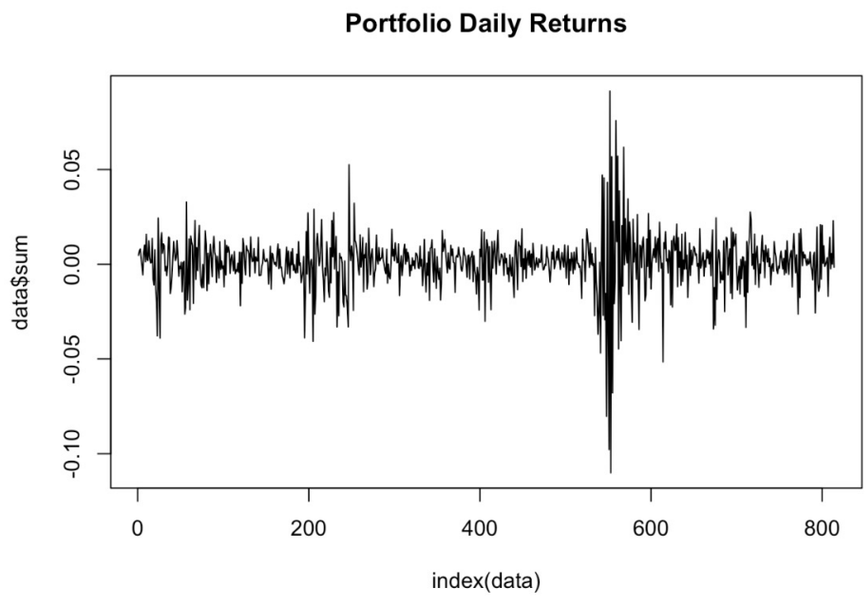
Calculate portfolio

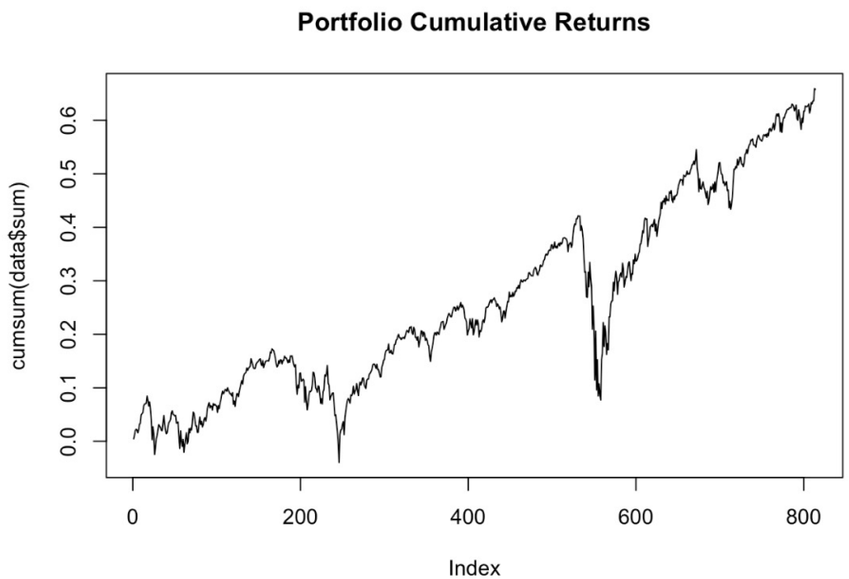
Stock	MCO	VZ	TSLA	SYY	AAPL	XOM	JPM
Weight	0.0764	0.1078	0.0343	0.0487	0.0932	0.0818	0.0250

UNH	ENB	LIN	ASML	AMZN	MSFT	UPS	NEE
0.0436	0.0439	0.0843	0.0654	0.0868	0.0657	0.0915	0.0513

Data result

Return	Risk	Sharpe ratio
0.2257	0.2324	0.9596





Capital Asset Pricing Model (CAPM) Model

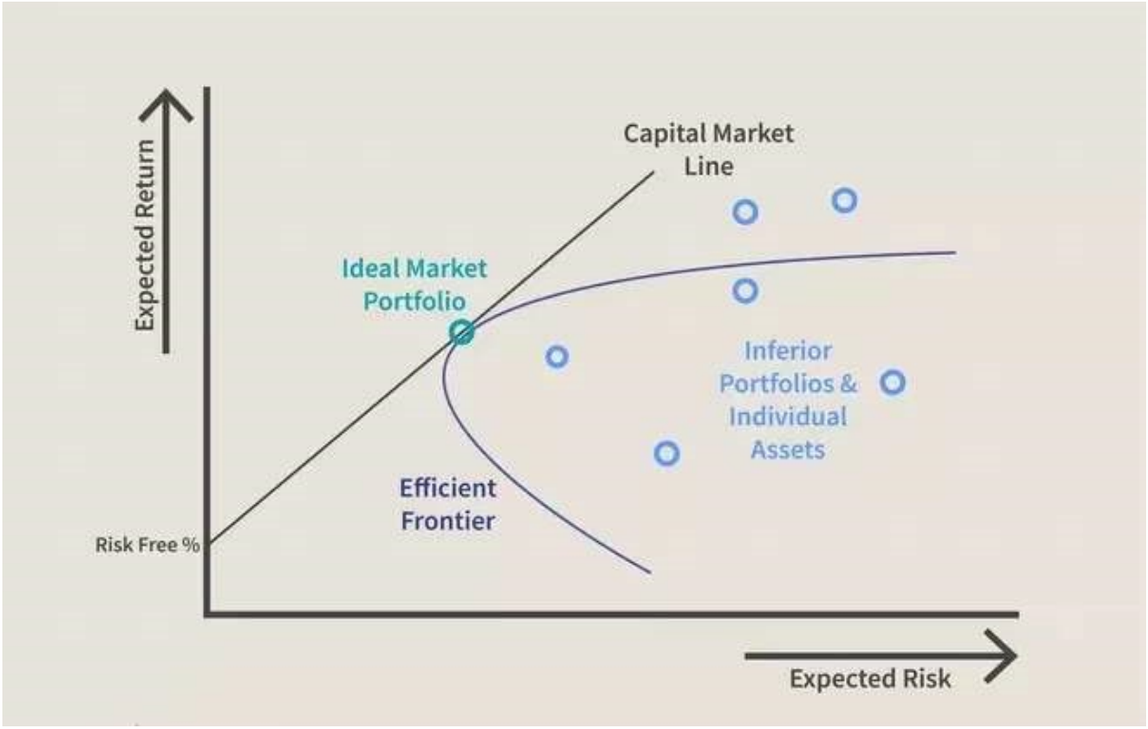
$$ER_i = R_f + \beta_i(ER_m - R_f)$$

ER_i = expected return of investment

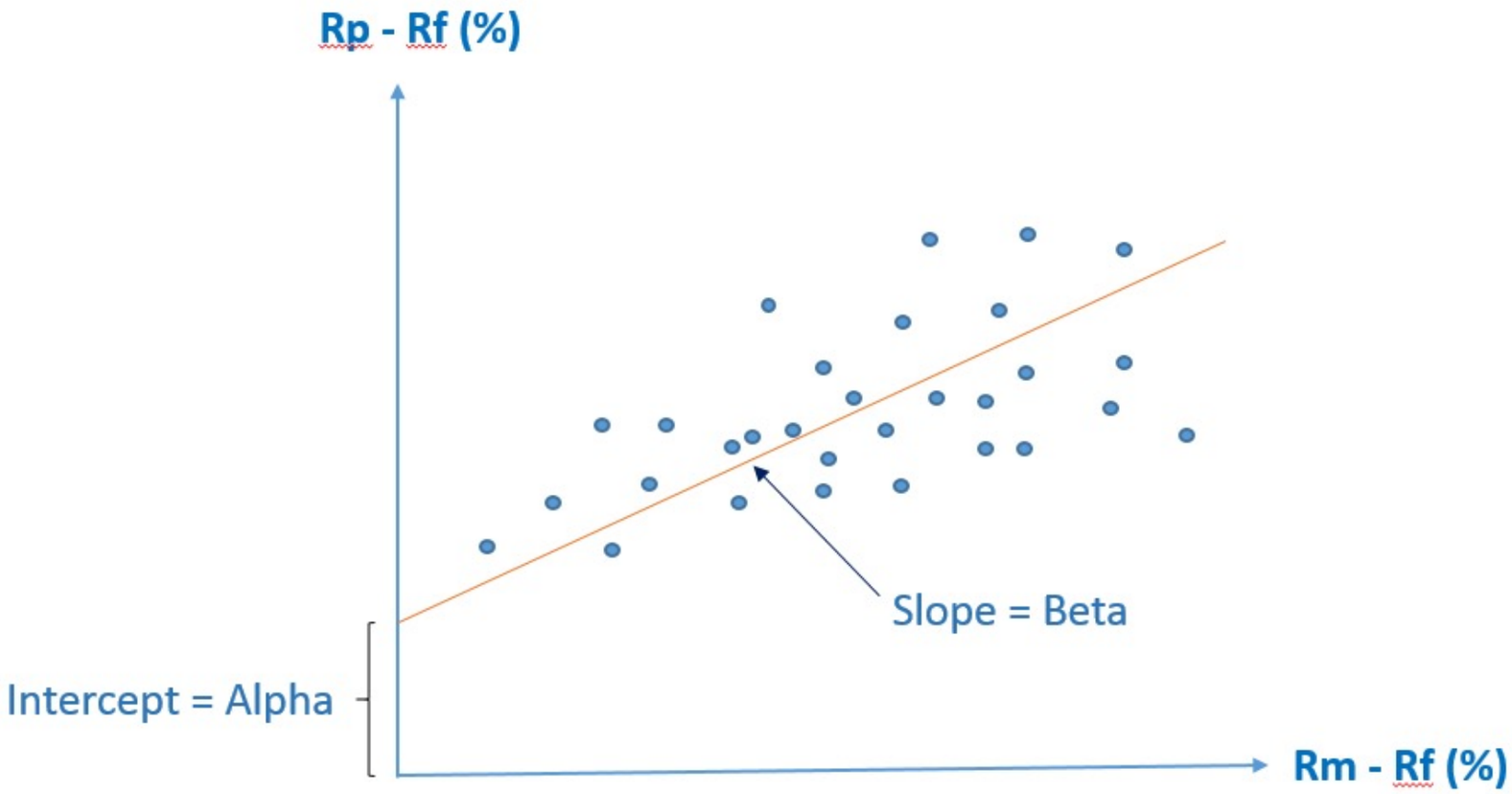
R_f = risk − free rate

β_i = beta of the investment

$ER_m - R_f$ = market risk premium



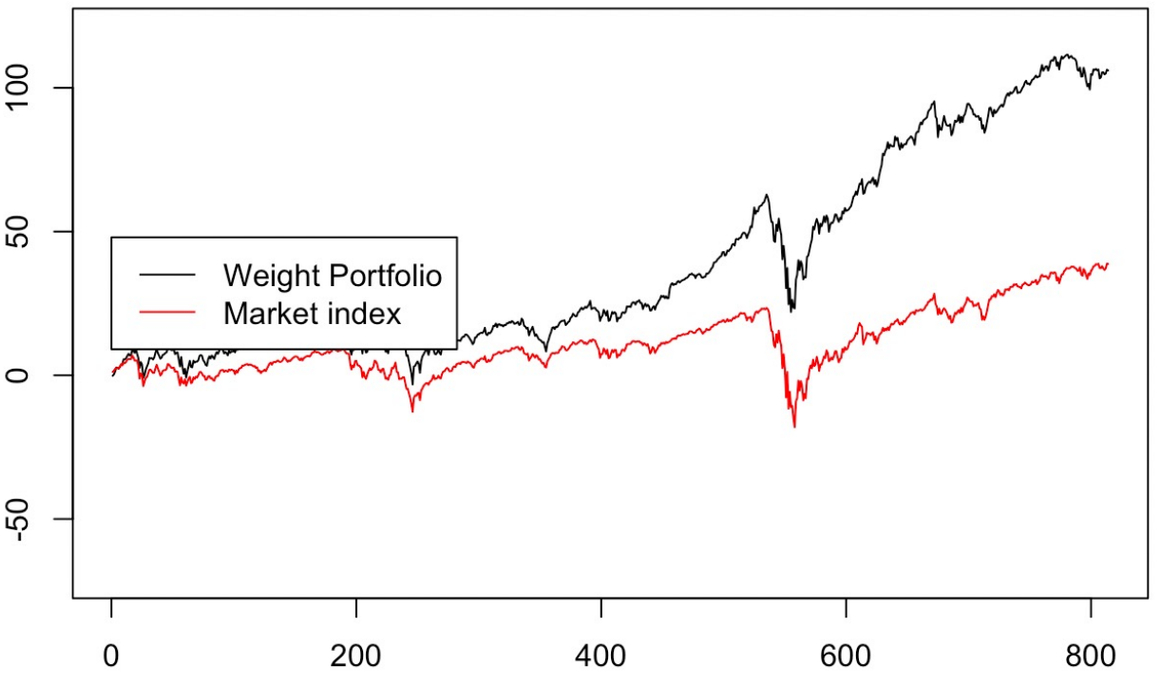
$$Rp - Rf = \underbrace{Alpha}_{\text{Intercept}} + \underbrace{Beta}_{\text{Slope}} X\ (Rm - Rf)$$



regression of portfolio

For GSPC

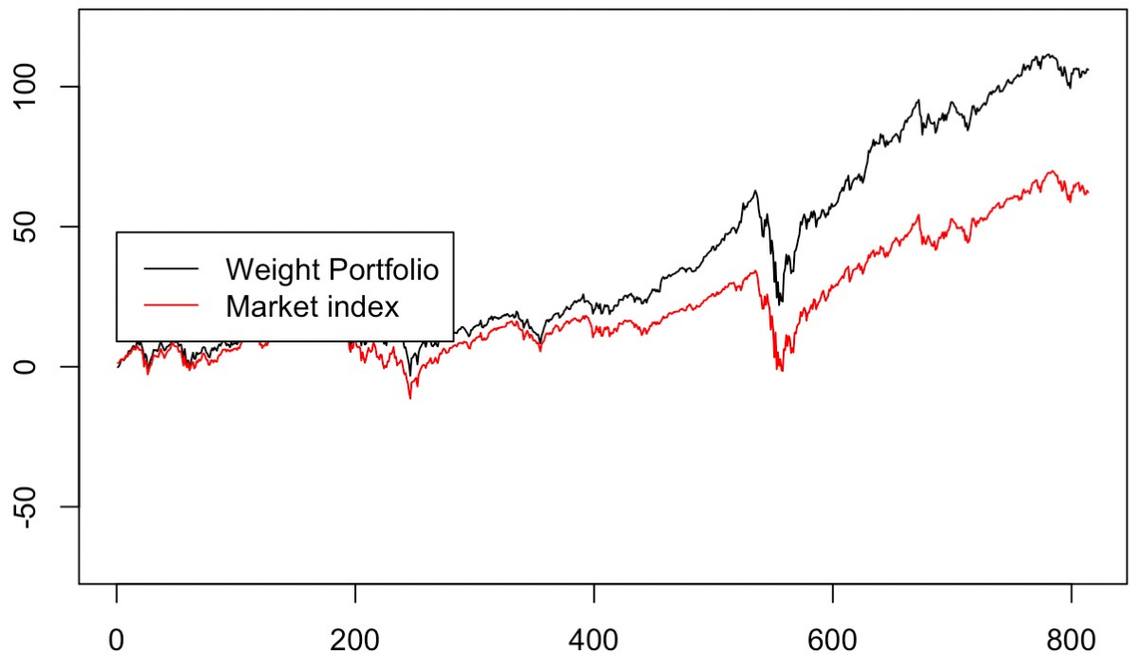
```
##
## Call:
## lm(formula = df$fundX ~ GSPC)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.4909 -0.4192  0.0015  0.4034  3.7152
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.11539    0.02861   4.033 6.03e-05 ***
## GSPC         1.06839    0.01804  59.223  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
##
## Residual standard error: 0.7784 on 812 degrees of freedom
## Multiple R-squared:  0.812,  Adjusted R-squared:  0.8118
## F-statistic:  3507 on 1 and 812 DF,  p-value: < 2.2e-16
```



regression of portfolio

For IXIC

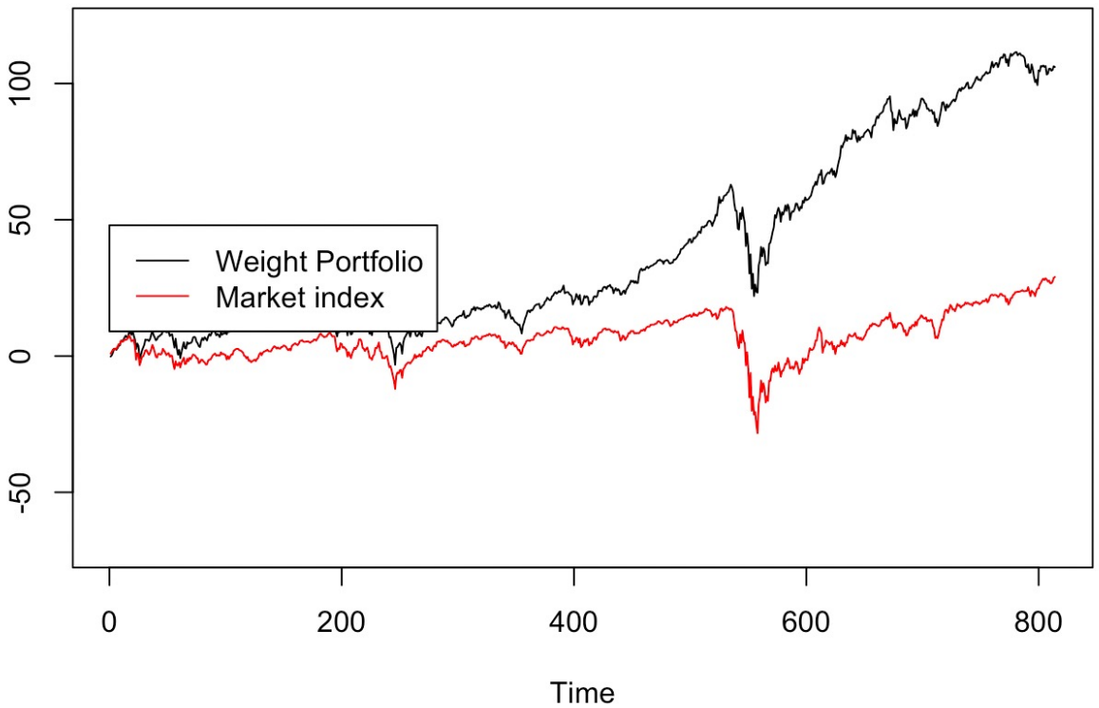
```
##
## Call:
## lm(formula = df$fundX ~ IXIC)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.3636 -0.3255 -0.0139  0.3265  3.1409
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.05889    0.02222   2.651  0.00819 **
## IXIC         1.01133    0.01287  78.572  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
##
## Residual standard error: 0.6121 on 812 degrees of freedom
## Multiple R-squared:  0.8838, Adjusted R-squared:  0.8836
## F-statistic:  6173 on 1 and 812 DF,  p-value: < 2.2e-16
```



regression of portfolio

For DJI

```
##
## Call:
## lm(formula = df$fundX ~ DJI)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.3516 -0.4884   0.0069   0.4693   5.1678
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.07335    0.03518   2.085   0.0374 *
## DJI          0.95644    0.02120  45.105   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9589 on 812 degrees of freedom
## Multiple R-squared:  0.7147, Adjusted R-squared:  0.7144
## F-statistic:  2034 on 1 and 812 DF,  p-value: < 2.2e-16
```



Fama French
Three Factor Model

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_t$$

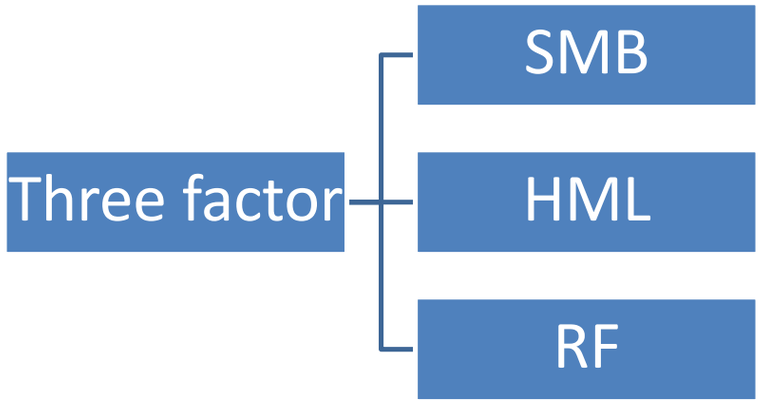
R_{it} is the total return of our portfolio at time t

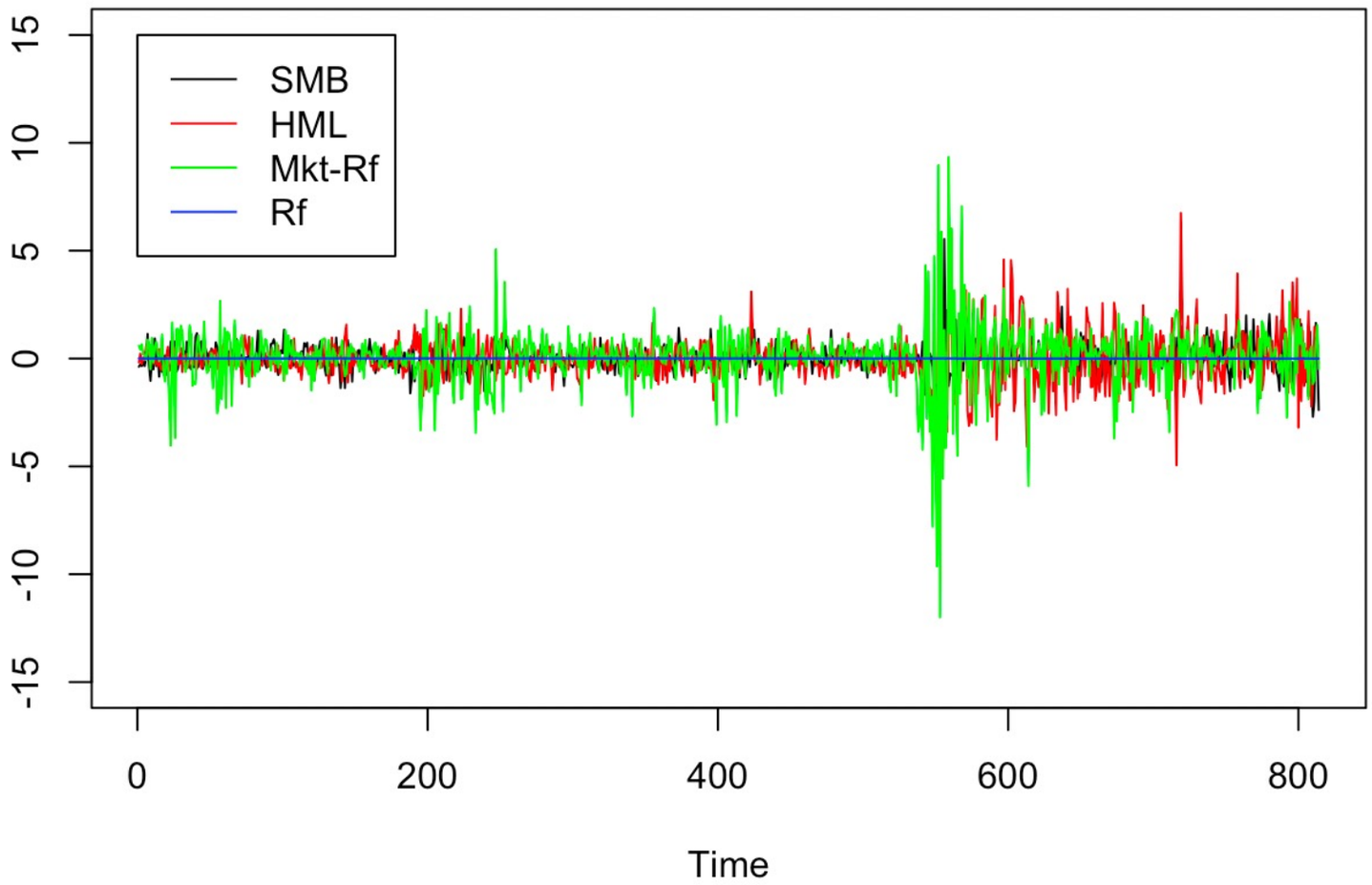
R_{ft} is the risk free rate at time t

R_{ft} is the total market portfolio return at time t

SMB_t is the size premium

HML_t is the value premium



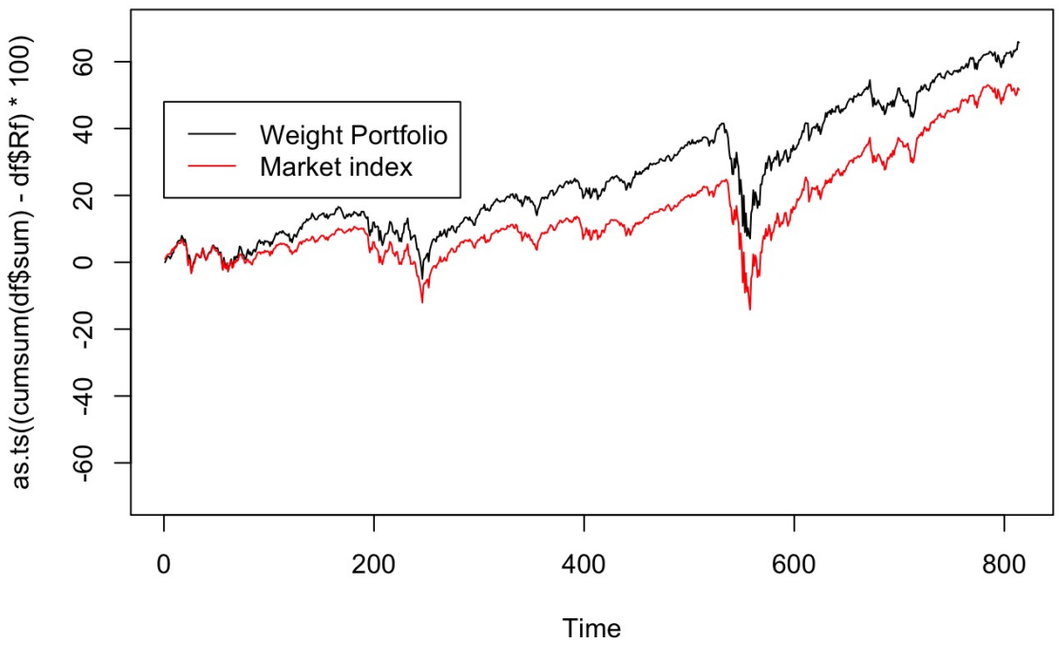

SMB
HML
Mkt-Rf
Rf
15
10
5
0
-5
-10
-15
0
200
400
600
800
Time

Compare with index

	alpha	beta	sharpe_ratio	return	risk
values	0.1143215	1.098846	1.399904	0.3883689	0.2755323

```
##
## Call:
## lm(formula = df$fundX ~ df$SMB + df$HML + GSPC)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.5642 -0.3706 -0.0155  0.3615  3.1993
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.11432    0.02516   4.543 6.39e-06 ***
## df$SMB       0.12459    0.03435   3.627 0.000304 ***
## df$HML      -0.34828    0.02251 -15.471  < 2e-16 ***
## GSPC         1.09885    0.01603  68.570  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.6842 on 810 degrees of freedom
## Multiple R-squared:  0.8551, Adjusted R-squared:  0.8546
## F-statistic:  1594 on 3 and 810 DF,  p-value: < 2.2e-16
```

Fama/French Factors from K. French



STEVENS

INSTITUTE *of* TECHNOLOGY

THE INNOVATION UNIVERSITY®

stevens.edu

Jiawei Lu, Yucan Li

FA 541

2021.12.14