CAMP vs Fama French 3-Factor

Manuela Lozano

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Contents

1 Introduction

This report will thoroughly examine the relationship between the returns of prominent tech companies such as Eventbrite (EB), BlackLine Inc. (BL), Microchip Technology Incorporated (MCHP), Forge Global Holdings (FRGE), Align Technology (ALGN), and Zoom Video Communications (ZM) in relation to the NASDAQ index. This analysis will be meticulously conducted using two widely recognized models in finance: the Capital Asset Pricing Model (CAPM) and the Fama French 3-Factor model. These models will form the basis for a comprehensive regression analysis aimed at shedding light on the complex interplay of factors that influence stock returns. The objective of this report is to understand how the Capital Asset Pricing model and the Fama French Three Factor model work. Ultimately, the analysis will help us determine whether having different factors impacts the expected returns of the assets and how it does this.

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2 Background Informaiton

The Capital Asset Pricing Model (CAPM) and the Fama-French Three-Factor model are indispensable frameworks for assessing the risk and return of assets in investment analysis.

The first model that is going to be presented in this report is the CAPM. The Capital Asset Pricing Model (CAPM) serves as a fundamental tool for evaluating the relationship between expected returns and the associated risk of assets. It postulates that investors should be compensated for the level of risk they undertake when investing in a particular asset.

Its formula can be expressed as:

E(Ri) = Rf + B1(E(Rm) - Rf) where it estimates the expected returns [E(Ri)] of an asset.

- Rf: represents risk-free rate of interest, typically given by government bonds
- B1: denotes assets' sensitivity to the markets movement
- E(Rm): expected returns on the market
- E(Rm) - Rf: market risk premium, representing the excess returns investors demand for bearing market risk

CAPM estimates expected returns by factoring in both the risk-free rate and the market risk premium, with the asset's beta indicating its sensitivity to market movements. A beta of 1 signifies market-like risk, while deviations indicate higher or lower volatility. Investors can employ CAPM to construct portfolios that balance risk and return by incorporating assets with different betas, thus optimizing their investment strategies.

On the other hand, the Fama-French Three-Factor model extends the CAPM framework by incorporating additional factors to better assess asset returns. This model considers market risk alongside size and value factors, aiming to capture a more comprehensive understanding of stock returns.

Fama French's 3 Factor model formula expands on CAPM by integrating 2 additional factors into the equation:

E(Ri) = Rf + B1(E(Rm) - Rf) + B2(SMB) + B3(HML)

- SMB (size factor): The size factor accounts for the historical out performance of small-cap companies relative to large-cap counterparts.
- B2: indicates the degree to which the asset's align with SMB
- HML (value factor): The value factor captures the historical out performance of high book-to-market value companies versus low book-to-market companies.
- B3: illustrates the extend to which the asset's returns align with HML

By analyzing these three factors, the Fama-French model provides insights into the risk-return dynamics of assets, allowing investors to make more informed decisions in portfolio management and risk assessment.

These formulas, variables, and coefficients enable investors to gauge the risk and return profiles of assets comprehensively. CAPM focuses on market risk and beta, while the Fama-French model incorporates size and value factors alongside market risk. By considering these factors, investors can refine their portfolio allocation strategies, better manage risk, and make more informed investment decisions.

3 About the Data

```
##      Date       EB.SH.      BL..MH.    MCHP..BH.    FRGE..SL.    ALGN..ML.
## 1  3/9/21  0.062805078  0.060368611  0.061763206 -0.004996157  0.039154111
## 2 3/10/21  0.001262860  0.037377755 -0.028924072  0.005962235 -0.007990191
## 3 3/11/21  0.072156859  0.006675182  0.047653320 -0.000949693  0.061084652
## 4 3/12/21 -0.004894015 -0.019123320 -0.005141072  0.003992021 -0.013994523
## 5 3/15/21  0.053673079  0.007537957  0.014158546 -0.000049800  0.040876527
## 6 3/16/21 -0.041986537 -0.012520880  0.002220795 -0.003042572 -0.029669334
##   ZM..BL.  NASDAQ     SMB    HML
## 1  0.0956  0.0362 -0.0787 0.0184
## 2 -0.0180 -0.0004  0.0524 0.0099
## 3  0.0554  0.0249 -0.0479 0.0036
## 4 -0.0250 -0.0059  0.0507 0.0020
## 5  0.0103  0.0104 -0.0127 0.0081
## 6 -0.0436  0.0009  0.0475 0.0080
```

3.1 Description of Variables and Data

1. **Risk-Free Rate (SGOV)**: Used as a benchmark for comparing investment returns, particularly for low-risk investments.
2. **Excess Returns of Stocks**: Calculated by subtracting the risk-free rate from the compound daily return of each stock.
3. **High Book-to-Market and Low Book-to-Market Stocks**
    - High Book-to-Market: EB, BL, MCHP
    - Low Book-to-Market: FRGE, ALGN, ZM
4. **NASDAQ Premium**: Reflects the market premium of the NASDAQ index, which includes many tech and growth-oriented companies similar to those in your data set.
5. **SMB (Small Minus Big Factor)**: Describes the difference in returns between small-cap and big-cap companies. This factor was calculated the following way:

- Calculate excess returns for each company
- Calculate the average between small-cap companies (S)
- Calculate the average between big-cap companies (B)
- Calculate the difference between S - B to get SMB

6. **HML (High Minus Low Factor)**: Describes the difference in returns between high book-to-market and low book-to-market companies. This factor was calculated the following way:

- Calculate excess returns for each company
- Calculate the average between high book-to-market companies (H)
- Calculate the average between low book-to-market companies (L)
- Calculate the difference between H - L to get HML

4 Creating Regressions

4.1 CAPM

```
EB_model <- lm(data$EB.SH. ~ data$NASDAQ)

BL_model <- lm(data$BL..MH. ~ data$NASDAQ)

MCHP_model <- lm(data$MCHP..BH. ~ data$NASDAQ)

FRGE_model <- lm(data$FRGE..SL. ~ data$NASDAQ)

ALGN_model <- lm(data$ALGN..ML. ~ data$NASDAQ)

ZM_model <- lm(data$ZM..BL. ~ data$NASDAQ)
```

I created 6 individual linear regressions all regressed against NASDAQ:

- EB_model
- BL_model
- MCHP_model
- FRGE_model
- ALGN_model
- ZM_model

4.2 FAMA-FRENCH 3 FACTOR

```
EB_FF3 <- lm(data$EB.SH. ~ data$NASDAQ + data$SMB + data$HML)

BL_FF3 <- lm(data$BL..MH. ~ data$NASDAQ + data$SMB + data$HML)

MCHP_FF3 <- lm(data$MCHP..BH. ~ data$NASDAQ + data$SMB + data$HML)

FRGE_FF3 <- lm(data$FRGE..SL. ~ data$NASDAQ + data$SMB + data$HML)

ALGN_FF3 <- lm(data$ALGN..ML. ~ data$NASDAQ + data$SMB + data$HML)

ZM_FF3 <- lm(data$ZM..BL. ~ data$NASDAQ + data$SMB + data$HML)
```

As well, I did the same for Fama-French 3, creating 6 individual regressions, regressing each stock against Nasdaq, Small Minus Big Factor, and High Minus Low Factor

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5 Analyses

5.1 *Eventbrite (EB)*

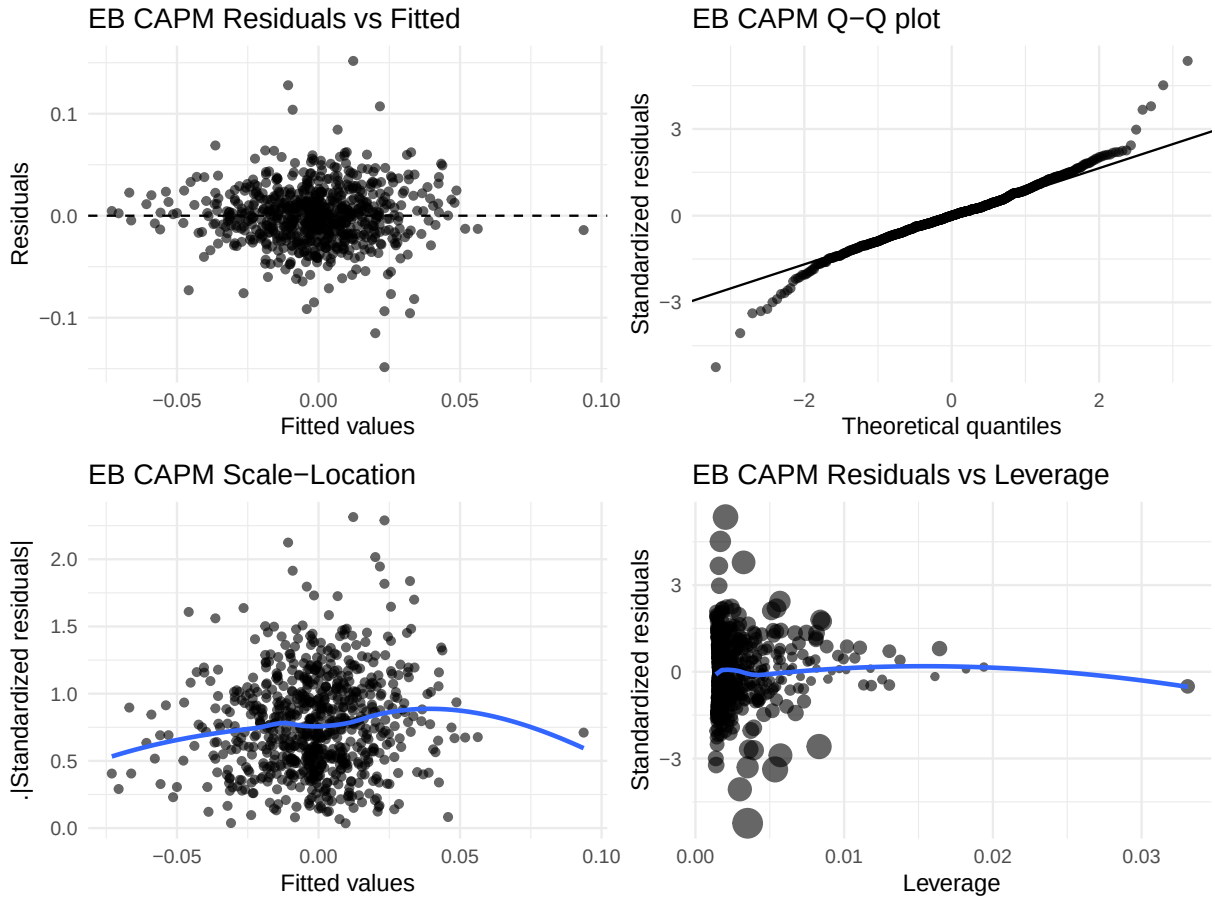
- Sector: Technology
- Industry: Software-Application
- Description: Eventbrite, Inc. is a two-sided marketplace facilitating self-service ticketing and marketing tools for event creators globally. Based in San Francisco, California, the company streamlines event planning, promotion, and production processes, enabling creators to reduce costs, increase reach, and drive ticket sales efficiently. Established in 2008 as Mollyguard Corporation, it rebranded as Eventbrite, Inc. in 2009.

```
## [1] 0.5718219
```

```
## [1] -0.2370674
```

```
## [1] 0.2784563
```

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$EB.SH. ~ data$NASDAQ)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.148455 -0.016479 -0.000002  0.015336  0.151785
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.001723   0.001050   -1.64    0.101
## data$NASDAQ  1.345491   0.071543   18.81   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02838 on 728 degrees of freedom
## Multiple R-squared:  0.327,  Adjusted R-squared:  0.3261
```

```
## F-statistic: 353.7 on 1 and 728 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$EB.SH.
##               Df Sum Sq  Mean Sq F value    Pr(>F)
## data$NASDAQ    1 0.2848 0.284801  353.69 < 2.2e-16 ***
## Residuals    728 0.5862 0.000805
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

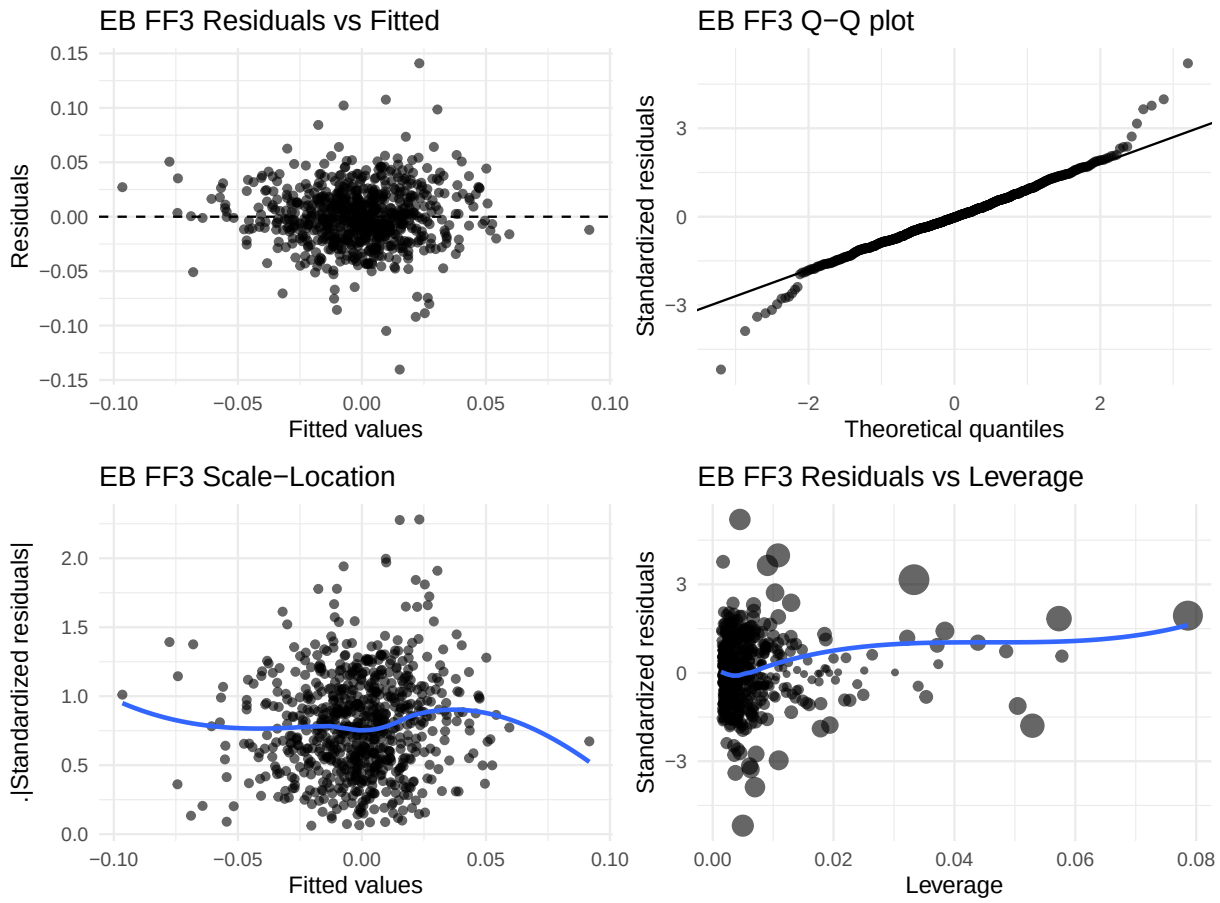
5.1.0.1 *CAPM*

- ALPHA = -0.002 (p-value = 0.0152)
- B1 = 1.35 (p-value = <2e-16)
- R2ADJ = 33%

Diagnostic Tests:

- Residuals vs. Fitted: as can be seen from the graph, there is a random scatter around the horizontal line, which indicates a good fit, thus affirming that it has a linear pattern.
- Q-Q plot: In general, this plot shows that the residuals do follow a normal trend, however, it has a small deviation along the points of the plot.
- Scale-Location: based on the plot above, we can see that it confirms the homoscedasticity assumption since the residuals have a random variation and the line is fairly flat.
- Residuals vs. Leverage: as the graph shows, there are some influential points in the data (548, 352, 499)

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$EB.SH. ~ data$NASDAQ + data$SMB + data$HML)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.140400 -0.016395 -0.000644  0.016369  0.140905
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.002062   0.001006  -2.051   0.0407 *
## data$NASDAQ  1.318721   0.077804  16.949  < 2e-16 ***
## data$SMB     0.005954   0.023414   0.254   0.7994
## data$HML     0.296242   0.035799   8.275 6.14e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02714 on 726 degrees of freedom
## Multiple R-squared:  0.386,  Adjusted R-squared:  0.3835
## F-statistic: 152.1 on 3 and 726 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$EB.SH.
```

```
##               Df  Sum Sq  Mean Sq  F value    Pr(>F)
## data$NASDAQ    1 0.28480 0.284801 386.6375 < 2.2e-16 ***
## data$SMB       1 0.00098 0.000983   1.3347    0.2483
## data$HML       1 0.05044 0.050440  68.4766 6.138e-16 ***
## Residuals    726 0.53478 0.000737
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.1.1 *FF3*

- ALPHA = -0.0021 (p-value = 0.0407)
- B1 = 1.319 (p-value = <2e-16)
- B2 = 0.006 (p-value = 0.7994) Insignificant
- B3 = 0.296 (p-value = <2e-16)
- R2ADJ = 73%

Diagnostic Tests:

- Residuals vs. Fitted: by adding the other factors, we can see how it affects the mean of the model, creating a small curve at the left end, affecting the linearity aspect of this regression.
- Q-Q plot: this plot expressed the normality of the residuals. As it is shown, most of the residuals follow a normal trend, however, it creates a small deviation around the endpoints.
- Scale-Location: On the other hand, the homoscedasticity is highly affected by the additional factors. The residuals do not have a constant variance, since it forms a cluster and the line is completely curved.
- Residuals vs. Leverage: As well, this plot shows that there are points that have a great weight on the model, and we can clearly identify the outliers (291, 263, 269)

5.2 *BlackLine Inc. (BL)*

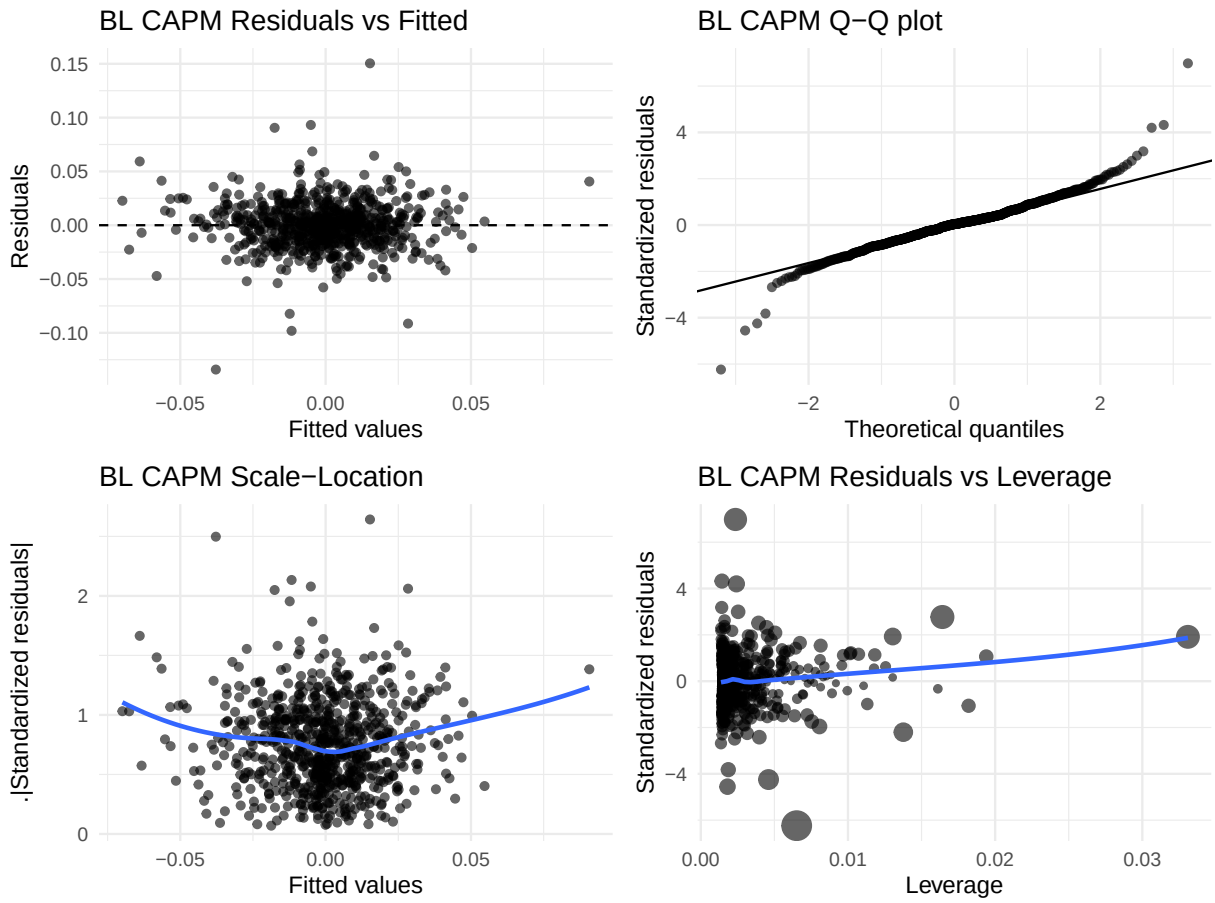
- Sector: Technology
- Industry: Software - Application
- Description: BlackLine, Inc. offers cloud-based solutions worldwide to automate and streamline accounting and finance operations, including financial close management, journal entry, variance analysis, and compliance. Headquartered in Woodland Hills, California, the company serves multinational corporations, large domestic enterprises, and mid-market companies across diverse industries through its direct sales force.

```
## [1] 0.6620235
```

```
## [1] -0.3401765
```

```
## [1] 0.1536152
```

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$BL..MH. ~ data$NASDAQ)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.13414 -0.01248  0.00095  0.01076  0.15044
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0012011  0.0007986  -1.504    0.133
## data$NASDAQ  1.2963823  0.0543946  23.833   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02157 on 728 degrees of freedom
## Multiple R-squared:  0.4383, Adjusted R-squared:  0.4375
## F-statistic:   568 on 1 and 728 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$BL..MH.
##              Df  Sum Sq  Mean Sq F value    Pr(>F)
## data$NASDAQ   1 0.26439 0.264390  568.01 < 2.2e-16 ***
```

```
## Residuals   728 0.33886 0.000465
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.2.1 *CAPM*

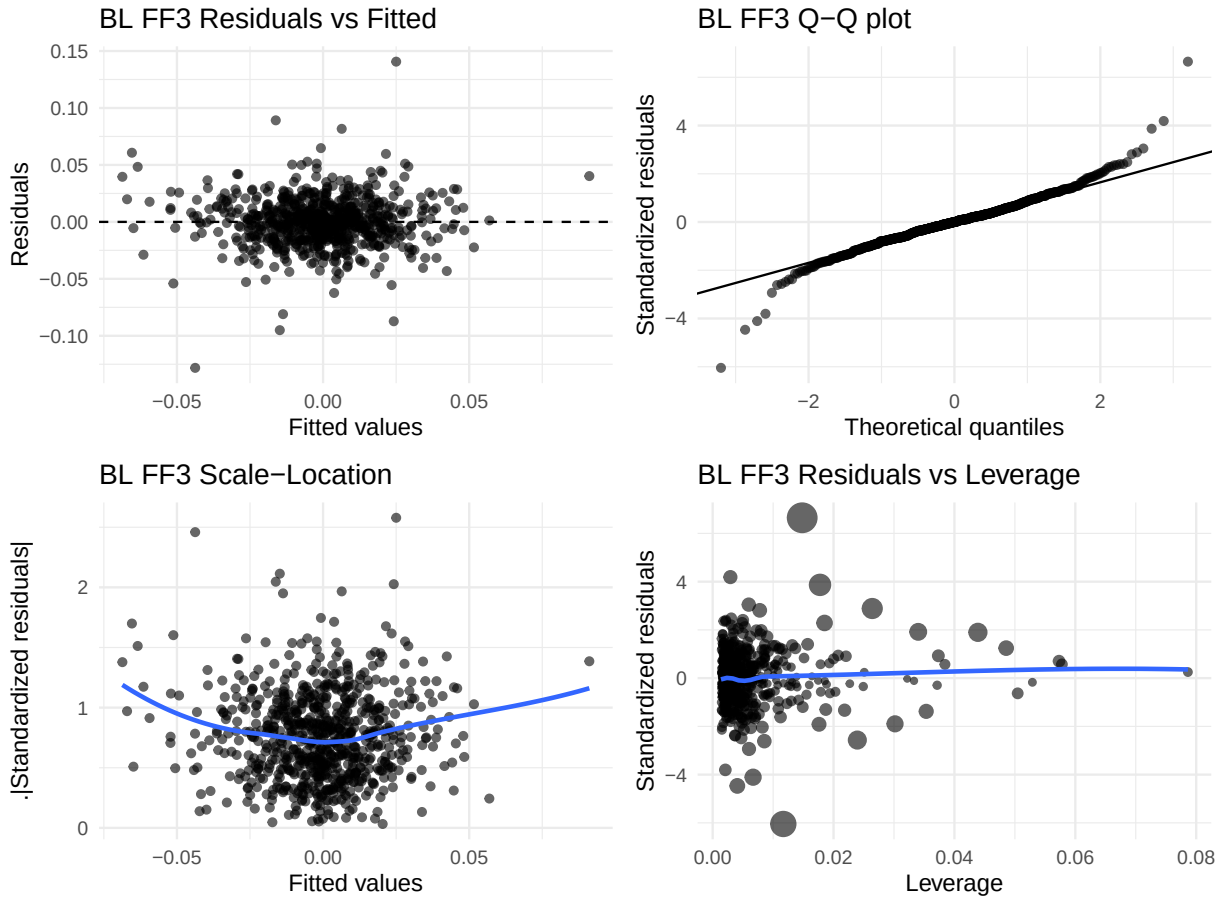
- ALPHA = -0.0012 (p-value = 0.133) Insignificant
- B1 = 1.30 (p-value = <2e-16)
- R2ADJ = 44%

Diagnostic Tests

- Residuals VS Fitted: verifies linearity since there is no apparent pattern, and there is a random scatter along the horizontal line. As well, we can see how the line is fairly flat, indicating a linear trend between these variables.

- Q-Q Plot: verifies normality since it follows trend along the diagonal line, however, there is a small drift along the ends of the plot
- Scale-Location: confirms homoscedasticity since there is variability between the residuals and the line if almost flat
- Residuals VS Leverage: 3 influential points (237, 303, 425)

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
```

```
## Call:
## lm(formula = data$BL..MH. ~ data$NASDAQ + data$SMB + data$HML)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.128139 -0.012457  0.000034  0.011482  0.140685
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0013531  0.0007898  -1.713   0.0871 .
## data$NASDAQ  1.2322145  0.0611100  20.164  < 2e-16 ***
## data$SMB    -0.0320206  0.0183899  -1.741   0.0821 .
## data$HML     0.1194392  0.0281179   4.248 2.44e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02132 on 726 degrees of freedom
## Multiple R-squared:  0.4531, Adjusted R-squared:  0.4509
## F-statistic: 200.5 on 3 and 726 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$BL..MH.
##              Df  Sum Sq  Mean Sq  F value    Pr(>F)
## data$NASDAQ   1 0.26439 0.264390 581.8238 < 2.2e-16 ***
## data$SMB      1 0.00076 0.000756   1.6633    0.1976
## data$HML      1 0.00820 0.008199  18.0437  2.44e-05 ***
## Residuals   726 0.32991 0.000454
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.2.2 *FF3*

- ALPHA = -0.00089 (p-value = 0.0871) Insignificant
- B1 = 1.23 (p-value = <2e-16)
- B2 = -0.032 (0.0821) Insignificant
- B3 = 0.119 (p-value = <2e-16)
- R2ADJ = 45%

Diagnostic Tests

- Residuals VS Fitted: verifies linearity assumption since the residuals are scattered randomly, however, the line shows a slight curvature at both ends, which can be cause for further analysis

- Q-Q Plot: confirms normality of residuals since most of them fall along the diagonal line, however we can see how the tails slight drift along both ends of the line
- Scale-Location: fails homoscedasticity since there is a clear bend on the line, and the residuals form a cluster
- Residuals VS Leverage: 3 significant points (421, 237, 305)

5.3 *Microchip Technology Incorporated (MCHP)*

- Sector: Technology
- Industry: Semiconductors

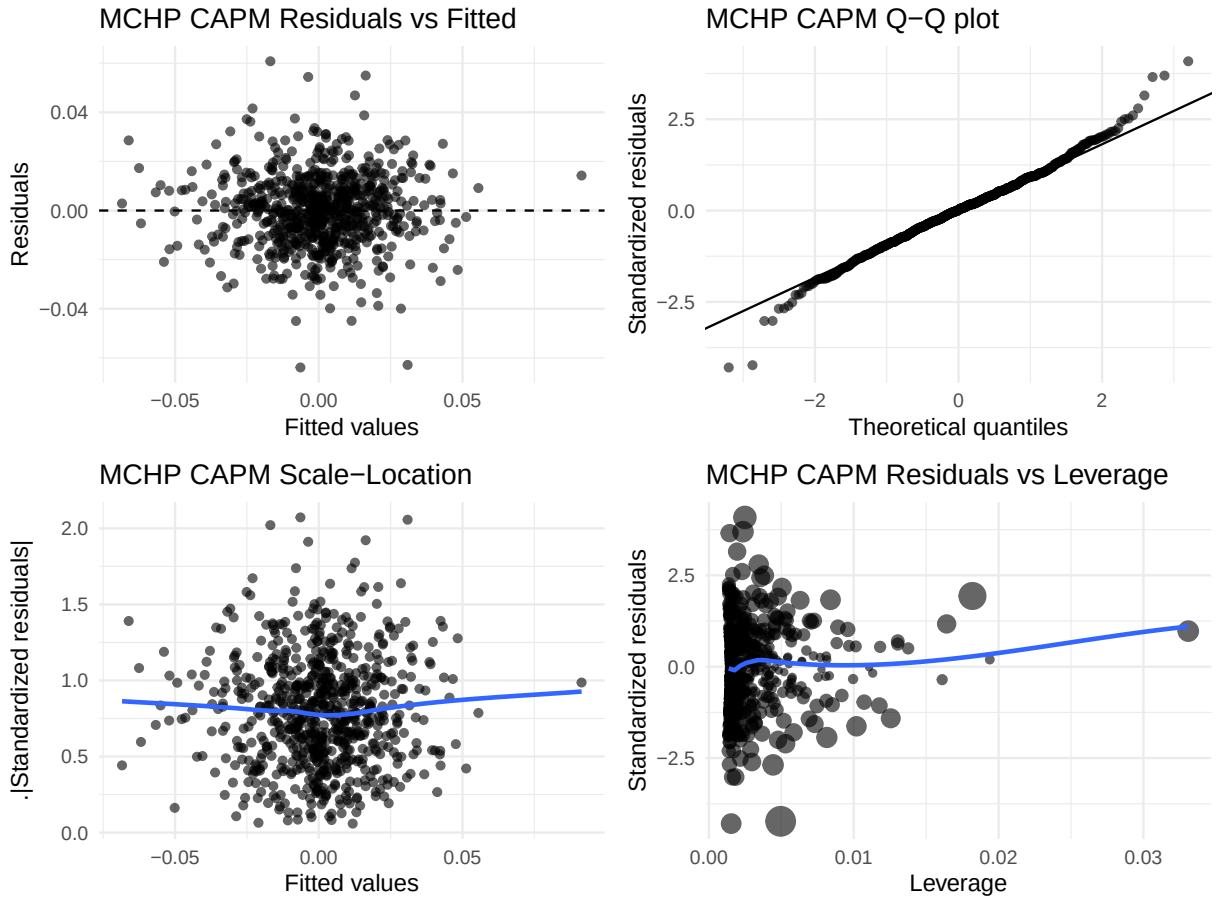
- Description: Microchip Technology Incorporated develops, manufactures, and sells smart, connected, and secure embedded control solutions globally, catering to diverse industries. Headquartered in Chandler, Arizona, the company provides a wide range of microcontrollers, microprocessors, application development tools, analog products, and memory technologies, serving system designers and manufacturers worldwide.

```
## [1] 0.7864328
```

```
## [1] -0.4842507
```

```
## [1] 0.2093813
```

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$MCHP..BH. ~ data$NASDAQ)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.063913 -0.009323  0.000246  0.009000  0.060781
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0000578  0.0005515  -0.105    0.917
```

```
## data$NASDAQ  1.2903990  0.0375627  34.353   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0149 on 728 degrees of freedom
## Multiple R-squared:  0.6185, Adjusted R-squared:  0.618
## F-statistic:  1180 on 1 and 728 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$MCHP..BH.
##              Df  Sum Sq  Mean Sq F value    Pr(>F)
## data$NASDAQ   1 0.26195 0.261955  1180.1 < 2.2e-16 ***
## Residuals   728 0.16159 0.000222
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

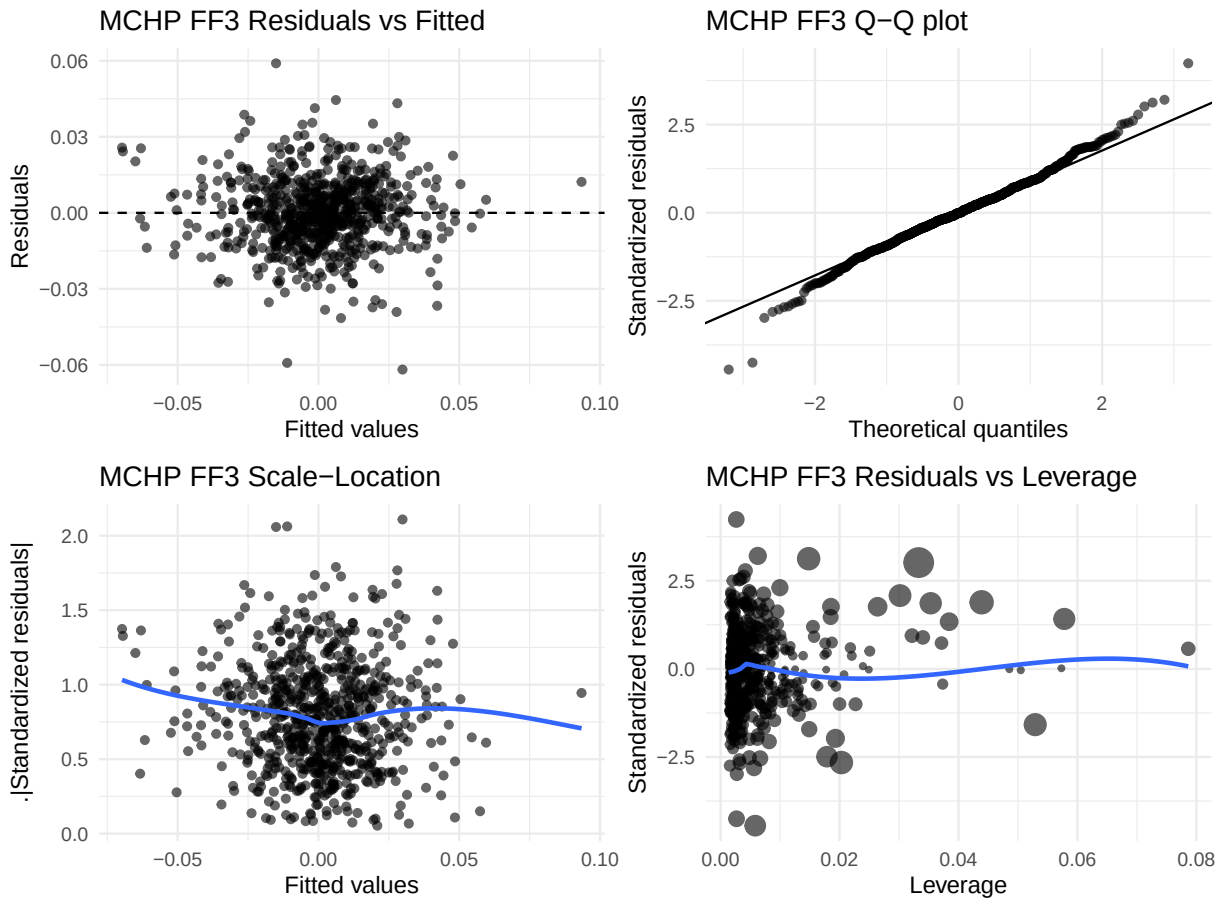
5.3.1 *CAPM*

- ALPHA = 6.392e-05 (p-value = 0.917) Insignificant
- B1 = 1.29 (p-value = <2e-16)
- R2ADJ = 62%

Diagnostic Tests

- Residuals VS Fitted: confirms linearity assumption since it has a random scatter along the horizontal line and it is fairly flat.
- Q-Q Plot: validates residual normality assumption since we can see that the majority of the residuals are along the diagonal line.
- Scale-Location: verifies homoscedasticity assumption since all of the residuals do not cluster around one specific point and the line is fairly straight
- Residuals VS Leverage: 3 influential points (539, 294, 567)

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$MCHP..BH. ~ data$NASDAQ + data$SMB + data$HML)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.061833 -0.008420 -0.000155  0.008198  0.059001
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0002689  0.0005165  -0.521    0.603
## data$NASDAQ  1.1407678  0.0399652  28.544  < 2e-16 ***
## data$SMB    -0.0846918  0.0120268  -7.042 4.40e-12 ***
## data$HML     0.1506166  0.0183888   8.191 1.17e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.01394 on 726 degrees of freedom
## Multiple R-squared:  0.6669, Adjusted R-squared:  0.6655
## F-statistic: 484.4 on 3 and 726 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$MCHP..BH.
```

```
##               Df   Sum Sq  Mean Sq  F value    Pr(>F)
## data$NASDAQ    1 0.261955 0.261955 1347.824 < 2.2e-16 ***
## data$SMB       1 0.007454 0.007454   38.354 9.875e-10 ***
## data$HML       1 0.013039 0.013039   67.087 1.169e-15 ***
## Residuals    726 0.141101 0.000194
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.3.2 *FF3*

- ALPHA = -0.0003 (p-value = 0.603) Insignificant
- B1 = 1.14 (p-value = <2e-16)
- B2 = -0.085 (p-value = 4.24e-09)
- B3 = 0.151 (p-value = 0.797) Insignificant
- R2ADJ = 67%

Diagnostic Tests

- Residuals VS Fitted: confirms linearity assumption since the residuals are scattered randomly along the graph, however, we can see that the line has a slight curve to it which might cause concern later on.
- Q-Q Plot: verifies residual normality since most of the residuals lie along the diagonal line
- Scale-Location: confirms homoscedasticity since the points are scattered randomly and the line is fairly straight

- Residuals VS Leverage: 3 significant points (421, 287, 291)

5.4 *Forge Global Holdings (FRGE)*

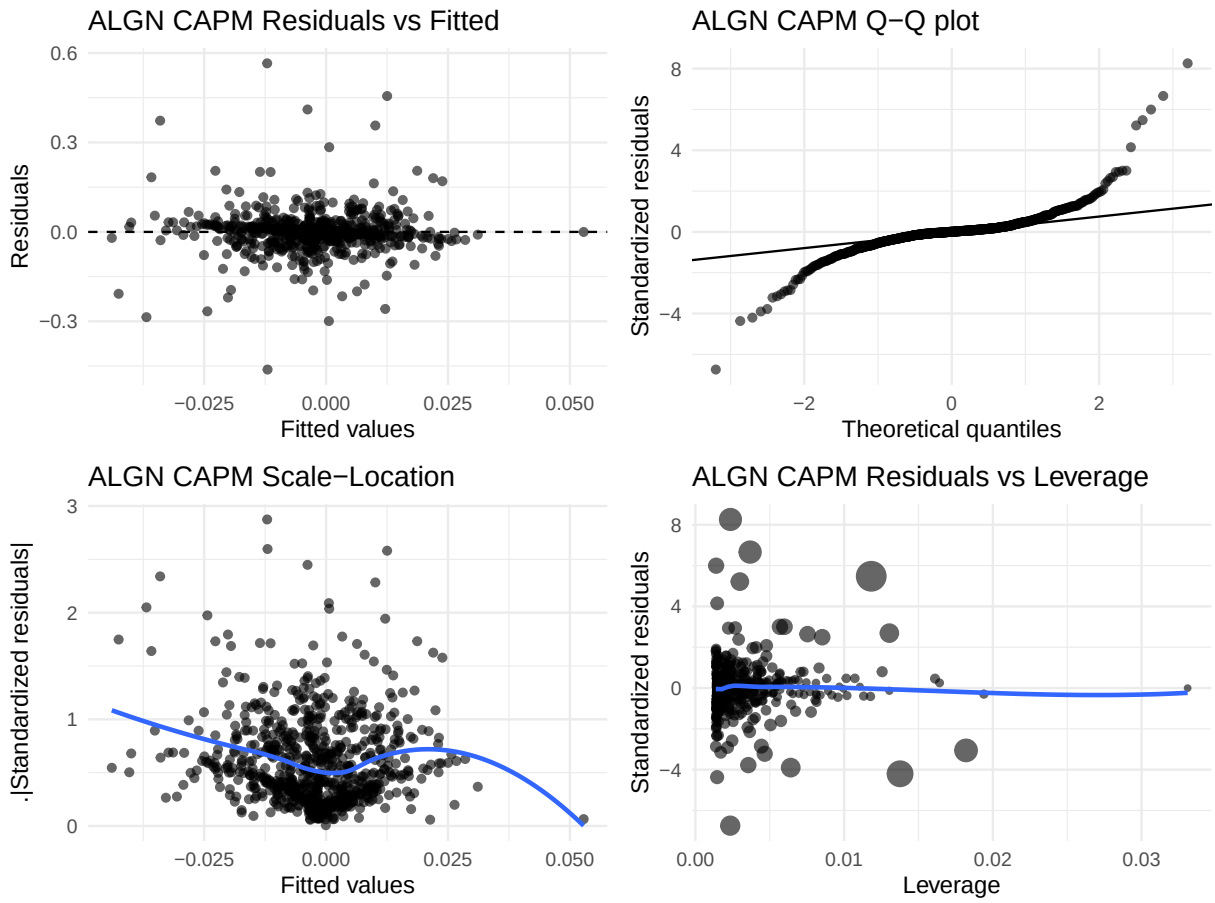
- Sector: Technology
- Industry: Software - Application
- Description: Forge Global Holdings, Inc. operates a financial services platform based in San Francisco, California, offering trading and custody solutions for private company shares. Founded in 2014, the company facilitates efficient private share transactions, connects investors with shareholders, and provides data solutions for investment decisions in the private market.

```
## [1] 0.1652127
```

```
## [1] -0.1628383
```

```
## [1] -0.7821695
```

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$FRGE..SL. ~ data$NASDAQ)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.46178 -0.01930  0.00044  0.01640  0.56551
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.002553   0.002537  -1.006    0.315
## data$NASDAQ  0.781057   0.172808   4.520 7.22e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06854 on 728 degrees of freedom
## Multiple R-squared:  0.0273, Adjusted R-squared:  0.02596
## F-statistic: 20.43 on 1 and 728 DF,  p-value: 7.223e-06
```

```
## Analysis of Variance Table
##
## Response: data$FRGE..SL.
##              Df Sum Sq  Mean Sq F value    Pr(>F)
## data$NASDAQ   1 0.0960 0.095972  20.428 7.223e-06 ***
```

```
## Residuals   728 3.4201 0.004698
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.4.1 *CAPM*

- ALPHA = -0.0026 (p-value = 0.315) Insignificant

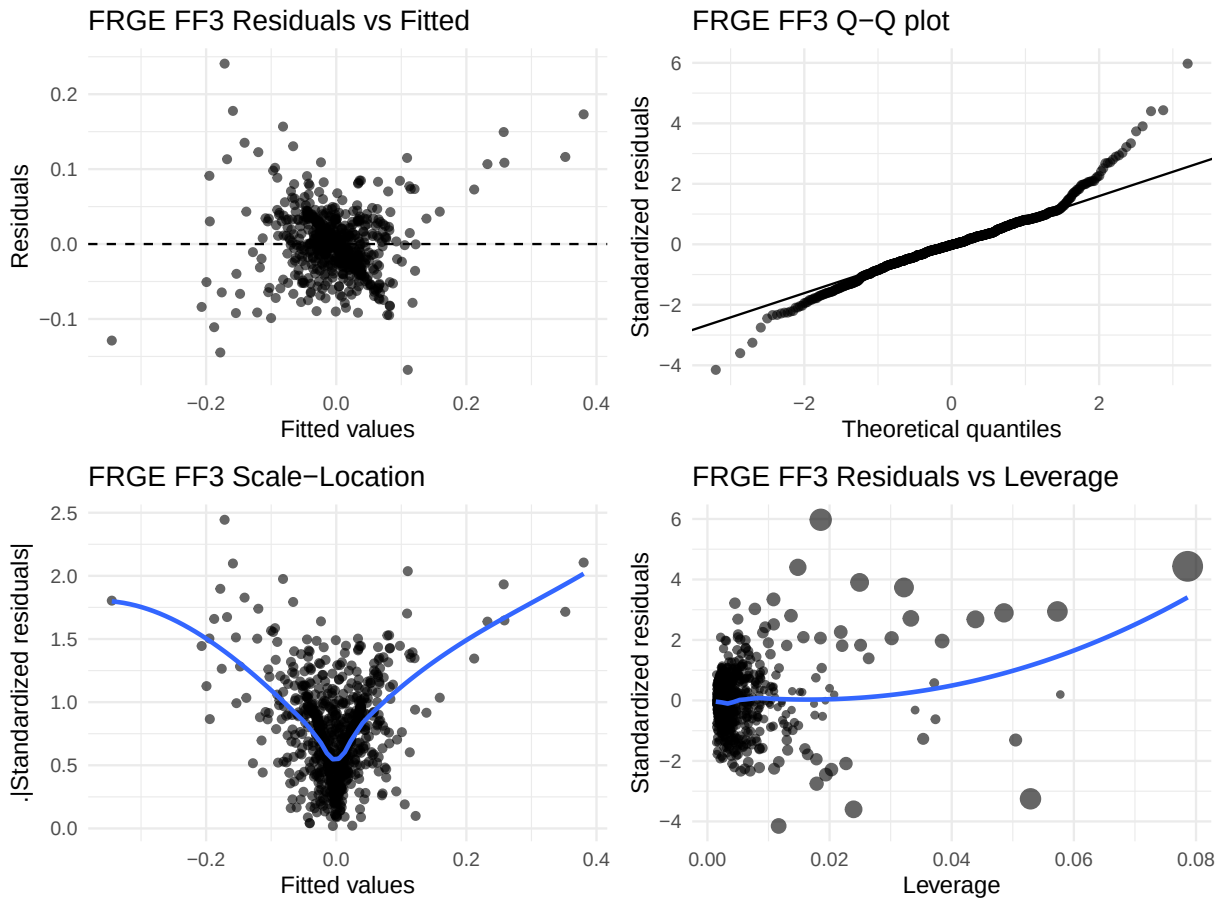
- B1 = 0.78 (p-value = 7.33e-06)
- R2ADJ = 26%

Diagnostic Tests

- Residuals VS Fitted: verifies linearity assumption since the data is randomly scattered around the graph and the line is fairly flat.
- Q-Q Plot: validates normality since the majority of the data is along the diagonal line, however, there strong drifts along the tails of the plot.

- Scale-Location: we can see how it forms a cluster along the lower part of the graph, and the line has a slight dent on the middle.
- Residuals VS Leverage: 3 significant points (295, 294, 287)

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
```

```
## Call:
## lm(formula = data$FRGE..SL. ~ data$NASDAQ + data$SMB + data$HML)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.167913 -0.022351 -0.000863  0.021604  0.240796
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0003096  0.0015077  -0.205    0.837
## data$NASDAQ  0.9899193  0.1166474   8.486   <2e-16 ***
## data$SMB    -0.0181148  0.0351029  -0.516    0.606
## data$HML    -1.9497708  0.0536718 -36.328   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04069 on 726 degrees of freedom
## Multiple R-squared:  0.6581, Adjusted R-squared:  0.6567
## F-statistic: 465.9 on 3 and 726 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$FRGE..SL.
##              Df  Sum Sq Mean Sq  F value    Pr(>F)
## data$NASDAQ   1 0.09597 0.09597   57.965 8.319e-14 ***
## data$SMB      1 0.03305 0.03305   19.964 9.153e-06 ***
## data$HML      1 2.18501 2.18501 1319.696 < 2.2e-16 ***
## Residuals   726 1.20203 0.00166
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.4.2 *FF3*

- ALPHA = -0.00031 (p-value = 0.837) Insignificant
- B1 = 0.9899 (p-value = < 2e-16)
- B2 = -0.18 (p-value = 0.606) Insignificant
- B3 = -1.949 (p-value = < 2e-16)
- R2ADJ = 66%

Diagnostic Tests

- Residuals VS Fitted: fails linearity assumption since we can clearly see the curvature of the red line.
- Q-Q Plot: validates normality since most of the residuals follow the path along the diagonal line.
- Scale-Location: fails homoscedasticity since it is clear that the data forms a cluster and the line is curved.
- Residuals VS Leverage: 3 significant points (269, 665, 301)

5.5 *Align Technology (ALGN)*

- Sector: Technology
- Industry: Medical Devices
- Description: Align Technology, Inc., based in Tempe, Arizona, designs and manufactures Invisalign clear aligners and iTero intraoral scanners for orthodontists and dentists worldwide. With a focus on

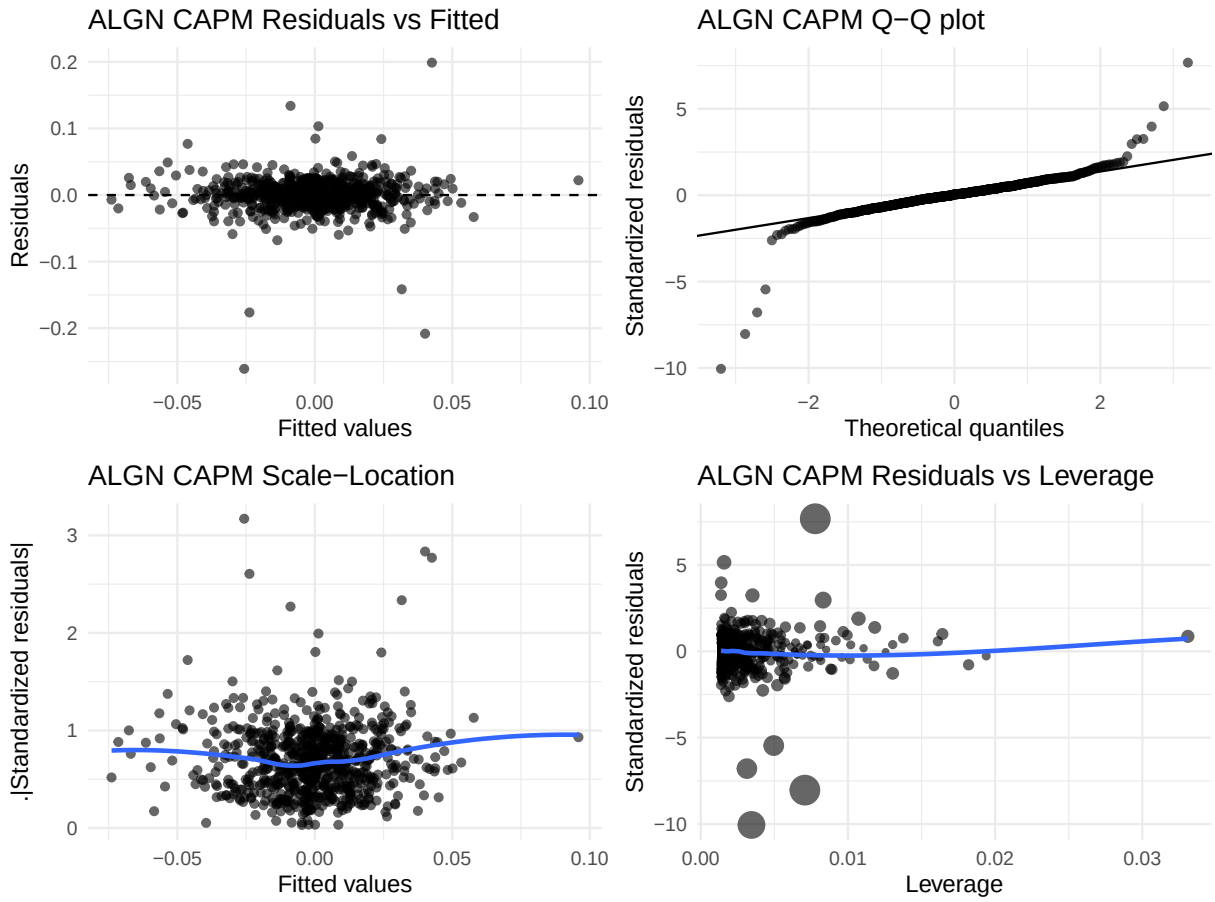
innovation, the company offers comprehensive orthodontic solutions and digital imaging systems to enhance patient care and streamline dental practices since its establishment in 1997.

```
## [1] 0.6123363
```

```
## [1] -0.2673802
```

```
## [1] -0.1894682
```

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$ALGN..ML. ~ data$NASDAQ)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.261054 -0.011203  0.001107  0.012414  0.198907
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0012870  0.0009631  -1.336    0.182
## data$NASDAQ  1.3708340  0.0655971  20.898   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 0.02602 on 728 degrees of freedom
## Multiple R-squared:  0.375,  Adjusted R-squared:  0.3741
## F-statistic: 436.7 on 1 and 728 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$ALGN..ML.
##              Df  Sum Sq  Mean Sq F value    Pr(>F)
## data$NASDAQ   1 0.29563 0.295630  436.72 < 2.2e-16 ***
## Residuals   728 0.49281 0.000677
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.5.1 *CAPM*

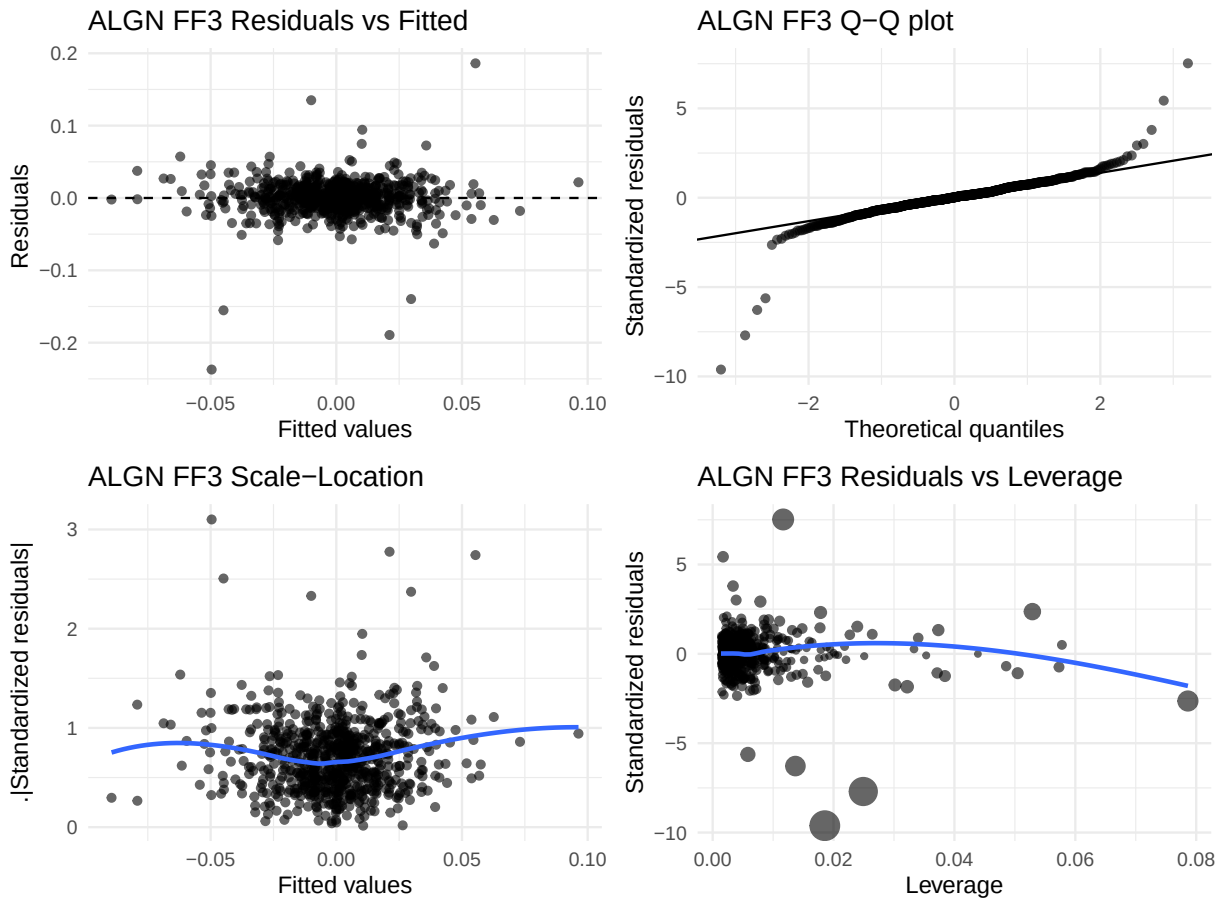
- ALPHA = -0.0013 (p-value = 0.182) Insignificant
- B1 = 1.37 (p-value = < 2e-16)
- R2ADJ = 37%

Diagnostic Tests

- Residuals VS Fitted: verifies linearity assumption true since the values are randomly scattered, and the red line is fairly flat.

- Q-Q Plot: verifies normality of residuals since the majority align with the diagonal line.
- Scale-Location: verifies homoscedasticity since the residuals are scattered around the graph and the line if fairly linear.
- Residuals VS Leverage: has 3 significant points (481, 289, 665)

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$ALGN..ML. ~ data$NASDAQ + data$SMB + data$HML)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.237148 -0.010294  0.000594  0.012169  0.186112
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0009577  0.0009224  -1.038    0.300
## data$NASDAQ  1.4581166  0.0713698  20.430  < 2e-16 ***
## data$SMB     0.0349786  0.0214774   1.629    0.104
## data$HML    -0.2718969  0.0328387  -8.280 5.92e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0249 on 726 degrees of freedom
## Multiple R-squared:  0.4293, Adjusted R-squared:  0.4269
## F-statistic:   182 on 3 and 726 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$ALGN..ML.
```

```
##               Df  Sum Sq  Mean Sq  F value    Pr(>F)
## data$NASDAQ    1 0.29563 0.295630 476.9696 < 2.2e-16 ***
## data$SMB       1 0.00034 0.000338   0.5449    0.4607
## data$HML       1 0.04249 0.042491  68.5547  5.92e-16 ***
## Residuals    726 0.44998 0.000620
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.5.2 *FF3*

- ALPHA = -0.00096 (p-value = 0.300) Insignificant
- B1 = 1.458 (p-value = < 2e-16)
- B2 = 0.035 (p-value = 0.104) Insignificant
- B3 = -0.272 (p-value = 5.92e-16)
- R2ADJ = 43%

Diagnostic Tests

- Residuals VS Fitted: validates linearity assumption. There is a random scatter across the horizontal line and the fitted line is fairly linear.
- Q-Q Plot: validates normality of the residuals since the points follow the diagonal line. However, we can see that it slightly drifts on both side of the graph.
- Scale-Location: validates homoscedasticity since all of the points are scattered around the graph, thus it represents constant variance, and the line is fairly flat.
- Residuals VS Leverage: we can see that this model has 3 influential points (481, 289, 665)

5.6 *Zoom Video Communications (ZM)*

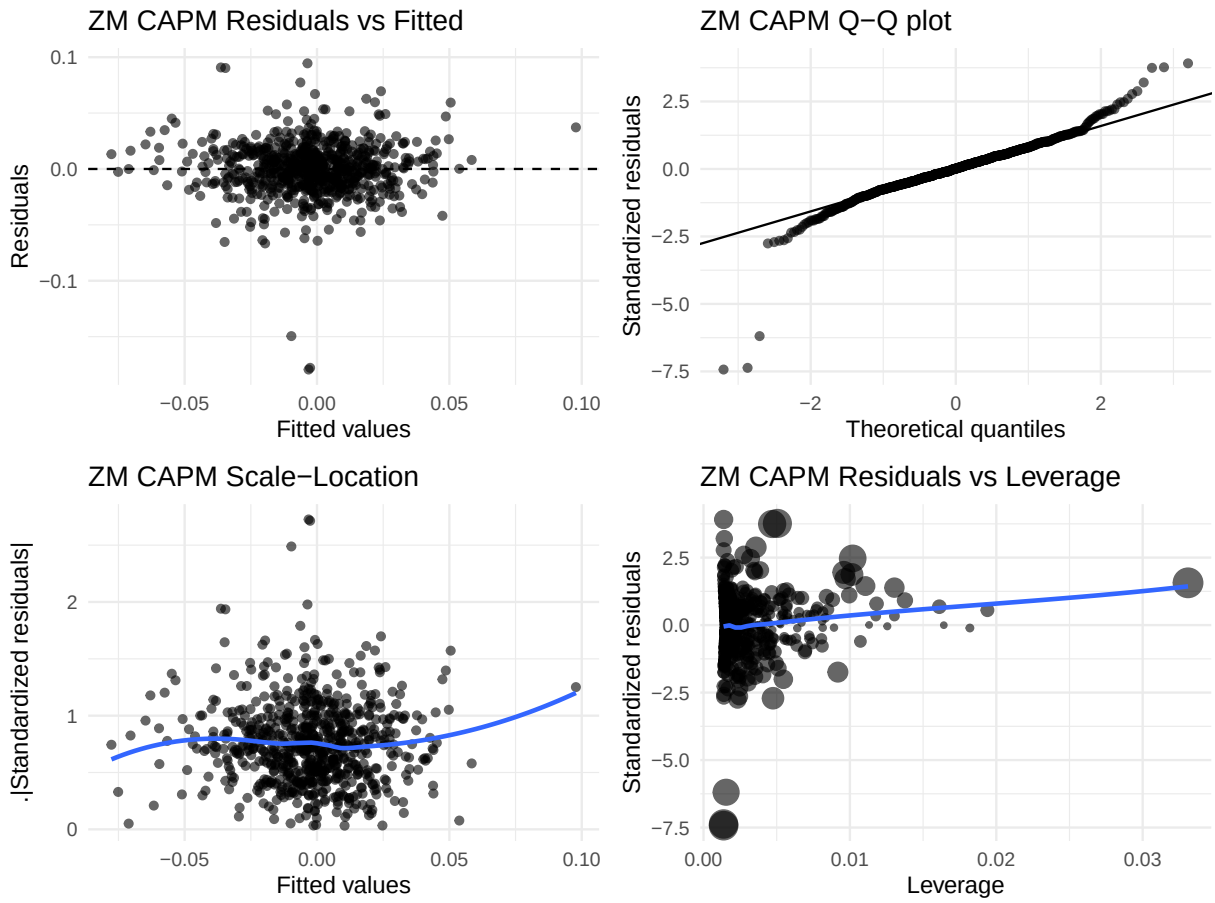
- Sector: Technology
- Industry: Software - Application
- Description: Zoom Video Communications, Inc., based in San Jose, California, provides a comprehensive unified communications platform globally, offering solutions such as Zoom Meetings, Zoom Phone, Zoom Chat, and Zoom Rooms for seamless video conferencing and collaboration across devices. Established in 2011, Zoom continues to innovate, with offerings like Zoom Events and OnZoom, enabling individuals and businesses to host virtual events and connect effectively in the digital landscape.

```
## [1] 0.6526526
```

```
## [1] -0.4754055
```

```
## [1] -0.1650354
```

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
## Call:
## lm(formula = data$ZM..BL. ~ data$NASDAQ)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.179431 -0.012630  0.000334  0.013125  0.094494
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0026024  0.0008945  -2.909  0.00373 **
## data$NASDAQ  1.4160487  0.0609261  23.242  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02417 on 728 degrees of freedom
## Multiple R-squared:  0.426,  Adjusted R-squared:  0.4252
## F-statistic: 540.2 on 1 and 728 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$ZM..BL.
##              Df  Sum Sq  Mean Sq F value    Pr(>F)
## data$NASDAQ   1 0.31545 0.315454  540.19 < 2.2e-16 ***
```

```
## Residuals   728 0.42513 0.000584
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.1 *CAPM*

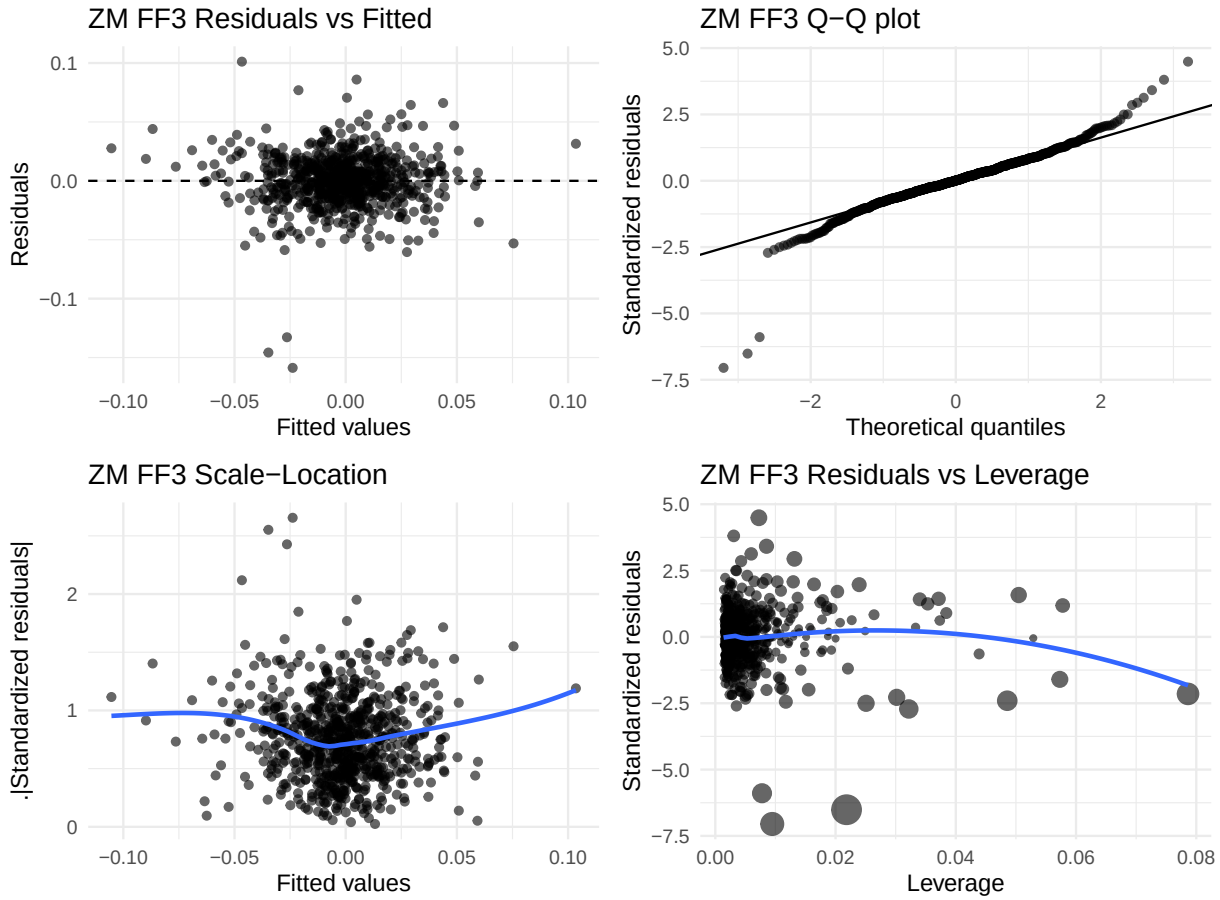
- ALPHA = -0.0026 (p-value = 0.00373)
- B1 = 1.42 (p-value = < 2e-16)
- R2ADJ = 43%

Diagnostic Tests

- Residuals VS Fitted: Asserts linearity since there is a random scatter along the horizontal line, however, we can see that the red line has a slight curve to it, which can be a cause for concern later on.
- Q-Q Plot: Validates normality since most of the most of the points follow the diagonal line, however, we can see that the tails start to drift away, specifically in the upper right corner.
- Scale-Location: Validates homoscedasticity since there is a random scatter, thus explaining constant variance of the residuals, as well, asserting us that it is fairly linear.

- Residuals VS Leverage: This plot shows 3 significant points that has a high influence on the model (425, 123, 309)

```
## `geom_smooth()` using formula = 'y ~ x'
## `geom_smooth()` using formula = 'y ~ x'
```




```
##
```

```
## Call:
## lm(formula = data$ZM..BL. ~ data$NASDAQ + data$SMB + data$HML)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.158751 -0.011547  0.000206  0.012820  0.101189
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0024136  0.0008383  -2.879   0.0041 **
## data$NASDAQ  1.2439225  0.0648588  19.179  < 2e-16 ***
## data$SMB    -0.1276238  0.0195181  -6.539 1.17e-10 ***
## data$HML    -0.2120748  0.0298428  -7.106 2.85e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02262 on 726 degrees of freedom
## Multiple R-squared:  0.4982, Adjusted R-squared:  0.4961
## F-statistic: 240.3 on 3 and 726 DF,  p-value: < 2.2e-16
```

```
## Analysis of Variance Table
##
## Response: data$ZM..BL.
##              Df  Sum Sq  Mean Sq F value    Pr(>F)
## data$NASDAQ   1 0.31545 0.315454 616.266 < 2.2e-16 ***
## data$SMB      1 0.02765 0.027651  54.019 5.361e-13 ***
## data$HML      1 0.02585 0.025850  50.501 2.851e-12 ***
## Residuals   726 0.37162 0.000512
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.2 *FF3*

- ALPHA = -0.0024 (p-value = 0.0041)
- B1 = 1.244 (p-value = < 2e-16)
- B2 = -0.128 (p-value = 1.17e-10)
- B3 = -0.212 (p-value = 2.85e-12)
- R2ADJ = 50%

Diagnostic Tests

- Residuals VS Fitted: validates the linearity test since there is not an apparent pattern and it is spread along the horizontal line. As well, the red line seems to be fairly straight, reassuring our linearity assumption.
- Q-Q Plot: checks normality assumption since the majority of the points follow the horizontal line, however, we can see a deviation along the top right corner, which can represent some concern.
- Scale-Location: fails homoscedasticity since we can clearly see a curvature along the line.
- Residuals VS Leverage: there are significant points in the plot that has a high weight on the model. (269, 123, 369)

6 Findings

The analysis of these six assets provides valuable insights into how different factors impact expected returns, particularly when comparing the traditional CAPM with the Fama-French model.

Starting with the CAPM analysis, the beta coefficient (B1) for each asset reflects its sensitivity to market movements. For instance, EB has a beta of 1.35, indicating that it tends to move 35% more than the market, while FRGE has a beta of 0.78, showing that it moves 22% less than the market. However, the adjusted R-squared values for these assets indicate that the CAPM might not fully explain their variability in returns, ranging from 26% to 62%. This suggests that factors beyond market risk could be influencing their expected returns.

Incorporating the Fama-French model, the analysis examines additional factors such as size and value. The size factor (B2), represented by the difference between small-cap and big-cap companies, shows distinct patterns across the six assets. Assets EB and FRGE, categorized as small-cap companies, should exhibit higher returns compared to big-cap companies like Assets MCHP and ZM, indicating that the riskier companies (small-cap) demand a higher expected returns. However, as can be seen from the results, only the big-cap companies show a significant p-value for B2 with a negative value (MCHP (b): -0.085, ZM(b): -0.128), as for the small and medium - cap companies outputs SMB are p-value are insignificant. This indicates that small-cap companies do not prove that small and middle companies should have higher expected returns than big-cap companies, leading us to fail our initial hypotheses, thus suggesting that further analysis should be conducted.

On the other hand, the value factor (B3), represented by the difference between high book-to-market and low book-to-market companies, reveals varying outcomes. Assets EB, BL, and MCHP, with higher book-to-market ratios, demonstrate different return patterns (EB: 0.296, BL: 0.119, MCHP: 0.085) compared to assets with lower book-to-market ratios (FRGE: -1.949, ALGN: -0.272, ZM: -0.212). Based on the analysis it can be observe that, in fact, the companies with High book-to-market have a positive B3, while the low book-to-market stocks have a negative B3. This validates the initial hypotheses that High book-to-market outperforms low book-to-markets.

The intercept (alpha) in these models provides additional insights. While traditionally, a significant alpha suggests the model's failure to capture all relevant risk factors, the figures indicate mixed results. Some assets show significant alphas (EB: -0.0021 and ZM: -0.0026) , potentially indicating either undervaluation or miss-pricing. However, considering the dynamic nature of financial markets, these alphas may fluctuate over time.

Overall, the analysis demonstrates that incorporating additional factors beyond market risk, such as size and value, enhances the understanding of expected returns. However, the significance of these factors varies across assets, emphasizing the need for ongoing refinement and evaluation of asset pricing models to accurately capture market dynamics and investor behavior.

7 References

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