MBA6693 Assignment 1

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Due 11/7/2020

Introduction

Different methods and models of pricing securities and thereby determining expected returns on capital investments has been improved and developed over the years. In the beginning, 1964, the single-factor model also known as the capital asset pricing model was developed. This single factor was beta and it was said that beta illustrated how much a stock moved compared to the market. Stocks that moved more than the market had a higher beta and thus higher risk and return (DeMuth, 2014).

In 1993, Fama and French came up with the three-factor model with its two additional factors being size and value (e.g. book to market value). The three-factor model was a significant improvement over the CAPM because it adjusted for outperformance tendency but it did not explain some anomalies nor the cross-sectional variation in expected returns particularly related to profitability and investment (ValueWalk, 2015).

The Fama-French five-factor model which added two factors, profitability and investment, came about after evidence showed that the three-factor model was an inadequate model for expected returns because it's three factors overlook a lot of the variation in average returns related to profitability and investment (Fama and French, 2015).

The file indu.csv contains historical monthly returns on the Fama-French 49 industry portfolios for the U.S. market over a 72 month period. The file 5factors.csv contains historical monthly returns on the set of factor returns for the U.S. market over the same 72 month period, as well as the risk free rate. The factors in the data set are:

- RF: The risk free rate of return for that month
- Mkt: The market return
- Mkt-RF: The market excess return for that month
- SMB: The size factor return (the return of a portfolio that is long smaller stocks and short larger stocks)
- HML: The value factor return (the return of a portfolio that is long cheaper value stocks and short more expensive stocks)
- RMW: the profitability factor (the return of a portfolio that is long robust operating profitability stock and short weak operating profitability stocks)
- CMA: the investment factor (the return of a portfolio that is long conservative investment stocks and short the aggressive investment stocks).

Before start this assignment, we need to load the required data and packages:

```r
setwd("D:/My Documents/GitHub/MBA6693")  #set working diretory
rm(list=ls()) #clear all variables out of the environment

fac <- read.csv("5factors.csv", header=TRUE) #load Fama French data
indu <- read.csv("indu.csv", header=TRUE) #load industry portfolios data

indu = indu - fac[,2] #compute the excess return
```

Models

Classic model

Transform the industry returns into excess returns and then regress each industry portfolio's return on the market excess return Mkt - RF by using single linear regression model:

$$r_I = \alpha + \beta(r_m - r_f) + \epsilon$$

In this case I will only analizing the Business Service portfolio returns. Which is the 35th column.

```
colnames(indu)[35] #show Business Service column is the 35th column
```

```
## [1] "BusSv"
```

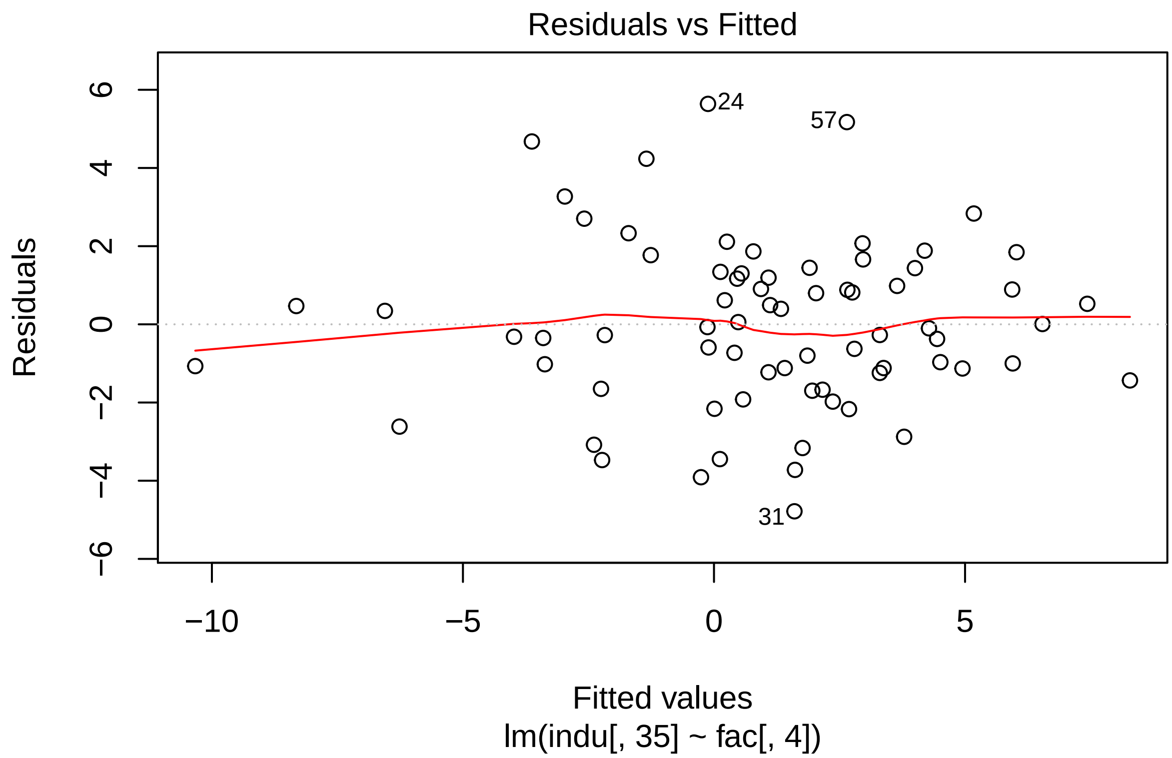
```
colnames(fac) #show factors column names
```

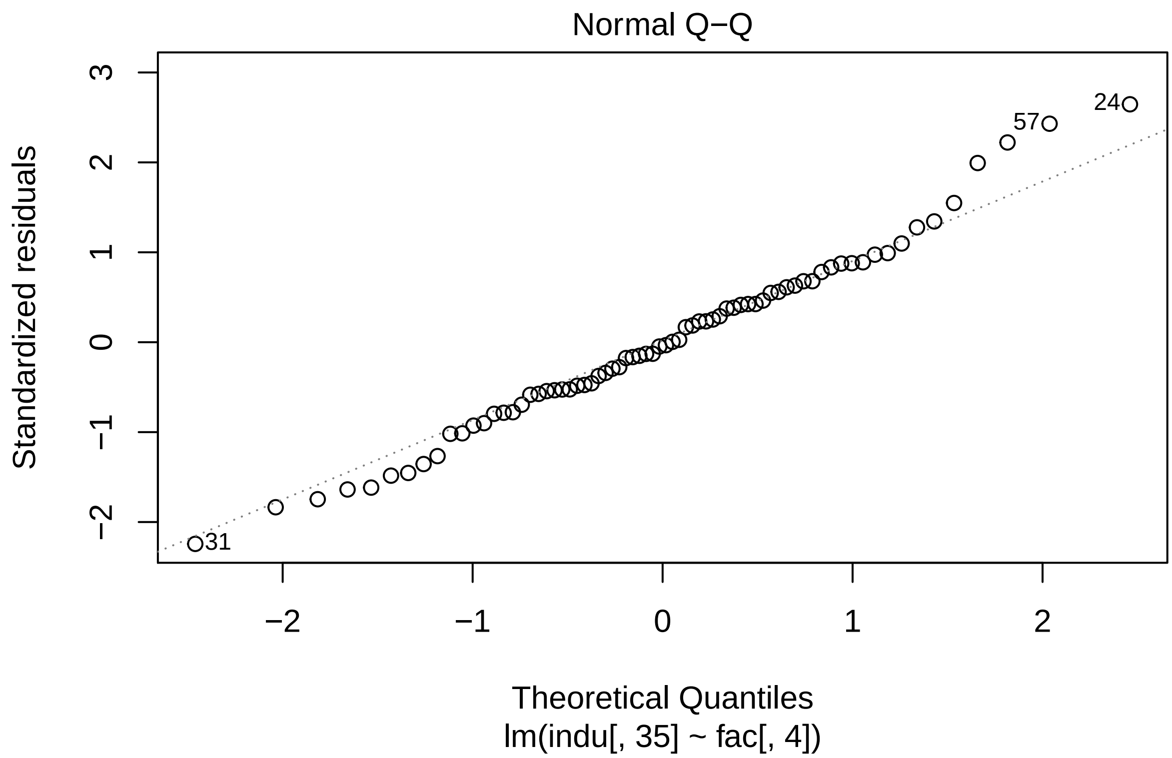
```
## [1] "Month"  "RF"     "Mkt"    "Mkt.RF" "SMB"    "HML"    "RMW"    "CMA"
```

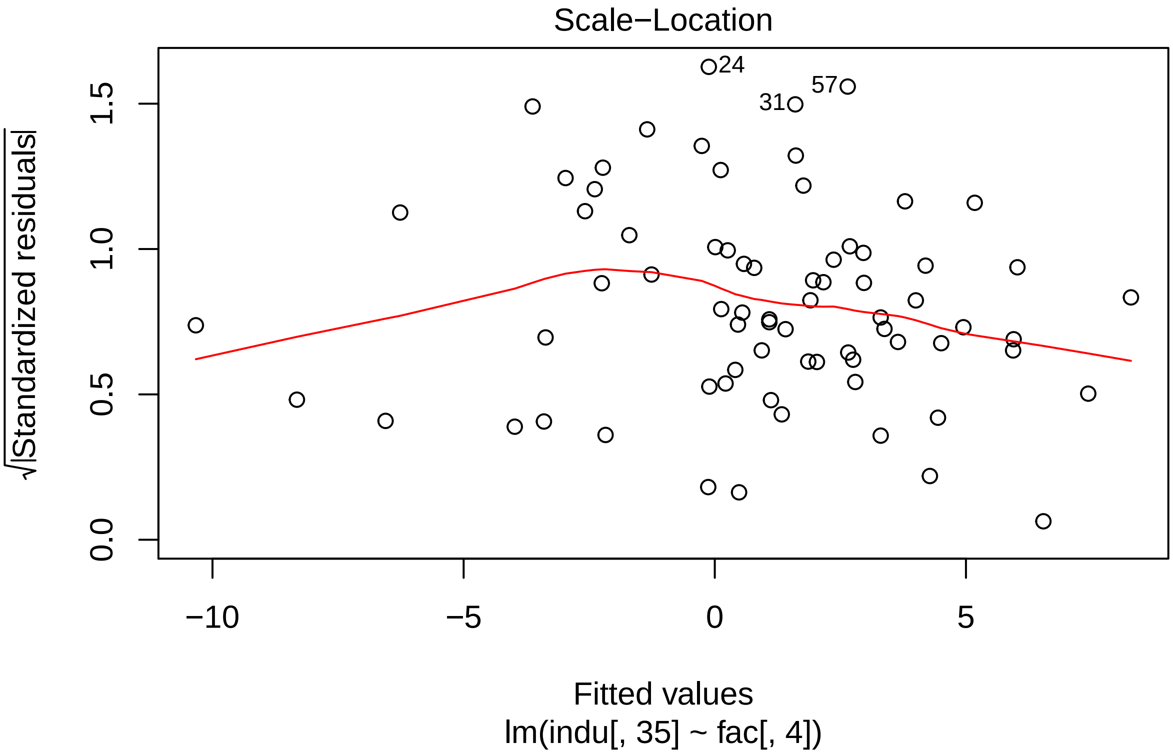
```
m1 <- lm(indu[,35] ~ fac[,4])
summary(m1)
```

```
##
## Call:
## lm(formula = indu[, 35] ~ fac[, 4])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.7824 -1.2301 -0.0859  1.3121  5.6393
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.05473    0.26449  -0.207    0.837
## fac[, 4]     1.07607    0.07892  13.635   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.148 on 70 degrees of freedom
## Multiple R-squared:  0.7265, Adjusted R-squared:  0.7226
## F-statistic: 185.9 on 1 and 70 DF,  p-value: < 2.2e-16
```

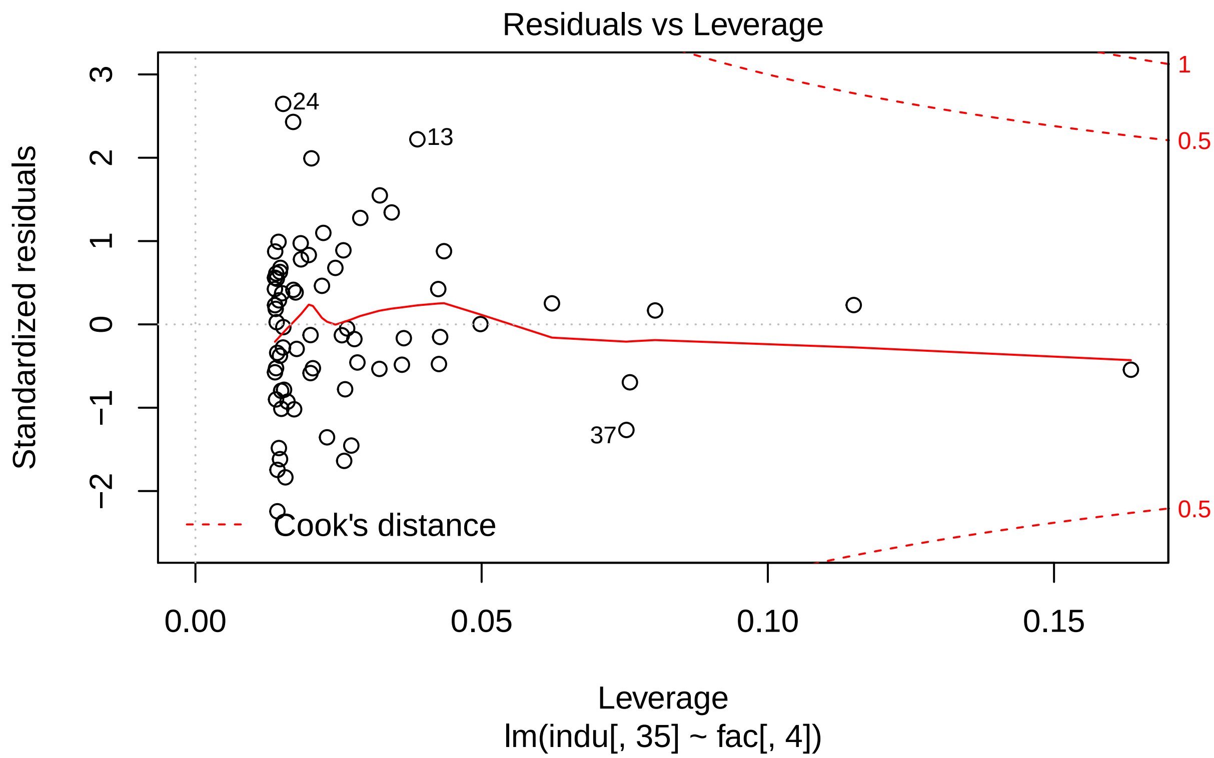
```
plot(m1)
```


Residuals vs Fitted
Residuals
Fitted values
lm(indu[, 35] ~ fac[, 4])
24
57
31
6
4
2
0
−2
−4
−6
−10
−5
0
5


Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(indu[, 35] ~ fac[, 4])
24
57
31
−2
−1
0
1
2
3



Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
−10
−5
0
5
Fitted values
lm(indu[, 35] ~ fac[, 4])
24
57
31



By using the market excess return, , the portfolio return is produced by:

$$r_I = -0.05473 + 1.07607(r_m - r_f) + \epsilon$$

Which means the portfolio returns increase by 1.08 if market excess return increase by 1.

The market excess return explains 72.26% of the variability in the portfolio returns.

Fama-French 3-factor model

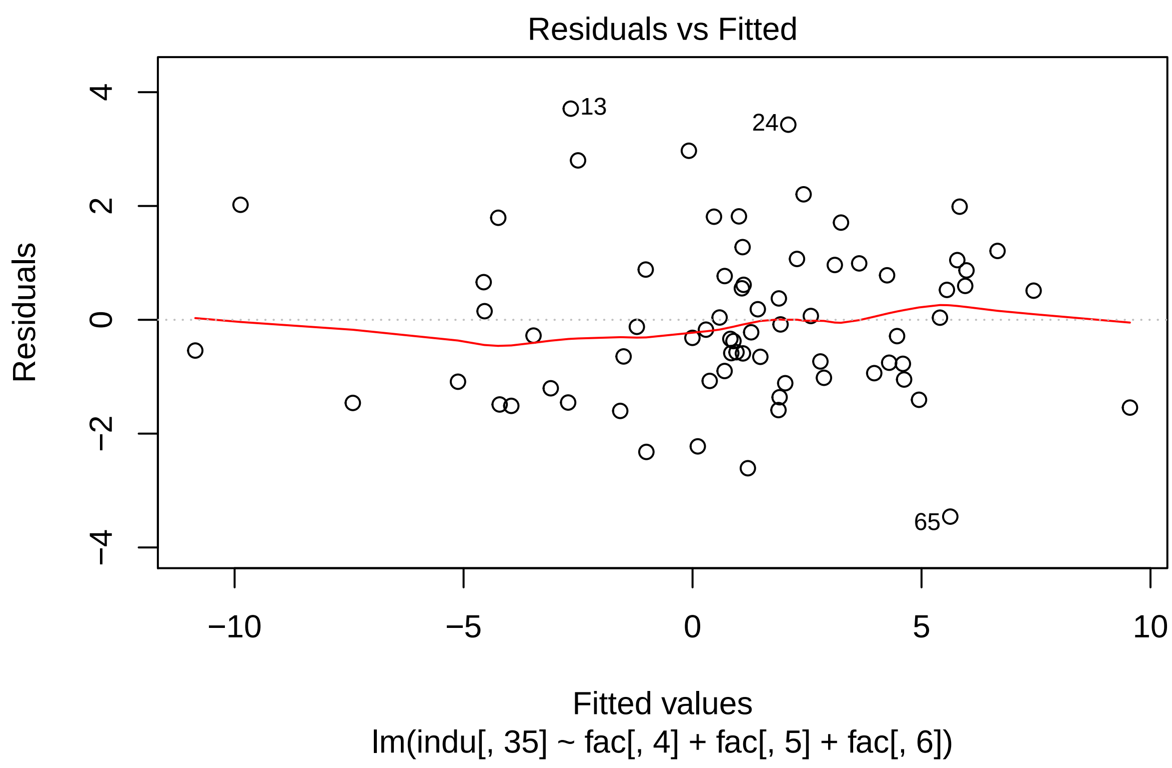
Next perform the same analysis as in before, but instead regress the industry portfolio excess returns on the three Fama French factors (Mkt-RF, SMB and HML) in a multivariate model.

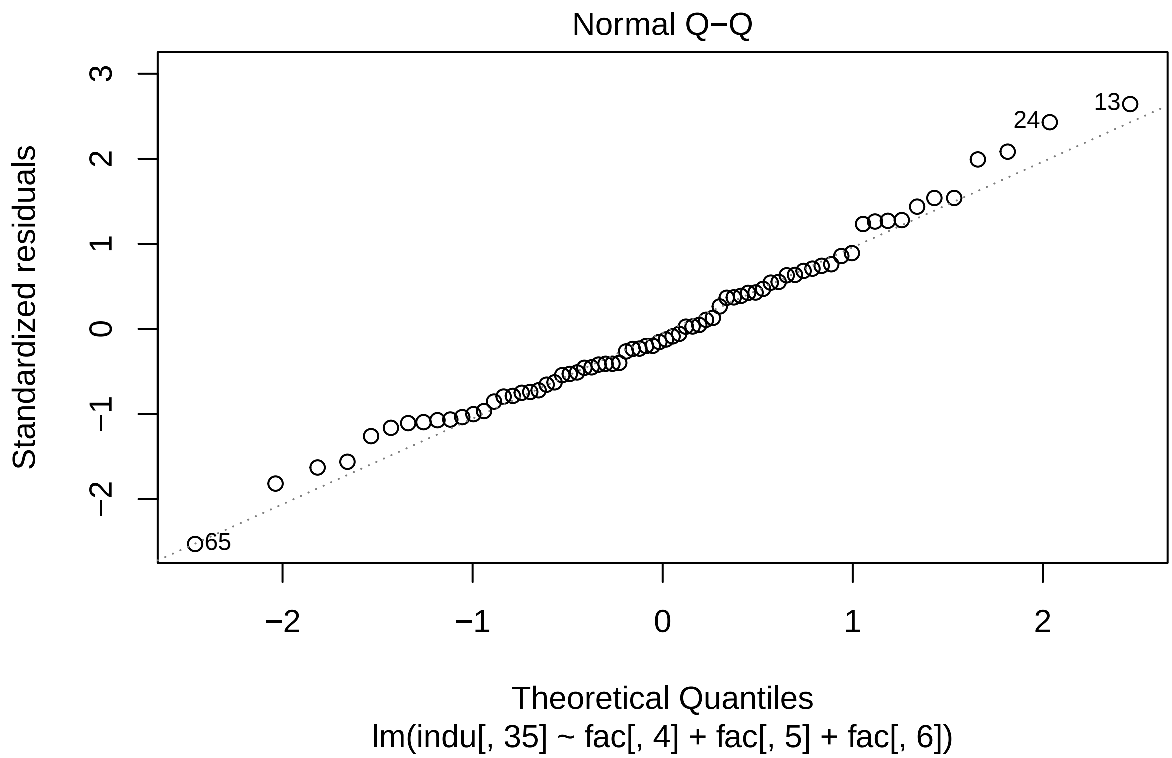
```
m2 <- lm(indu[,35] ~ fac[,4]+fac[,5]+fac[,6])
summary(m2)
```

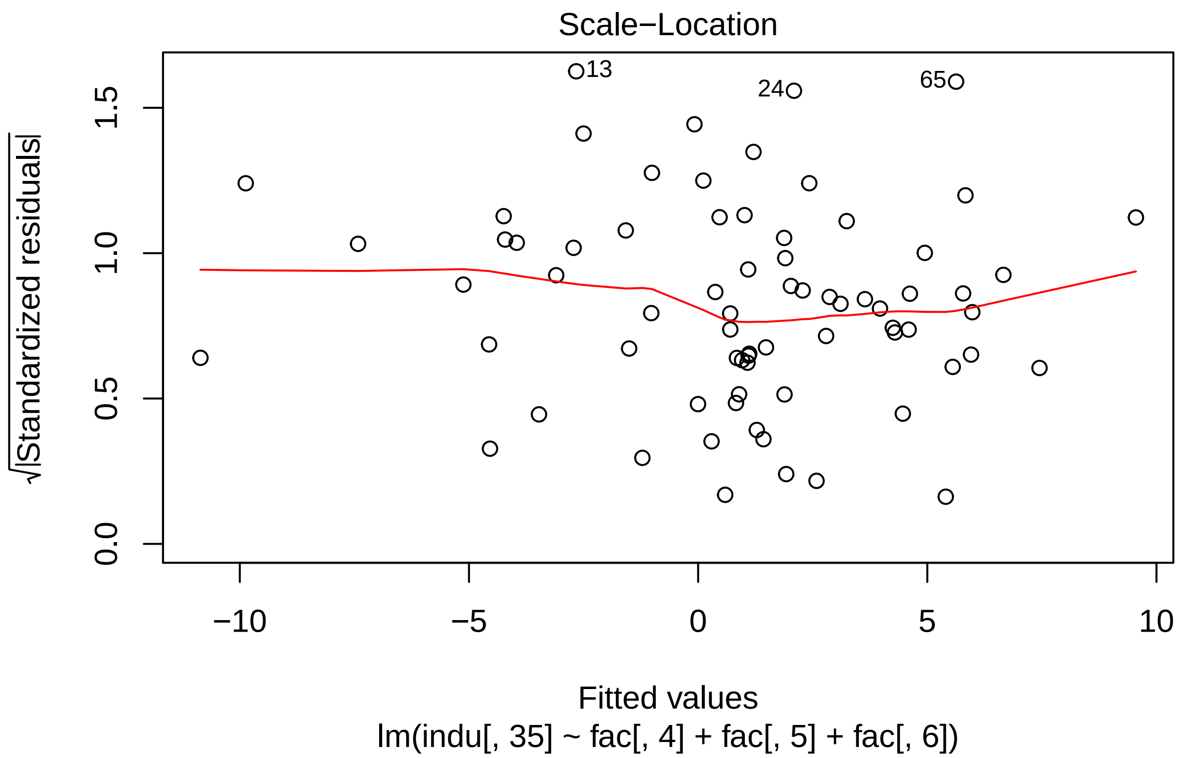
```
##
## Call:
## lm(formula = indu[, 35] ~ fac[, 4] + fac[, 5] + fac[, 6])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4580 -1.0268 -0.1963  0.8718  3.7100
```

```
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.15764    0.17989   0.876    0.384
## fac[, 4]     0.93614    0.05546  16.881  < 2e-16 ***
## fac[, 5]     0.66108    0.07329   9.020 3.11e-13 ***
## fac[, 6]     0.04137    0.07730   0.535    0.594
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.447 on 68 degrees of freedom
## Multiple R-squared:  0.8793, Adjusted R-squared:  0.874
## F-statistic: 165.1 on 3 and 68 DF,  p-value: < 2.2e-16
```

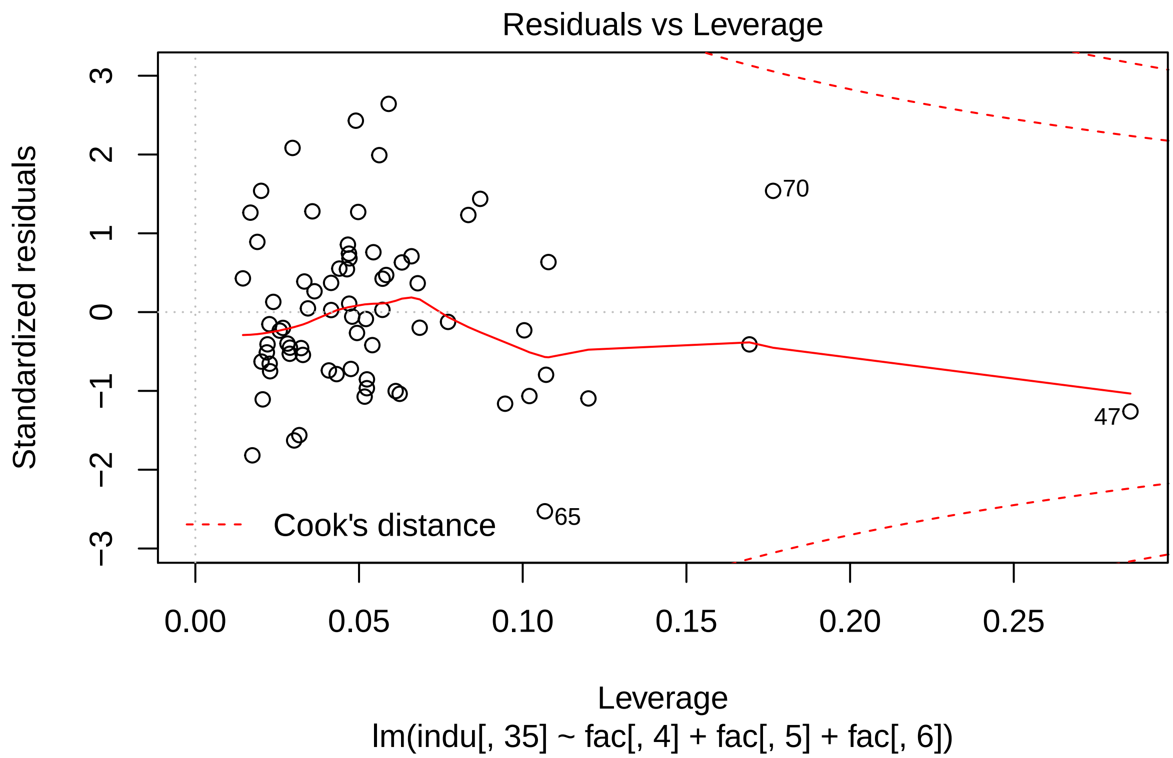
```
plot(m2)
```




Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(indu[, 35] ~ fac[, 4] + fac[, 5] + fac[, 6])
−2
−1
0
1
2
3
13
24
65



Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
13
24
65
−10
−5
0
5
10
Fitted values
lm(indu[, 35] ~ fac[, 4] + fac[, 5] + fac[, 6])



By using the market excess return, the size factor return and the value factor return, the portfolio return is produced by:

$$r_I = 0.15764 + 0.93614(r_m - r_f) + 0.66108SMB + 0.04137HML + \epsilon$$

All three factors show positive correlation with portfolio returns, the portfolio rtn increases by 0.94, 0.66, 0.04 if market excess return, size factor and value factor increases by 1.

```
summary(m2)$adj.r.squared
```

```
## [1] 0.8739841
```

The market excess return,the size factor return and the value factor return explains 87.398% of the variability in the portfolio returns.

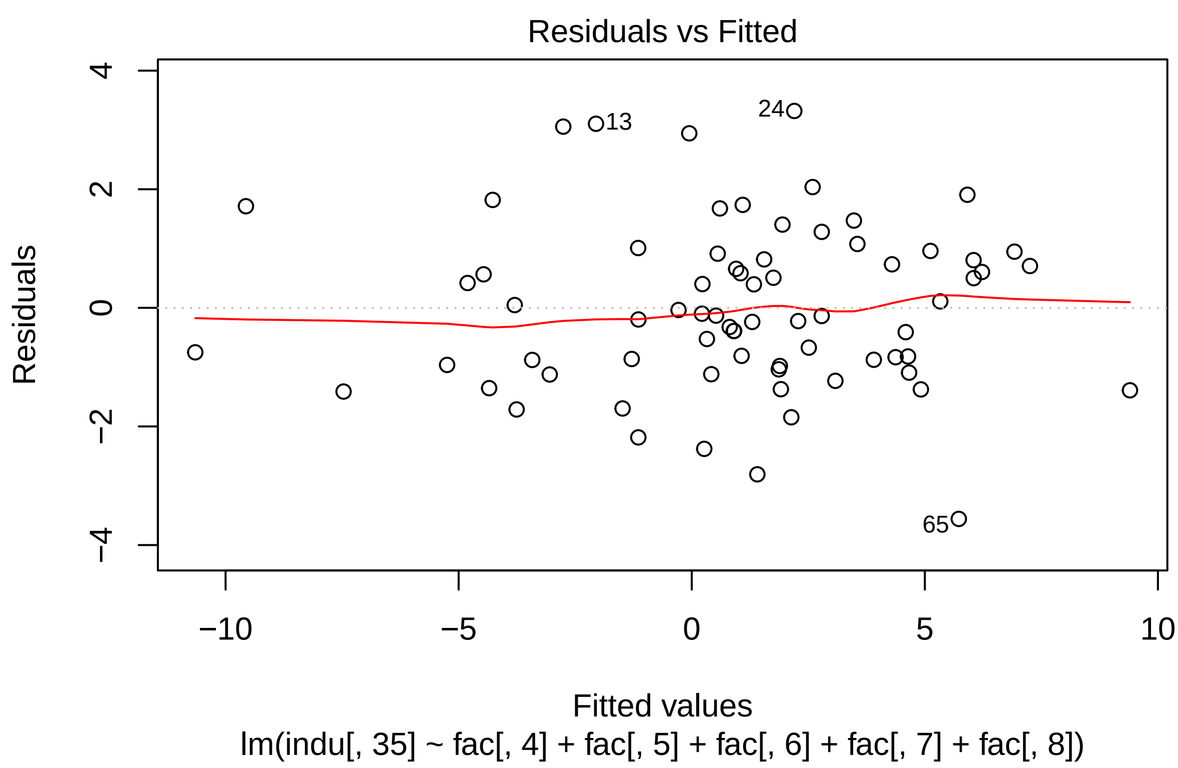
Fama-French 5-factor model

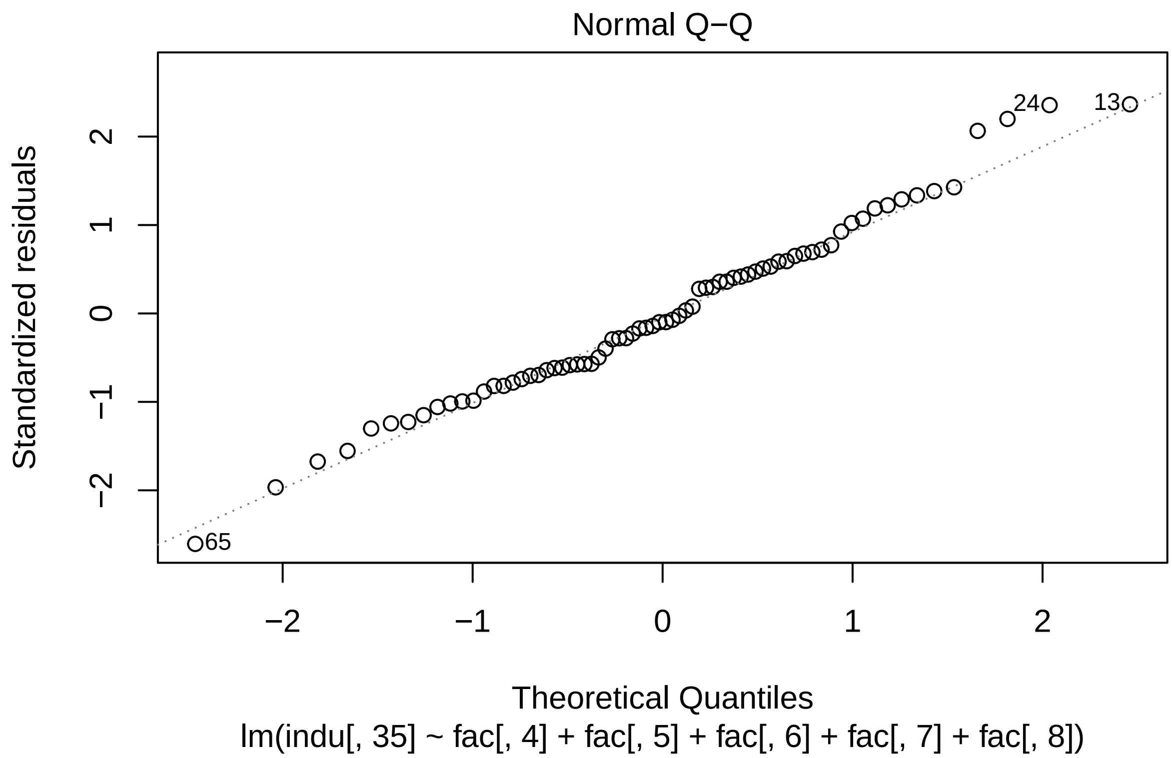
Perform the same analysis as in before, but instead regress the industry portfolio excess returns on the five Fama French factors (Mkt.RF, SMB, HML, RMW and CMA) in a multivariate model.

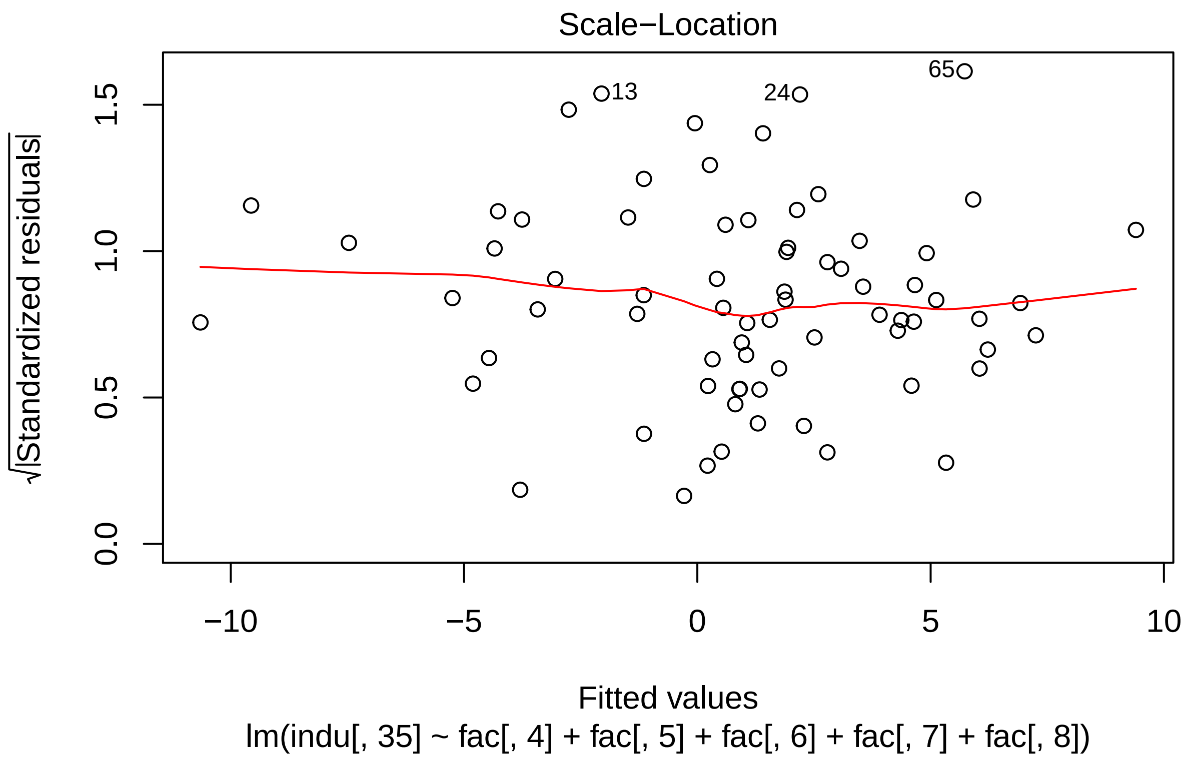
```
m3 <- lm(indu[,35] ~ fac[,4]+fac[,5]+fac[,6]+fac[,7]+fac[,8])
summary(m3)
```

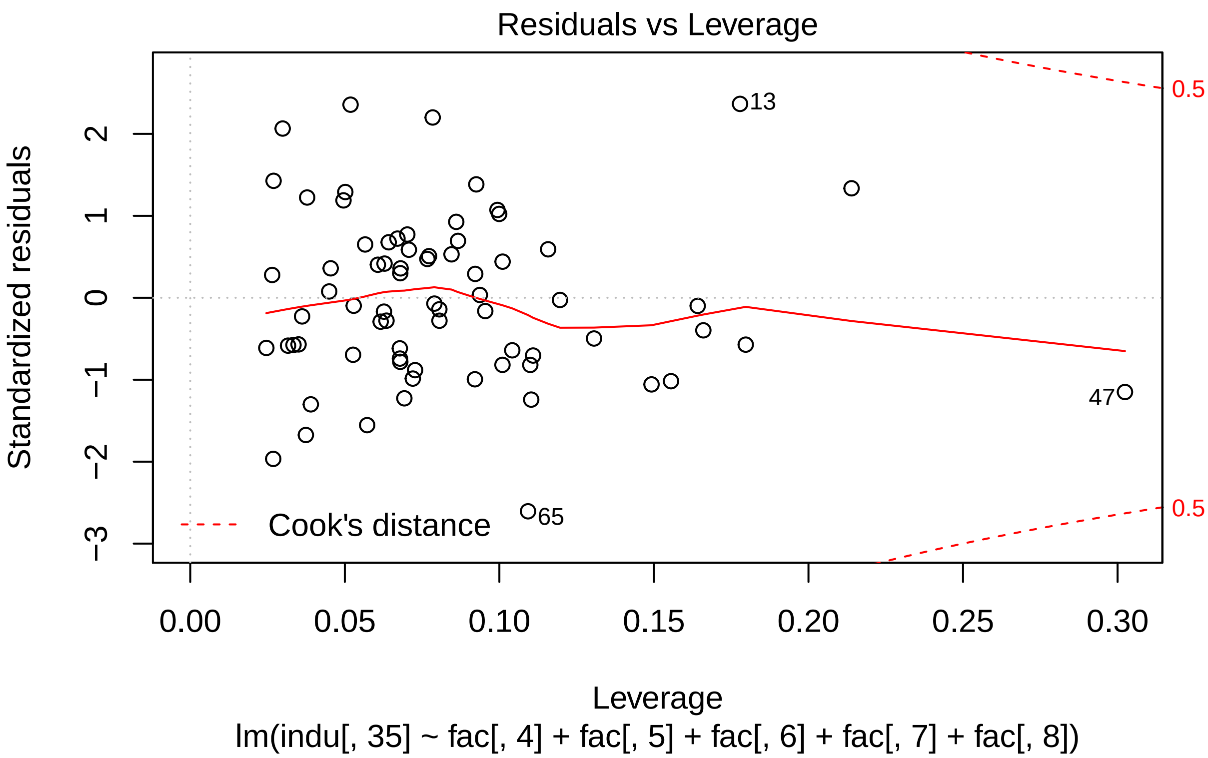
```
##
## Call:
## lm(formula = indu[, 35] ~ fac[, 4] + fac[, 5] + fac[, 6] + fac[,
##     7] + fac[, 8])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.5590 -0.9668 -0.1344  0.8414  3.3200
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.172854   0.180197   0.959    0.341
## fac[, 4]     0.941237   0.056014  16.804  < 2e-16 ***
## fac[, 5]     0.612116   0.082886   7.385 3.33e-10 ***
## fac[, 6]     0.005922   0.102519   0.058    0.954
## fac[, 7]    -0.180305   0.134808  -1.337    0.186
## fac[, 8]     0.112817   0.161616   0.698    0.488
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.447 on 66 degrees of freedom
## Multiple R-squared:  0.8829, Adjusted R-squared:  0.874
## F-statistic: 99.51 on 5 and 66 DF,  p-value: < 2.2e-16
```

```
plot(m3)
```




Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(indu[, 35] ~ fac[, 4] + fac[, 5] + fac[, 6] + fac[, 7] + fac[, 8])
24
13
65
−2
−1
0
1
2


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
−10
−5
0
5
10
13
24
65
Fitted values
lm(indu[, 35] ~ fac[, 4] + fac[, 5] + fac[, 6] + fac[, 7] + fac[, 8])



By using all Fama French factors, the portfolio return is produced by:

$$r_I = 0.172854 + 0.941237(r_m - r_f) + 0.612116SMB + 0.005922HML - 0.180305RMW + 0.112817CMA + \epsilon$$

Only the profitability factor shows negative correlation with the portfolio return, the portfolio returns decreases by 0.18 if the profitability factor increases by 1. the rest factors are positively correlated with the portfolio return,it increases by 0.94, 0.61, 0.01 and 0.11 if market excess return, size factor, value factor and investment factor increases by 1.

```r
summary(m3)$adj.r.squared
```

```
## [1] 0.8740128
```

All 5 factors explains 87.401% of the variability in the portfolio returns.

Conclusion

The five-factor model has yet to be proven as an improvement compared to previous models however it has left room for better models to be further developed from it in the future. Most investors still use the famous three-factor model but as methods seem to take some years before people start using, as industry personnel always have doubts. Looking at the practical work done and shown by Fama and French it seems it would be in the best interests for investors to use the other factor models until this method proves its self in the empirical evidence (Musarurwa, 2019).

By adding more factors In this small example, the R-Squared slightly increases, we clearly can say 5-factor model is better than 3- and 1-factor.

I would choose 5-factor models to explain the cross-section of excess returns of Business Service industry portfolios, the R-sq is slightly better than 3-factor model. Also by compareing all three models the third's residuals vs fitted plot is better, it better fitted the data. The normal QQ plot also shows the third are better fit as normal. The size of the standardized residuals is more consistent in the third model.