

UW

# Empirical Properties of Returns

Amath 546/Econ 589

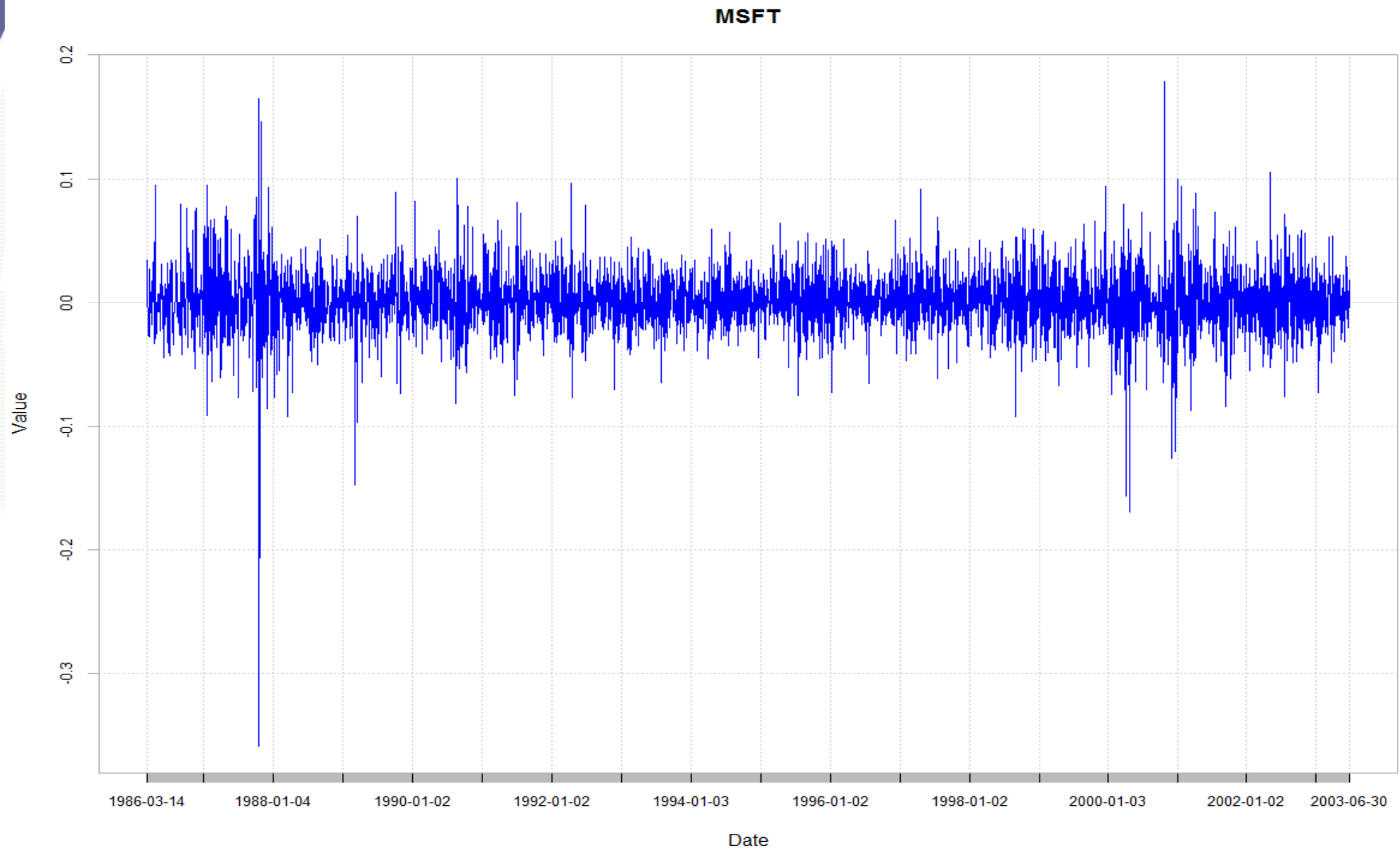
Eric Zivot

Spring 2013

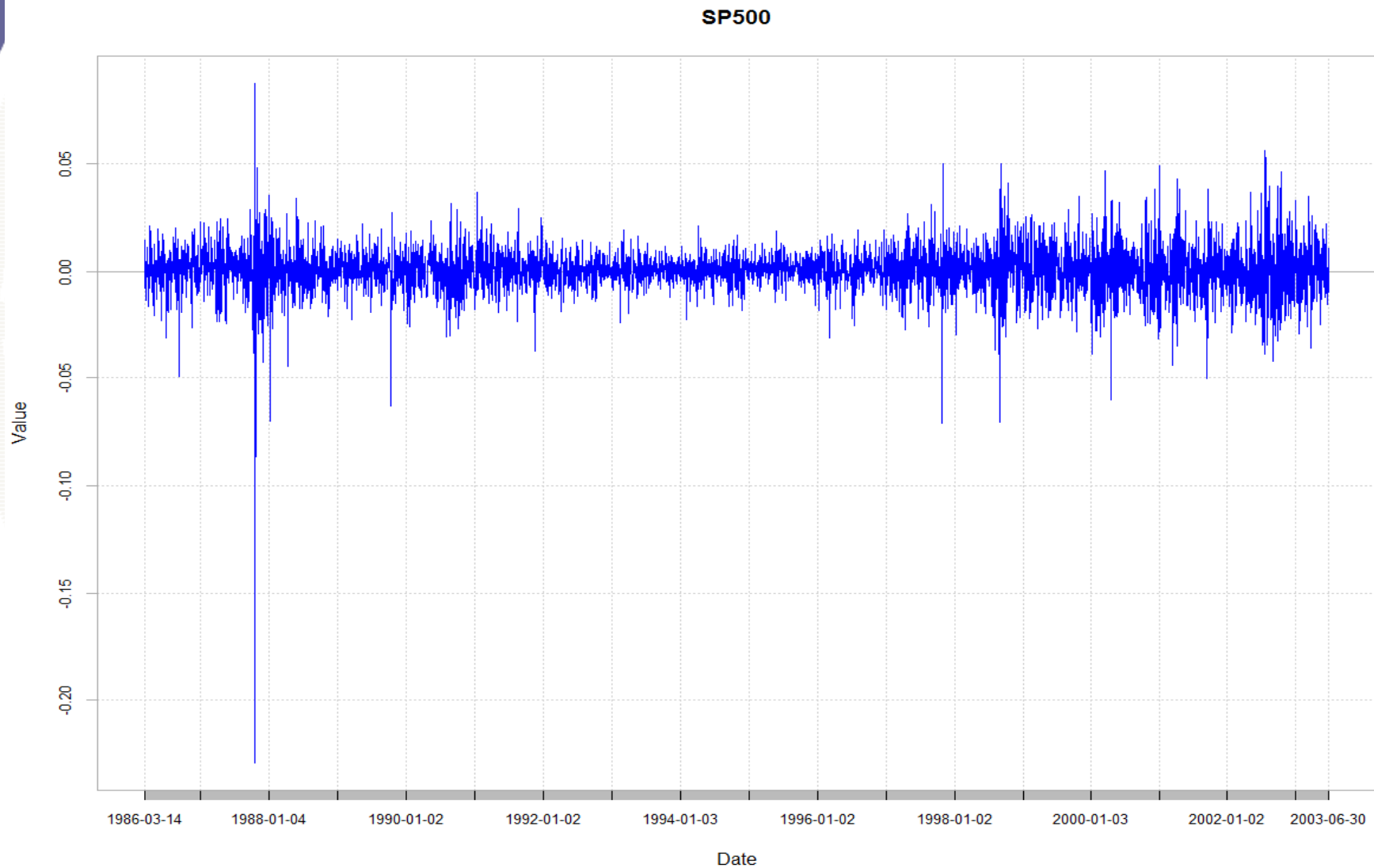
Updated: April 3, 2013

© Eric Zivot 2008

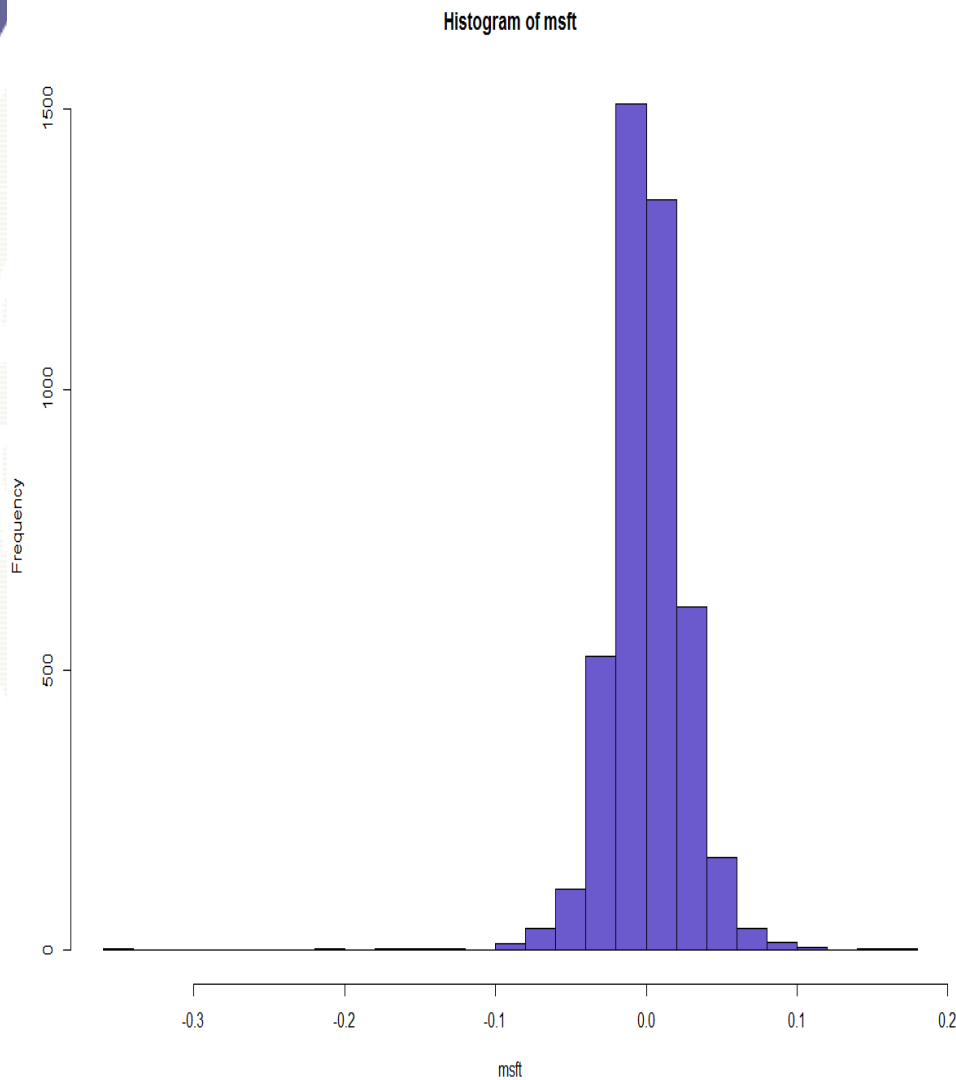
# Daily CC Returns on MSFT



# Daily CC Returns on SP500



# Distribution of Daily CC Returns on MSFT

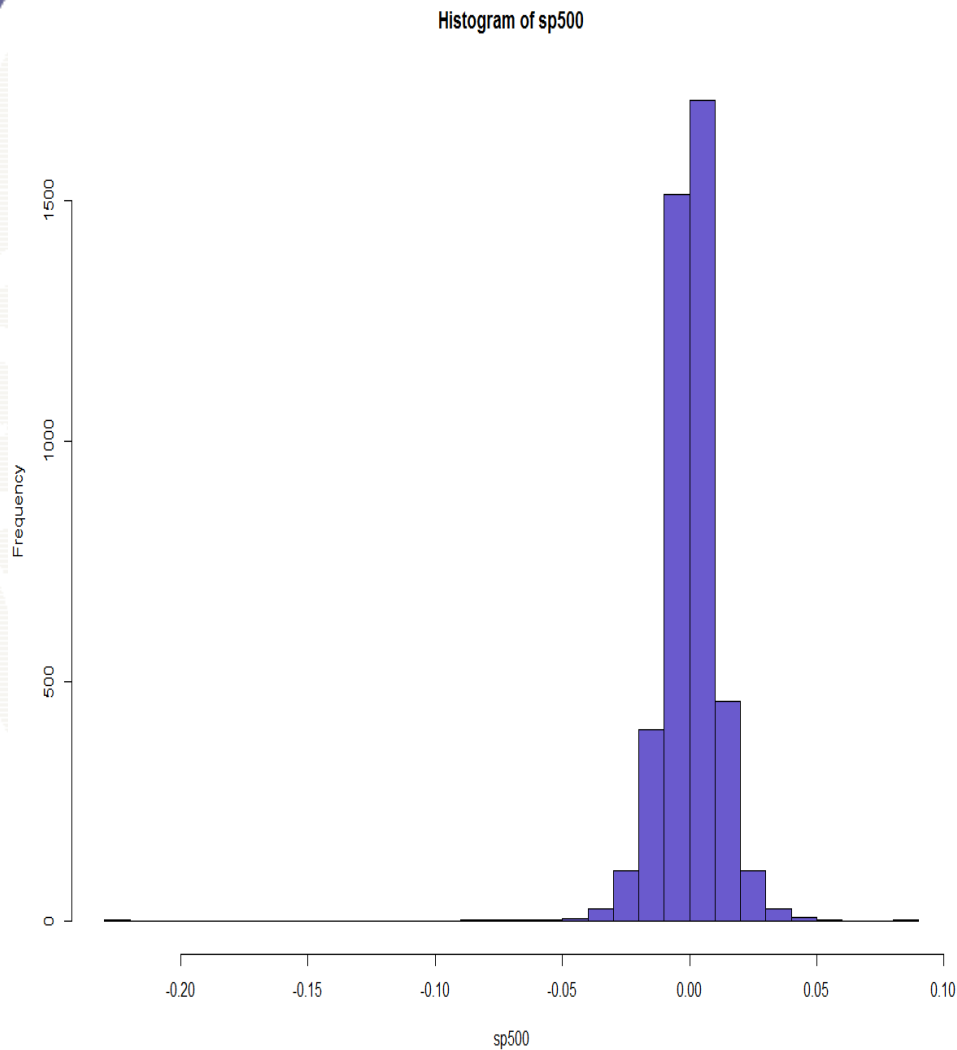


```
> table.Stats(msft.z)
```

|                 | MSFT      |
|-----------------|-----------|
| Observations    | 4365.0000 |
| NAs             | 0.0000    |
| Minimum         | -0.3583   |
| Quartile 1      | -0.0128   |
| Median          | 0.0000    |
| Arithmetic Mean | 0.0013    |
| Geometric Mean  | 0.0009    |
| Quartile 3      | 0.0155    |
| Maximum         | 0.1787    |
| SE Mean         | 0.0004    |
| LCL Mean (0.95) | 0.0005    |
| UCL Mean (0.95) | 0.0020    |
| Variance        | 0.0006    |
| Stdev           | 0.0254    |
| Skewness        | -0.7275   |
| Kurtosis        | 13.1187   |



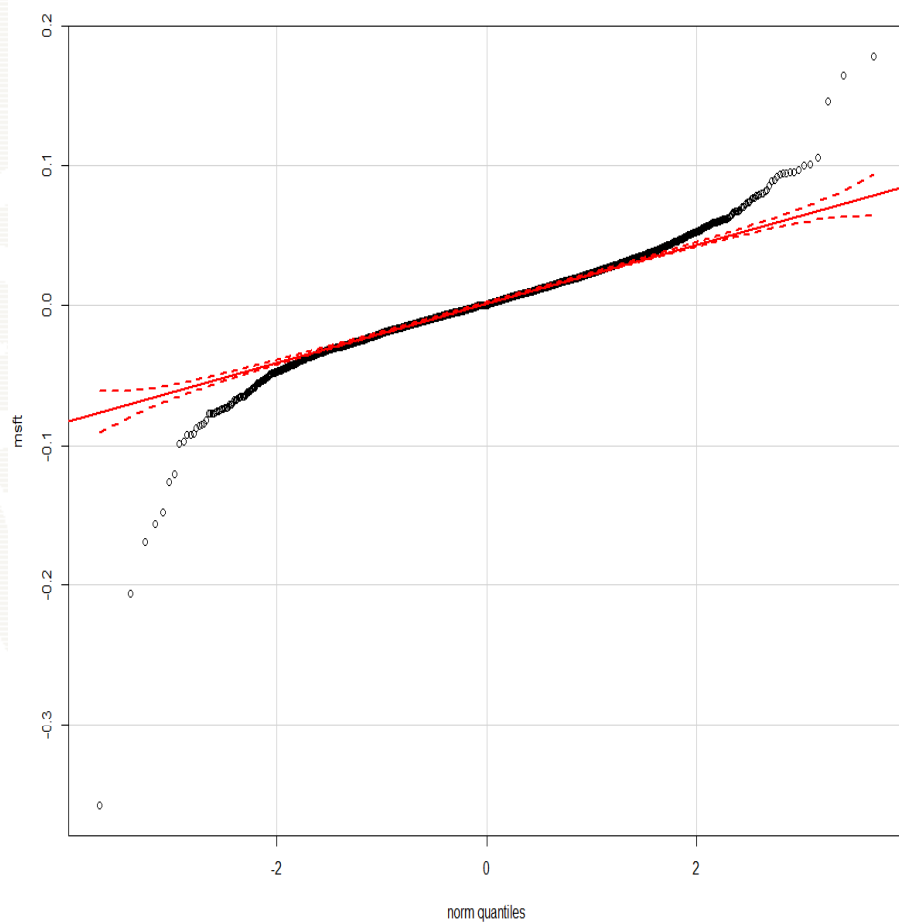
# Distribution of Daily CC Returns on S&P 500



```
> table.Stats(sp500.z)
```

|                 | SP500     |
|-----------------|-----------|
| Observations    | 4365.0000 |
| NAs             | 0.0000    |
| Minimum         | -0.2290   |
| Quartile 1      | -0.0047   |
| Median          | 0.0005    |
| Arithmetic Mean | 0.0003    |
| Geometric Mean  | 0.0003    |
| Quartile 3      | 0.0058    |
| Maximum         | 0.0871    |
| SE Mean         | 0.0002    |
| LCL Mean (0.95) | 0.0000    |
| UCL Mean (0.95) | 0.0007    |
| Variance        | 0.0001    |
| Stdev           | 0.0114    |
| Skewness        | -2.0832   |
| Kurtosis        | 42.1777   |

# Tests for Normality

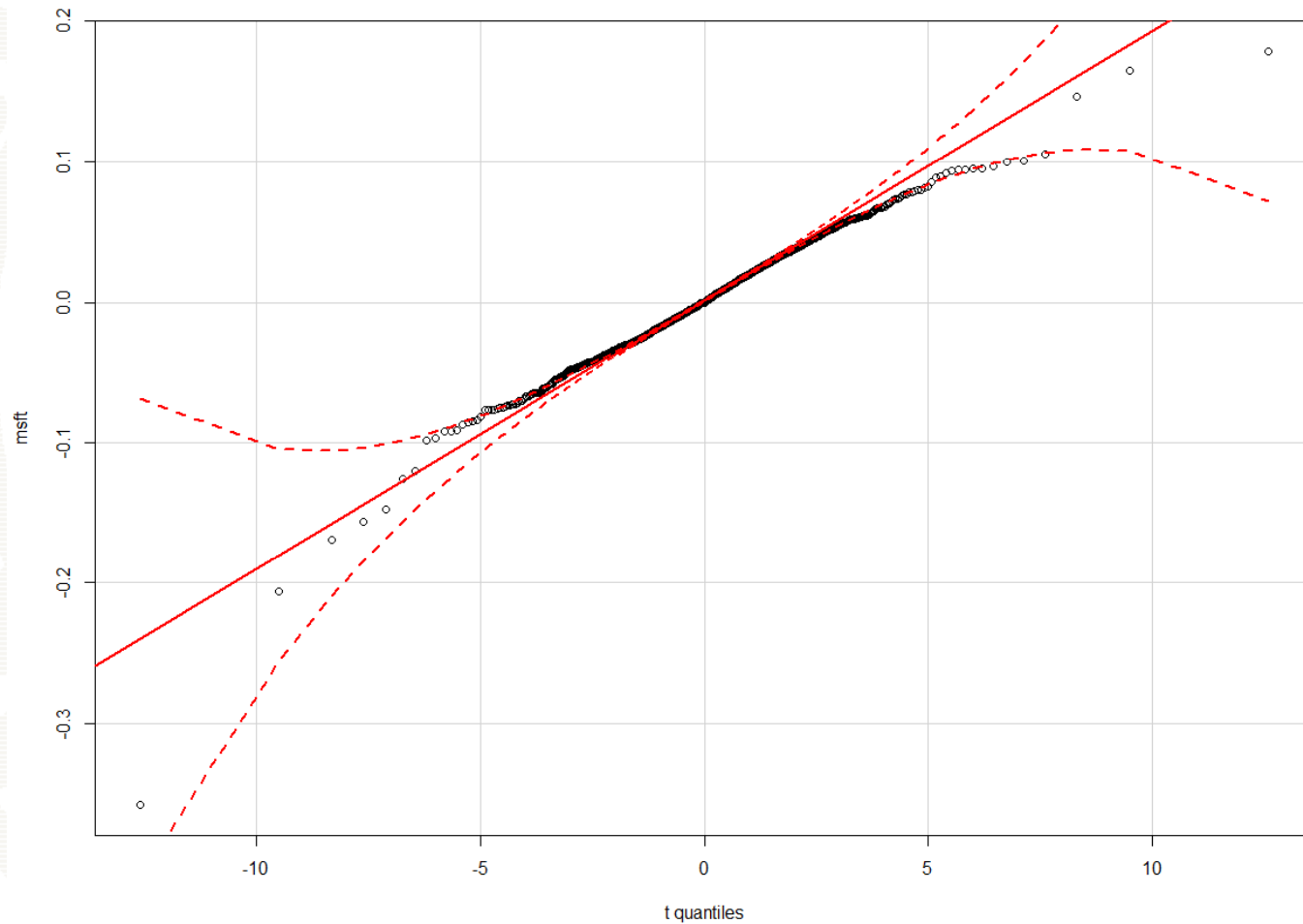


```
> jarque.bera.test(msft)
```

Jarque Bera Test

```
data: msft  
X-squared = 31685.64,  
df = 2, p-value < 2.2e-16
```

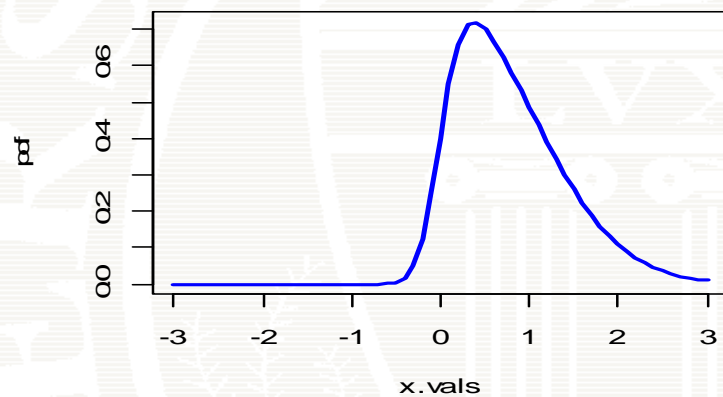
# QQ-Plot: Student-t with 4 degrees of freedom



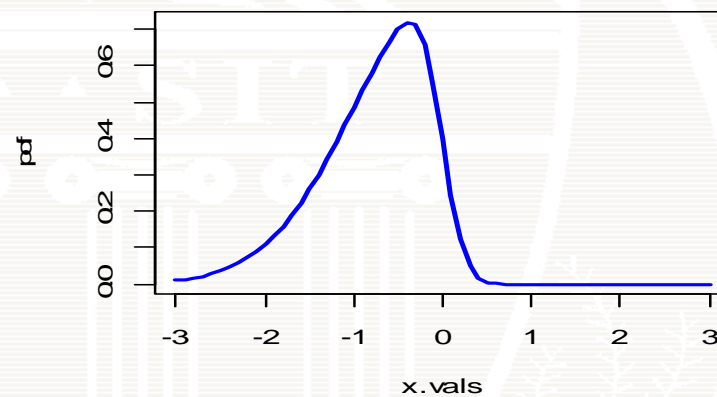
```
> qqPlot(msft, distribution="t", df=4)
```

# Skew Normal Distribution

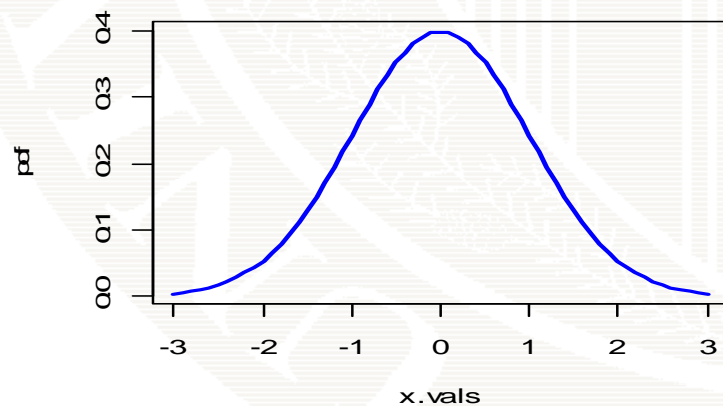
shape=5



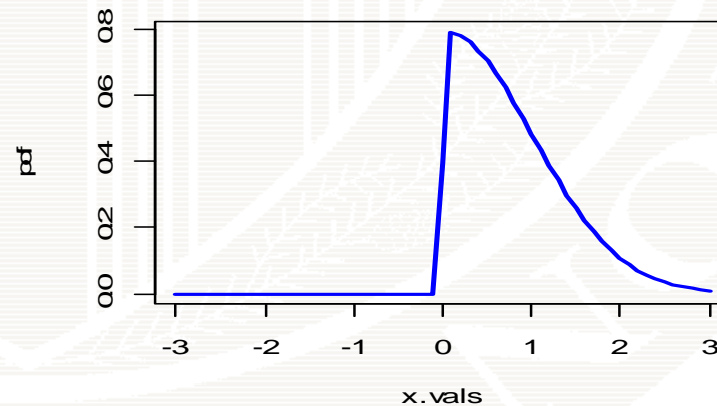
shape=-5



shape=0



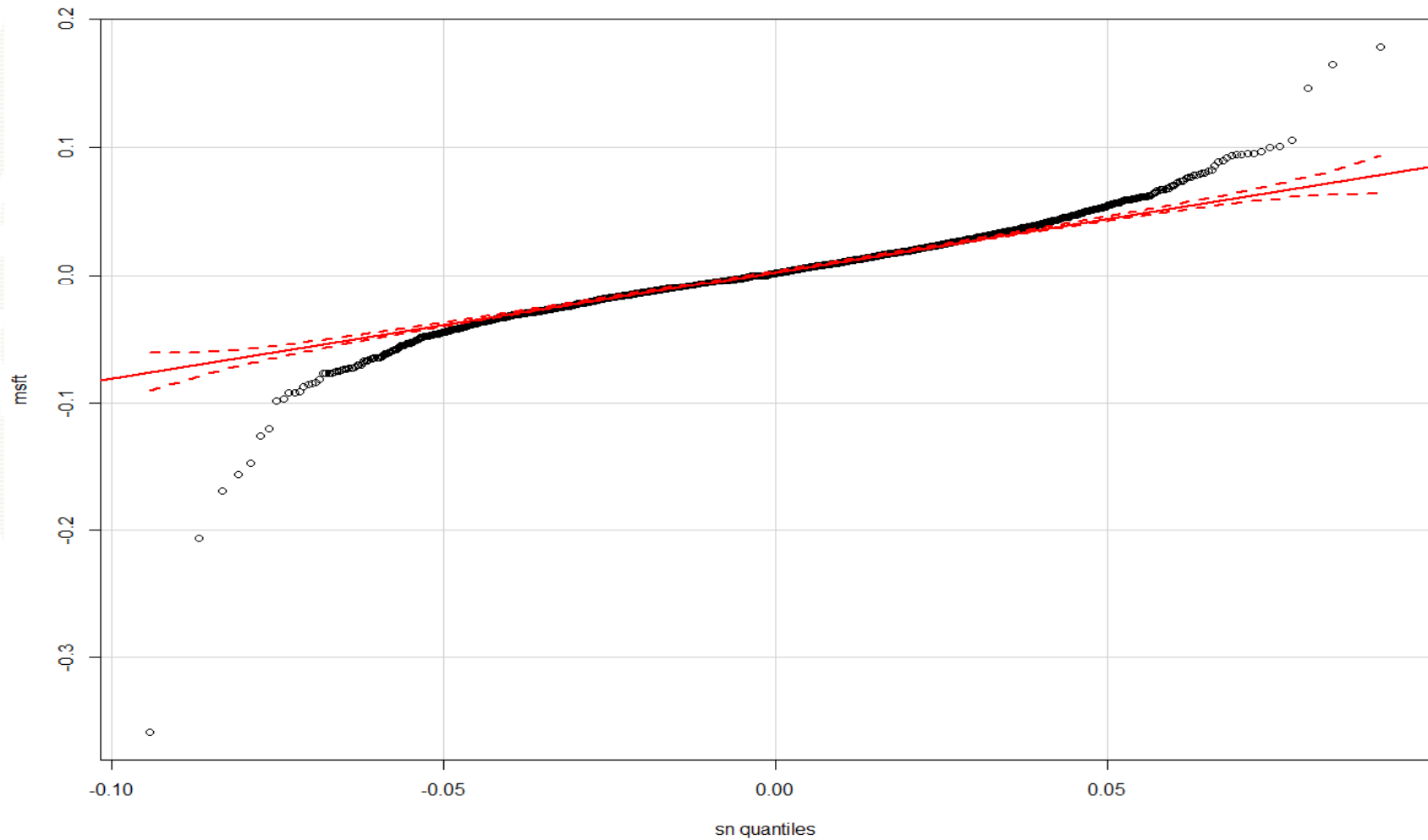
shape=1000



$\xi = 0, \omega = 1$

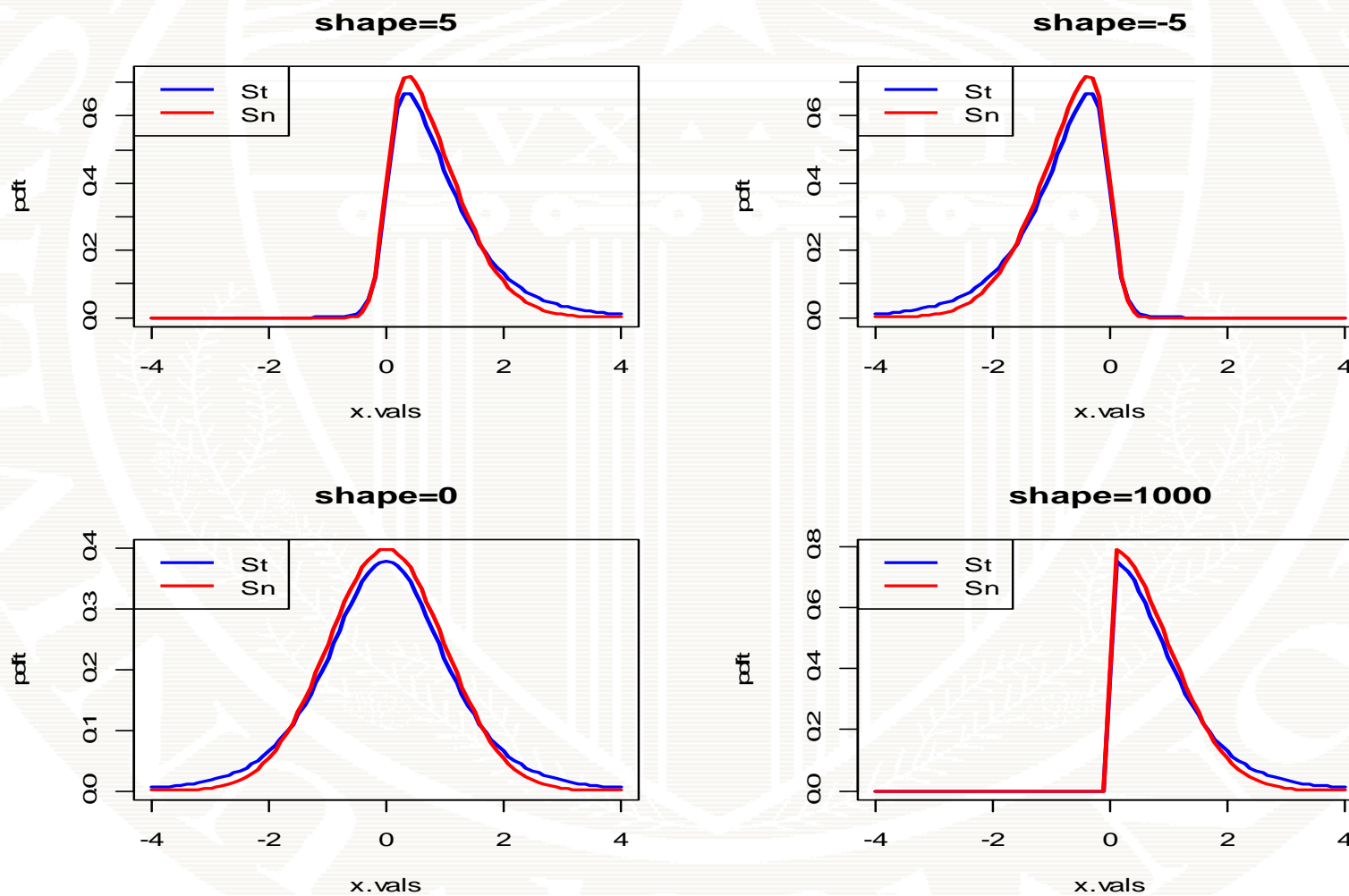


QQ-Plot: MLE of Skew-Normal for MSFT  
location = 0.001, scale = 0.025, shape = -0.131



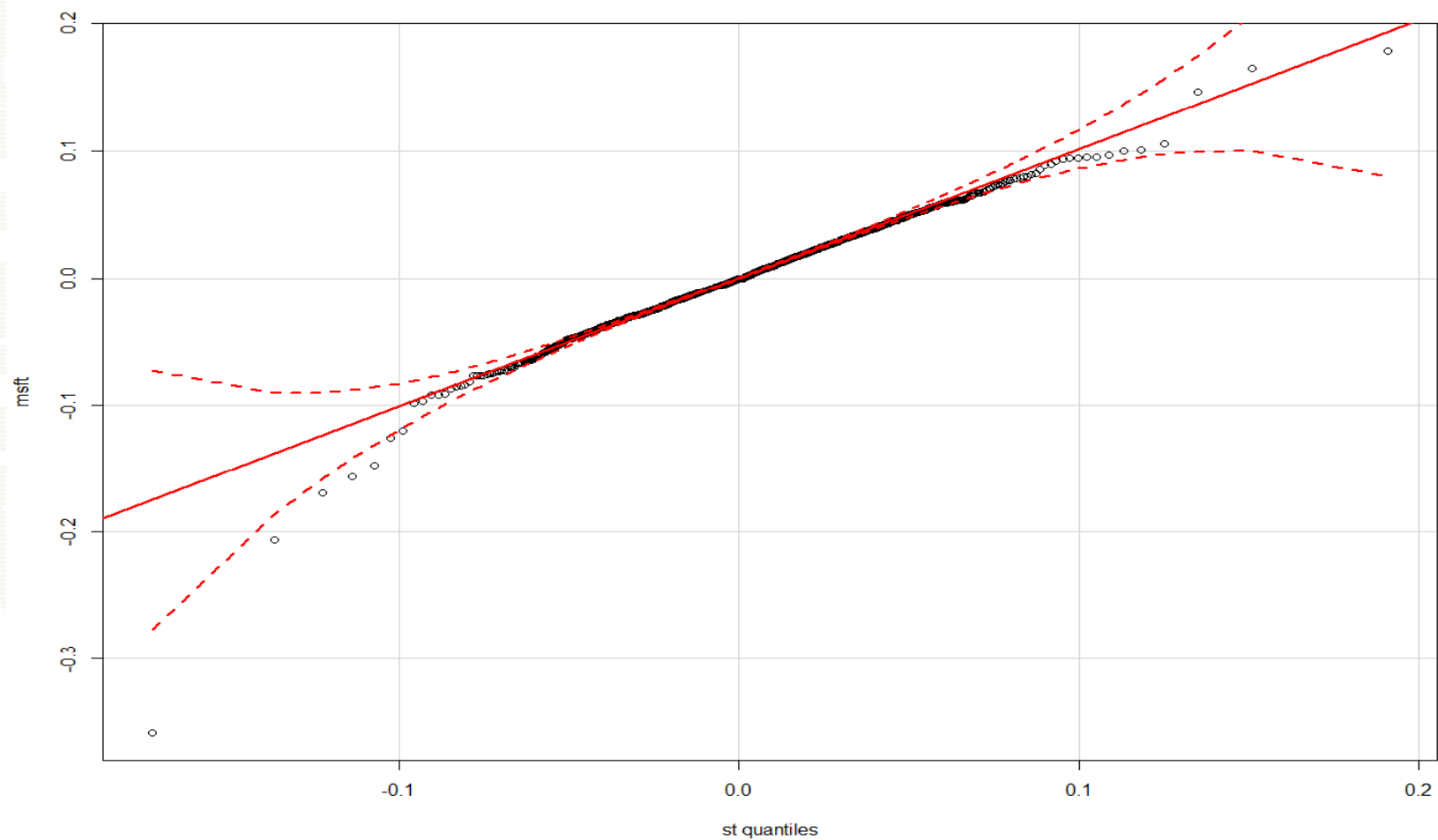
mle computed with R package sn, qqPlot() from R package car  
© Eric Zivot 2008

# Skew t Distribution



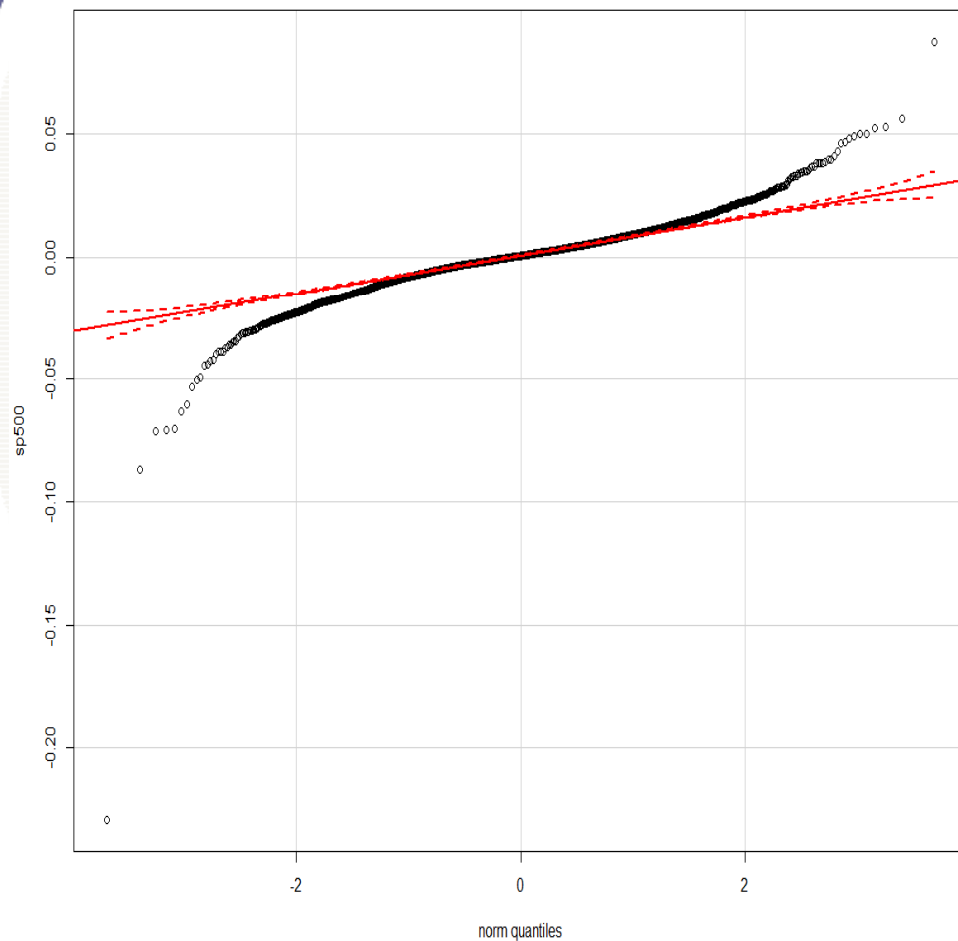
$\xi = 0, \omega = 1, \nu = 5$

QQ-Plot: MLE of Skew-t for MSFT  
location = -0.001, scale = 0.019, shape = 0.151, df = 4.98



mle computed with R package sn, qqPlot() from R package car  
© Eric Zivot 2008

# Test for Normality



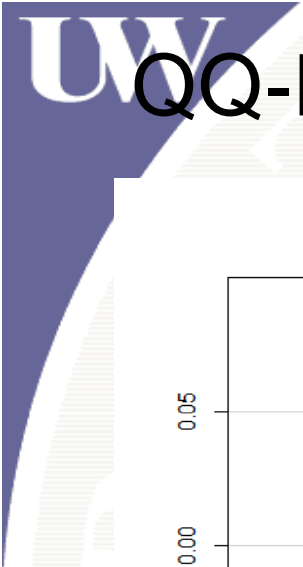
```
> jarque.bera.test(sp500)
```

Jarque Bera Test

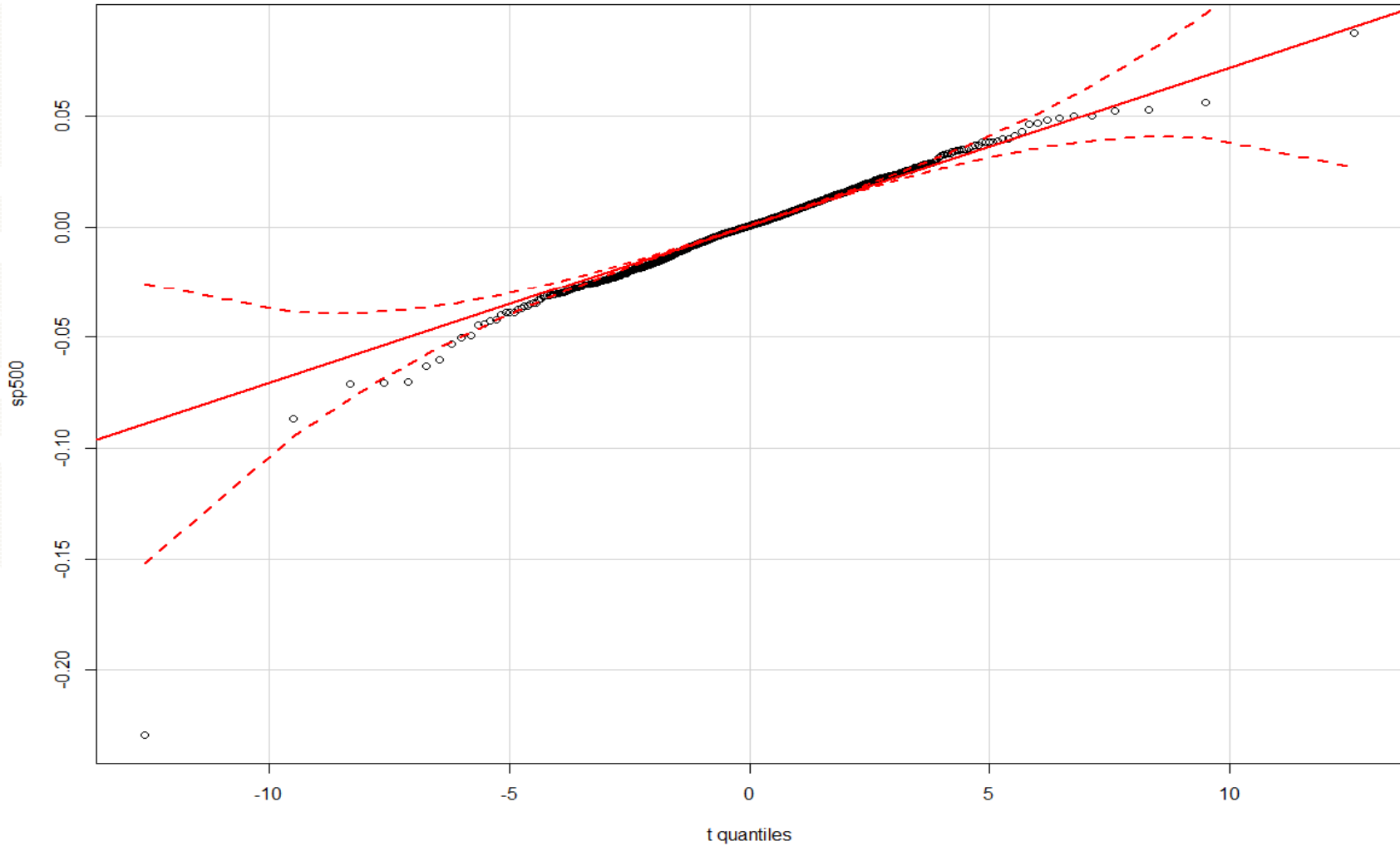
```
data: sp500
```

```
X-squared = 326705.3,
```

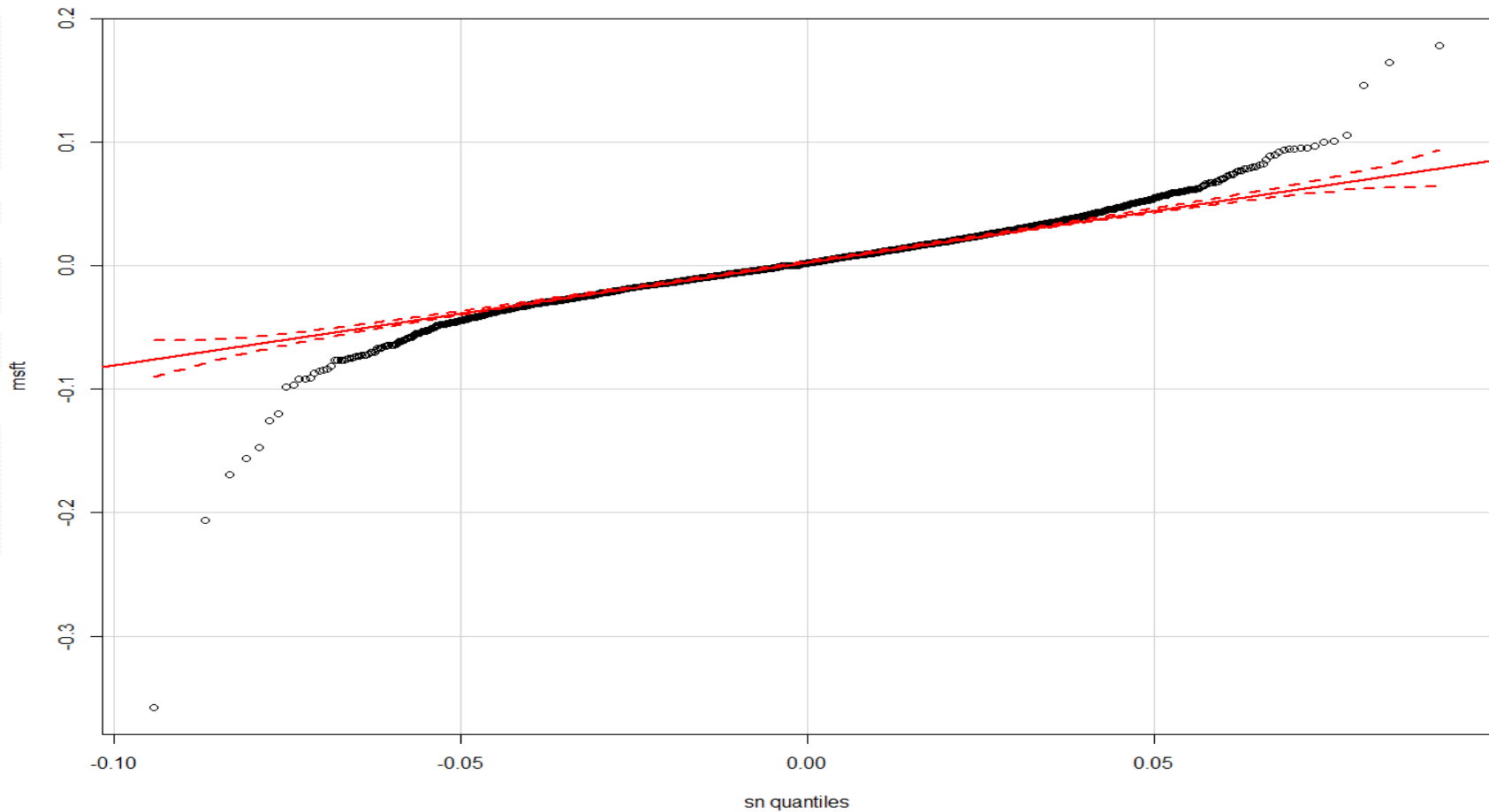
```
df = 2, p-value < 2.2e-16
```



# QQ-Plot: Student-t with 4 degrees of freedom

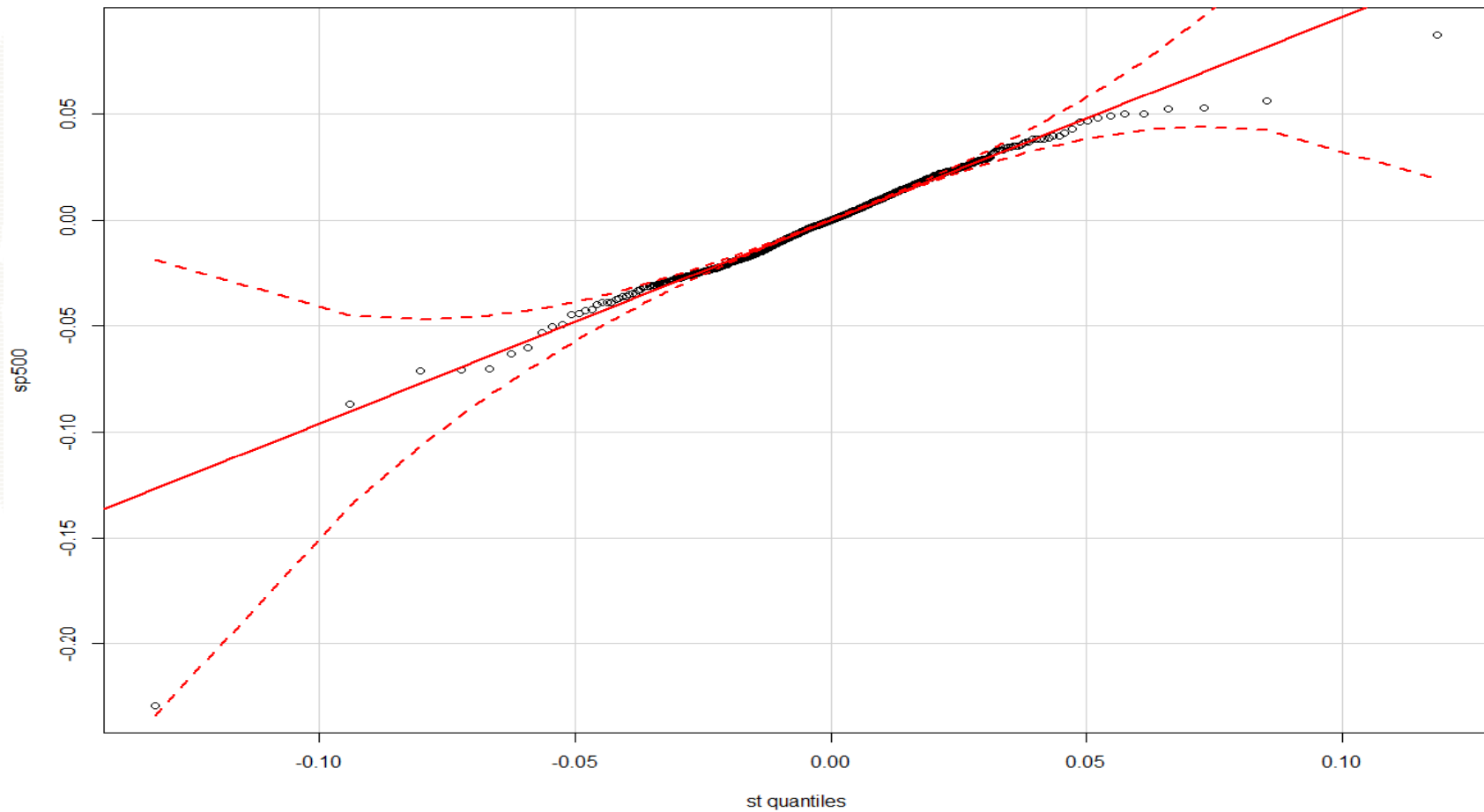


QQ-Plot: MLE of Skew-Normal for SP500  
location = 0.0002, scale = 0.011, shape = -0.218



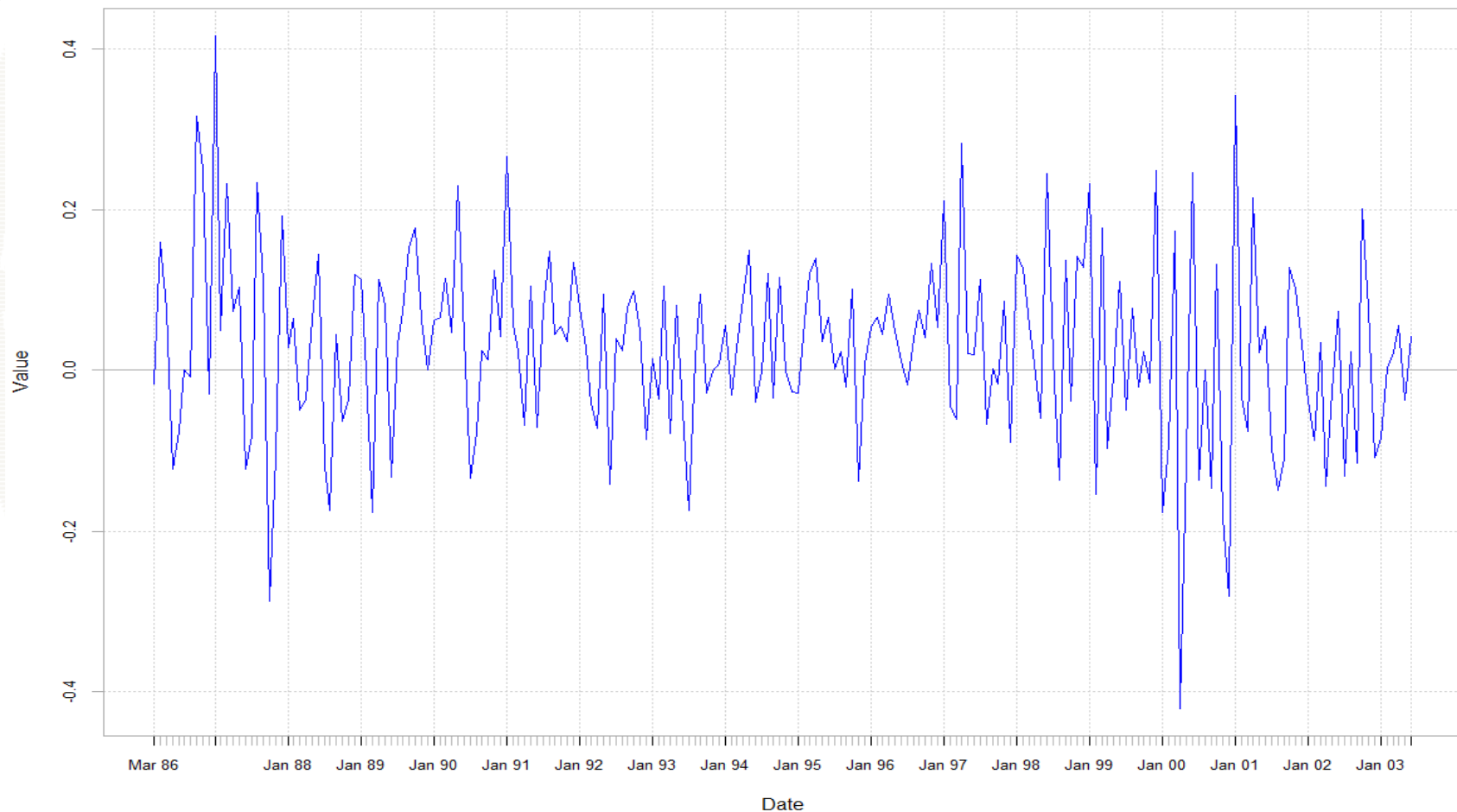
mle computed with R package sn, qqPlot() from R package car

QQ-Plot: MLE of Skew-t for SP500  
location = 0.001, scale = 0.007, shape = -0.138, df = 3.33



mle computed with R package sn, qqPlot() from R package car

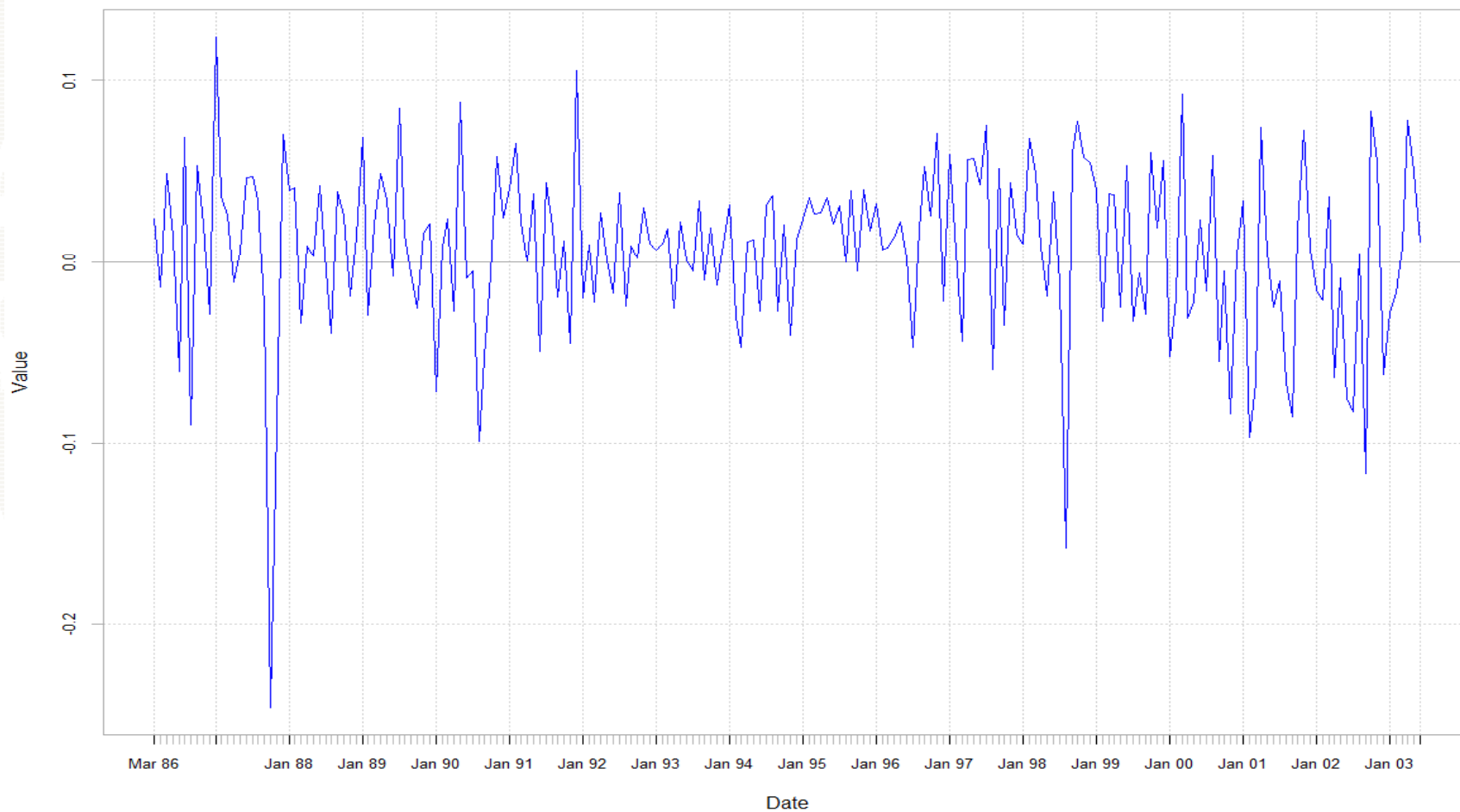
# Monthly CC Returns on MSFT



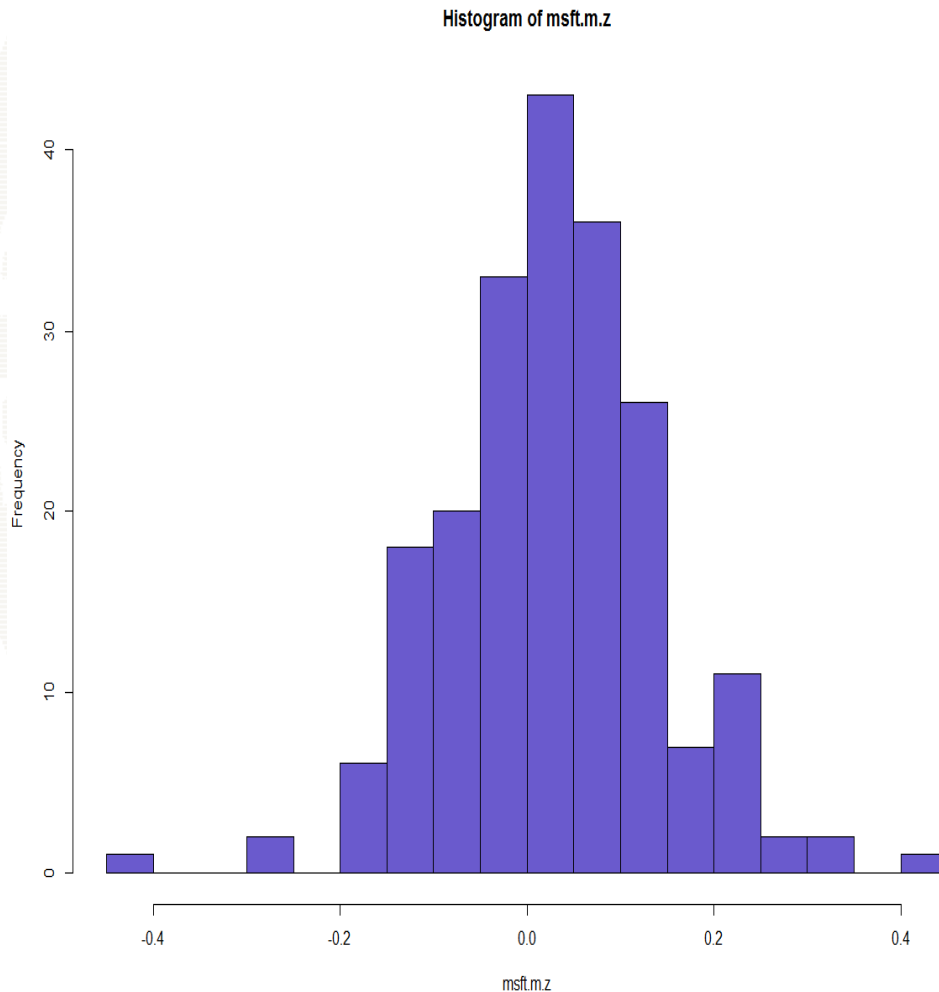
```
> msft.m.z = period.apply(msft.z, endpoints(msft.z, "months"), sum)
```



# Monthly CC Returns on SP500



# Distribution for Monthly CC Returns on MSFT

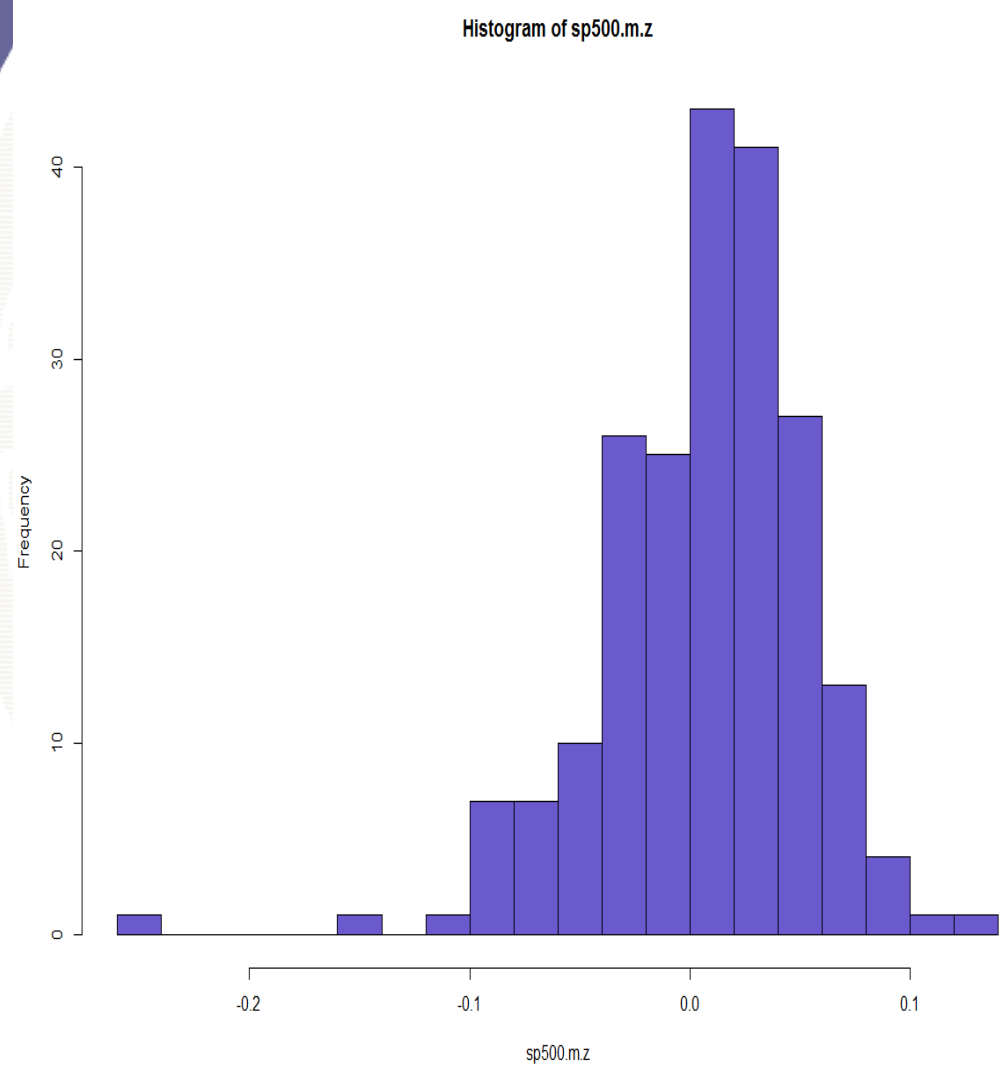


```
> table.Stats(msft.m.z)
```

|                 | msft.m.z |
|-----------------|----------|
| Observations    | 208.0000 |
| NAs             | 0.0000   |
| Minimum         | -0.4209  |
| Quartile 1      | -0.0394  |
| Median          | 0.0271   |
| Arithmetic Mean | 0.0268   |
| Geometric Mean  | 0.0201   |
| Quartile 3      | 0.0946   |
| Maximum         | 0.4158   |
| SE Mean         | 0.0080   |
| LCL Mean (0.95) | 0.0110   |
| UCL Mean (0.95) | 0.0427   |
| Variance        | 0.0134   |
| Stdev           | 0.1160   |
| Skewness        | -0.0130  |
| Kurtosis        | 1.1574   |

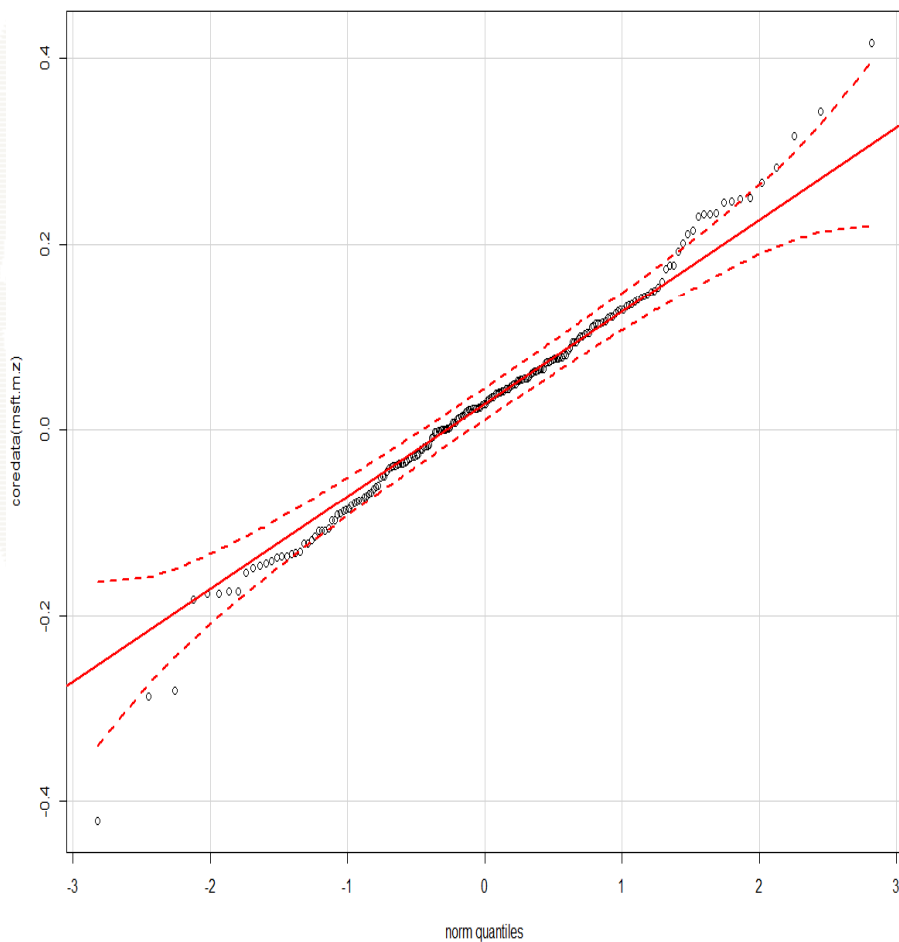


# Distribution for Monthly Returns on S&P 500



```
> table.Stats(sp500.m.z)
sp500.m.z
Observations      208.0000
NAs                0.0000
Minimum           -0.2454
Quartile 1        -0.0202
Median            0.0114
Arithmetic Mean   0.0069
Geometric Mean    0.0057
Quartile 3        0.0379
Maximum           0.1238
SE Mean           0.0033
LCL Mean (0.95)  0.0004
UCL Mean (0.95)  0.0133
Variance          0.0022
Stdev             0.0470
Skewness          -1.1008
Kurtosis          3.7185
```

# Test for Normality: MSFT



```
> jarque.bera.test(msft.m.z)
```

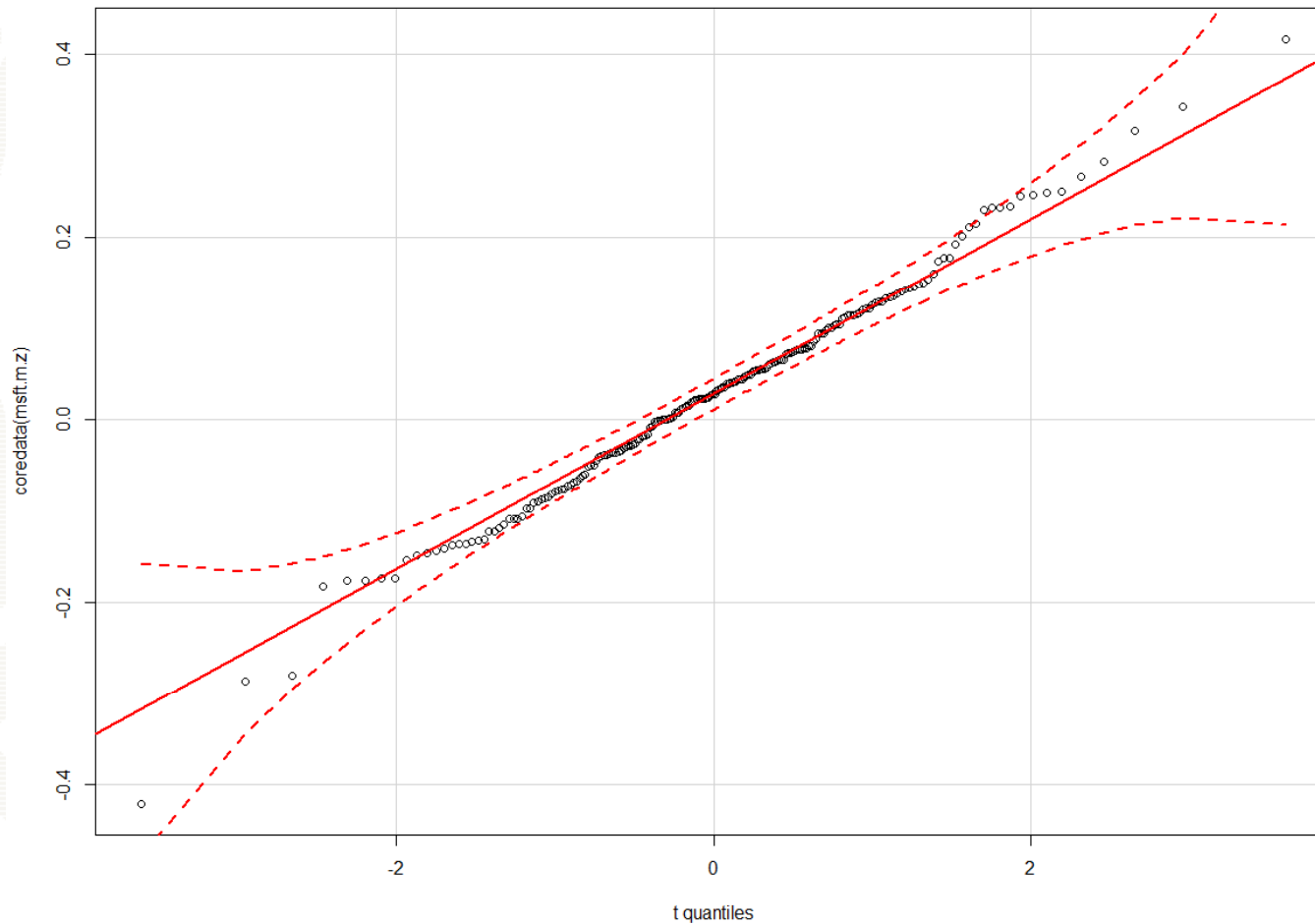
Jarque Bera Test

```
data: msft.m.z
```

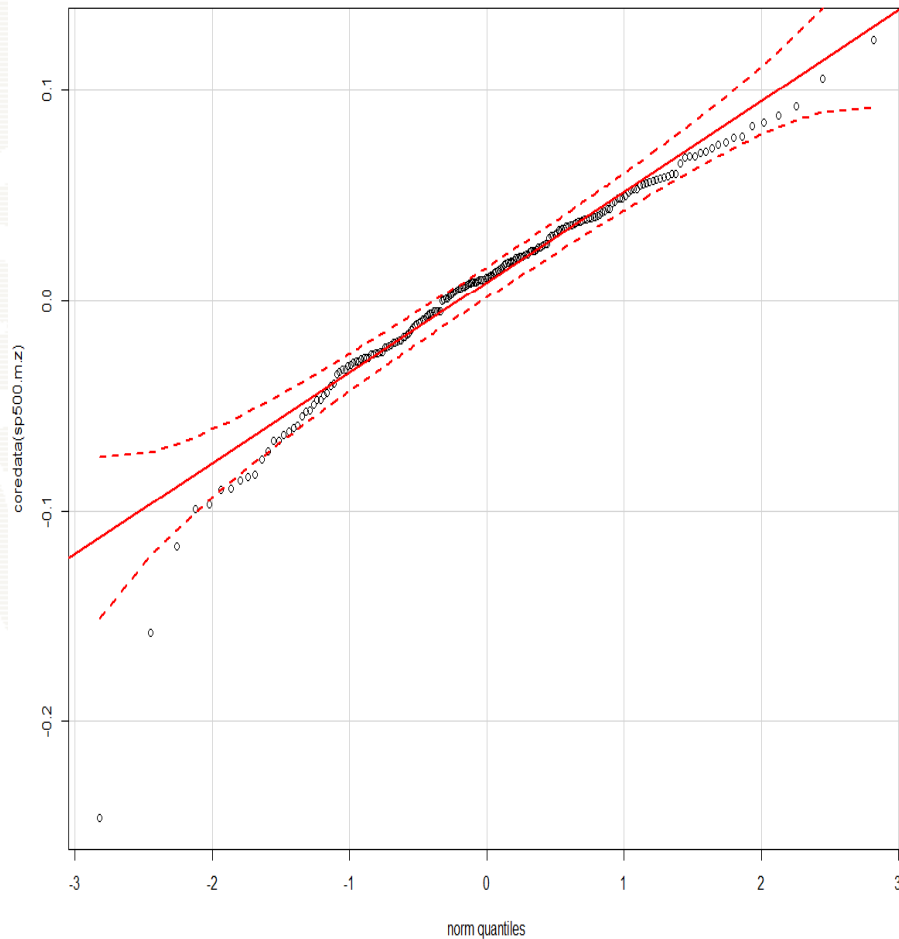
```
X-squared = 11.6156,
```

```
df = 2, p-value = 0.003004
```

# MSFT QQ-Plot: Student's t with 10 df



# Test for Normality: SP500

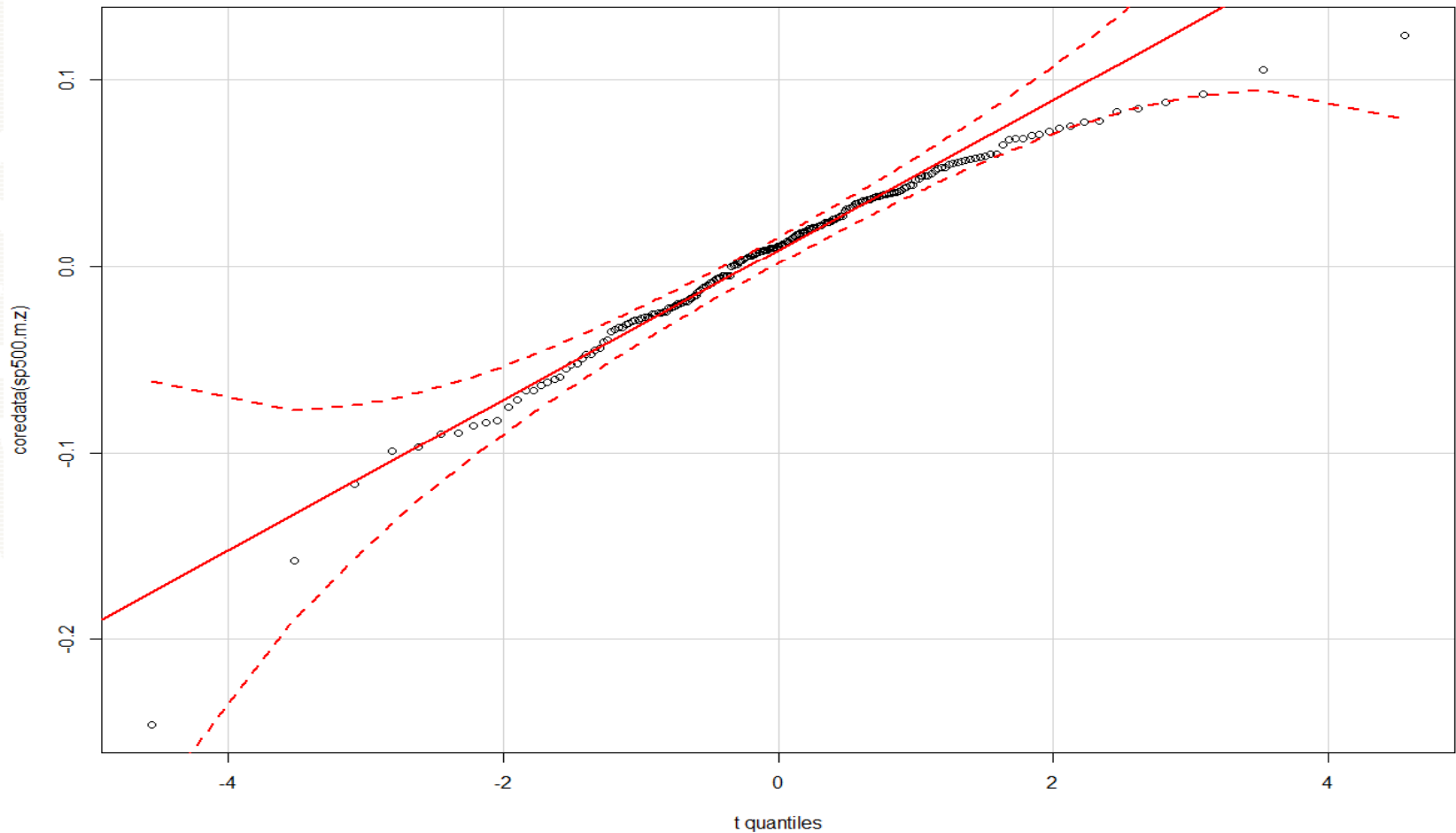


```
>  
jarque.bera.test(sp500.m.z)
```

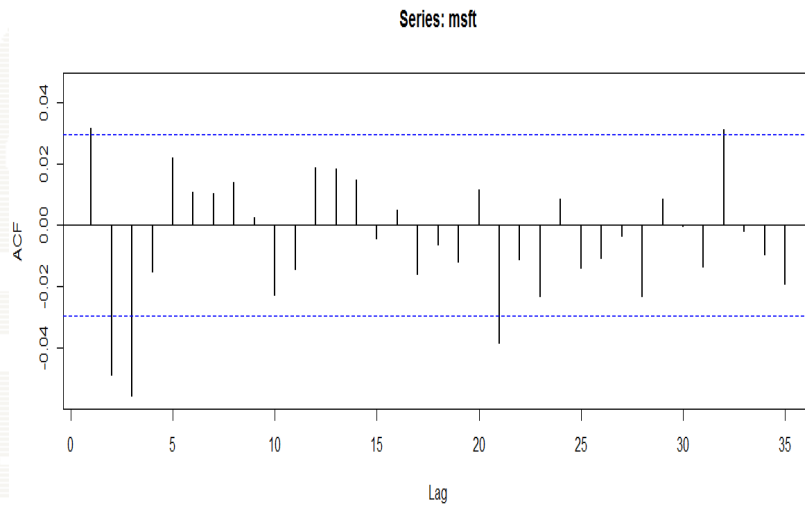
Jarque Bera Test

```
data: sp500.m.z  
X-squared = 161.845,  
df = 2, p-value < 2.2e-16
```

# SP500 QQ-Plot: Student's t with 5.5 df



# Testing for Autocorrelation



```
> Box.test(msft, type="Ljung-Box",  
lag = 12)
```

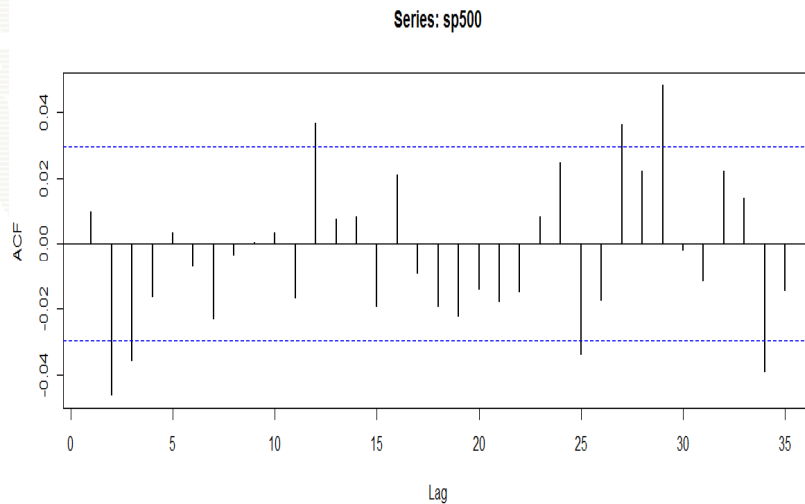
Box-Ljung test

```
data: msft  
X-squared = 38.0442, df = 12,  
p-value = 0.000151
```

```
> Box.test(sp500, type="Ljung-Box",  
lag = 12)
```

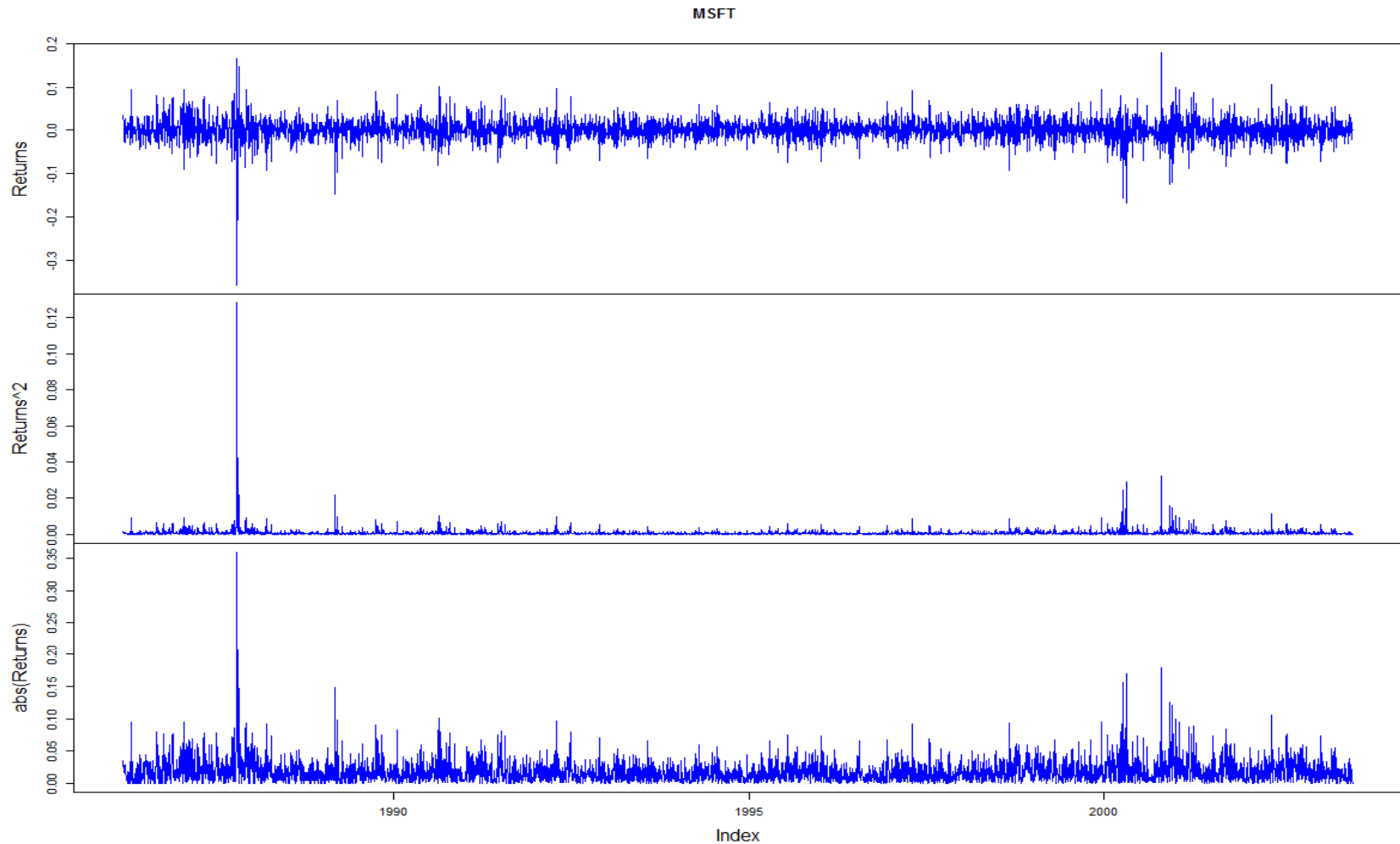
Box-Ljung test

```
data: sp500  
X-squared = 26.0727, df = 12,  
p-value = 0.01048
```

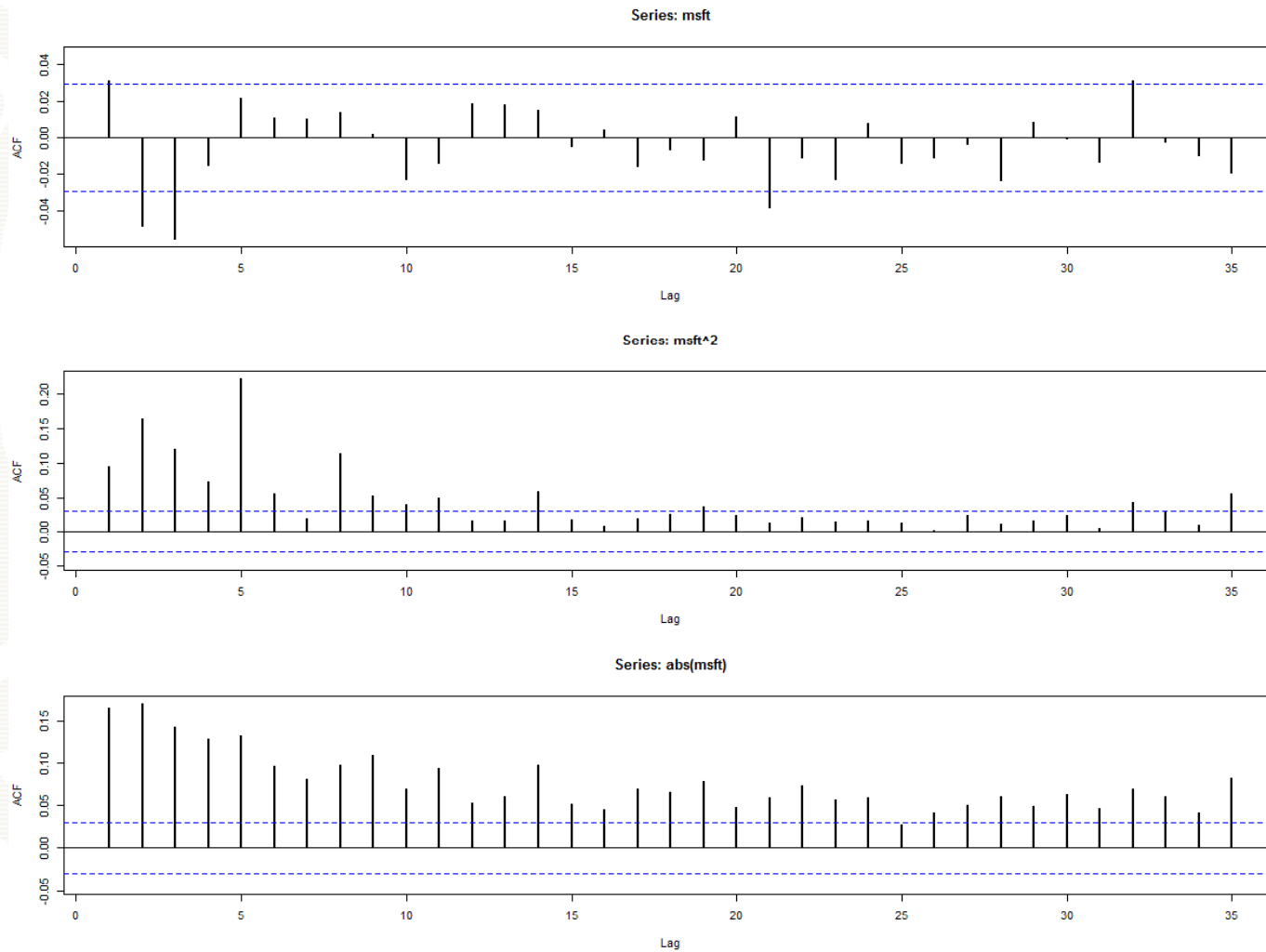




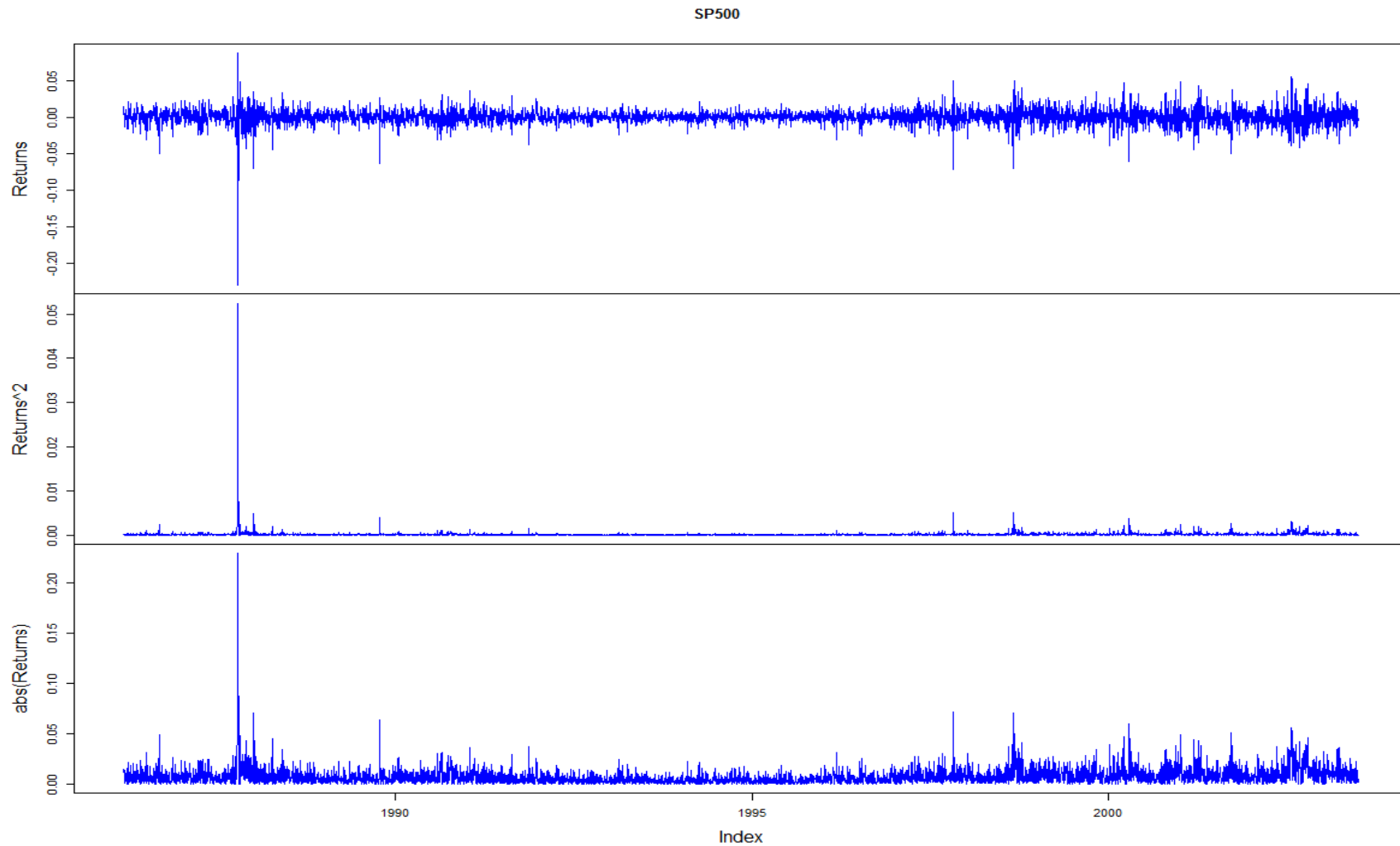
# MSFT: Volatility Clustering



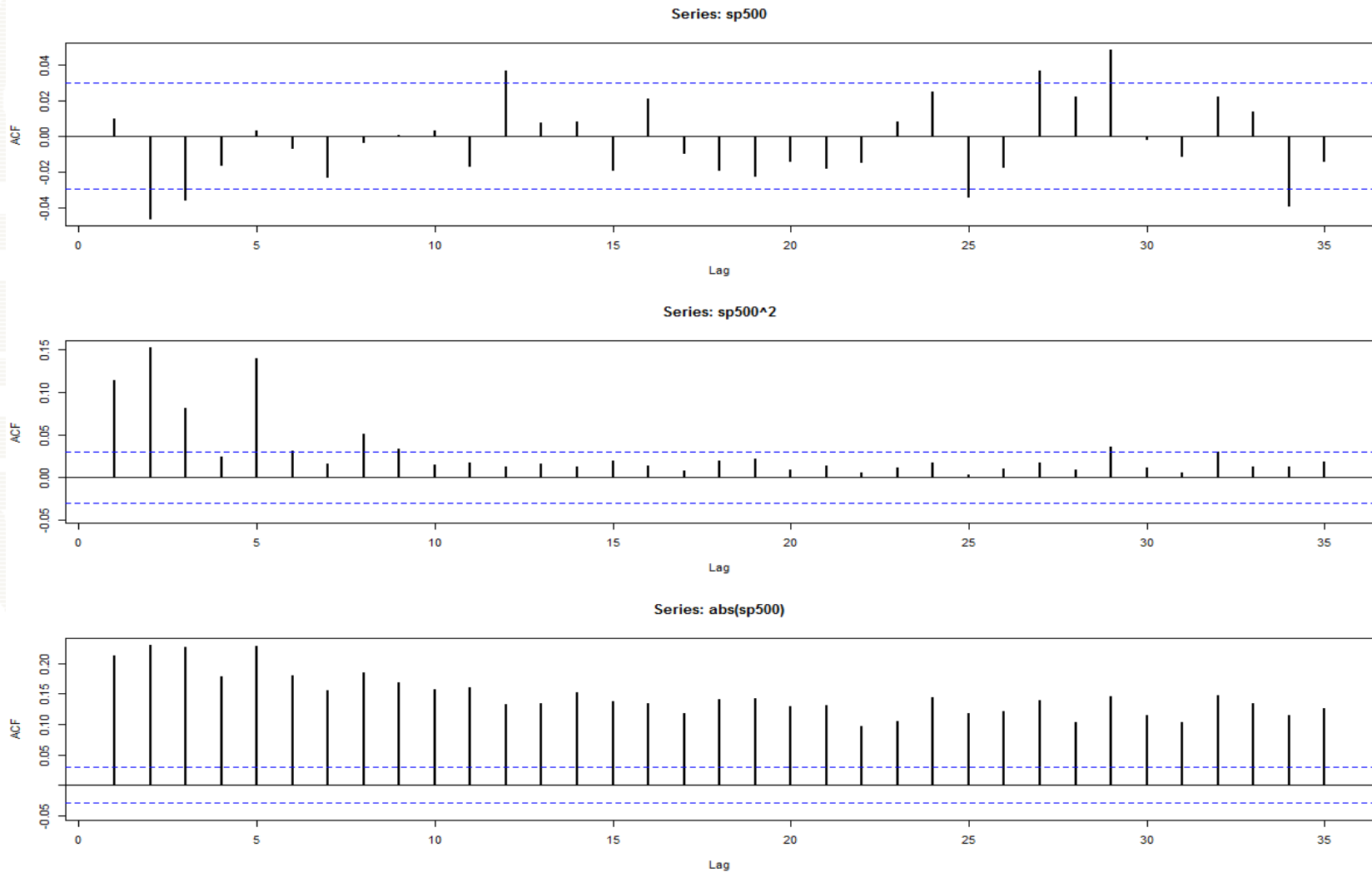
# MSFT: Volatility is Autocorrelated



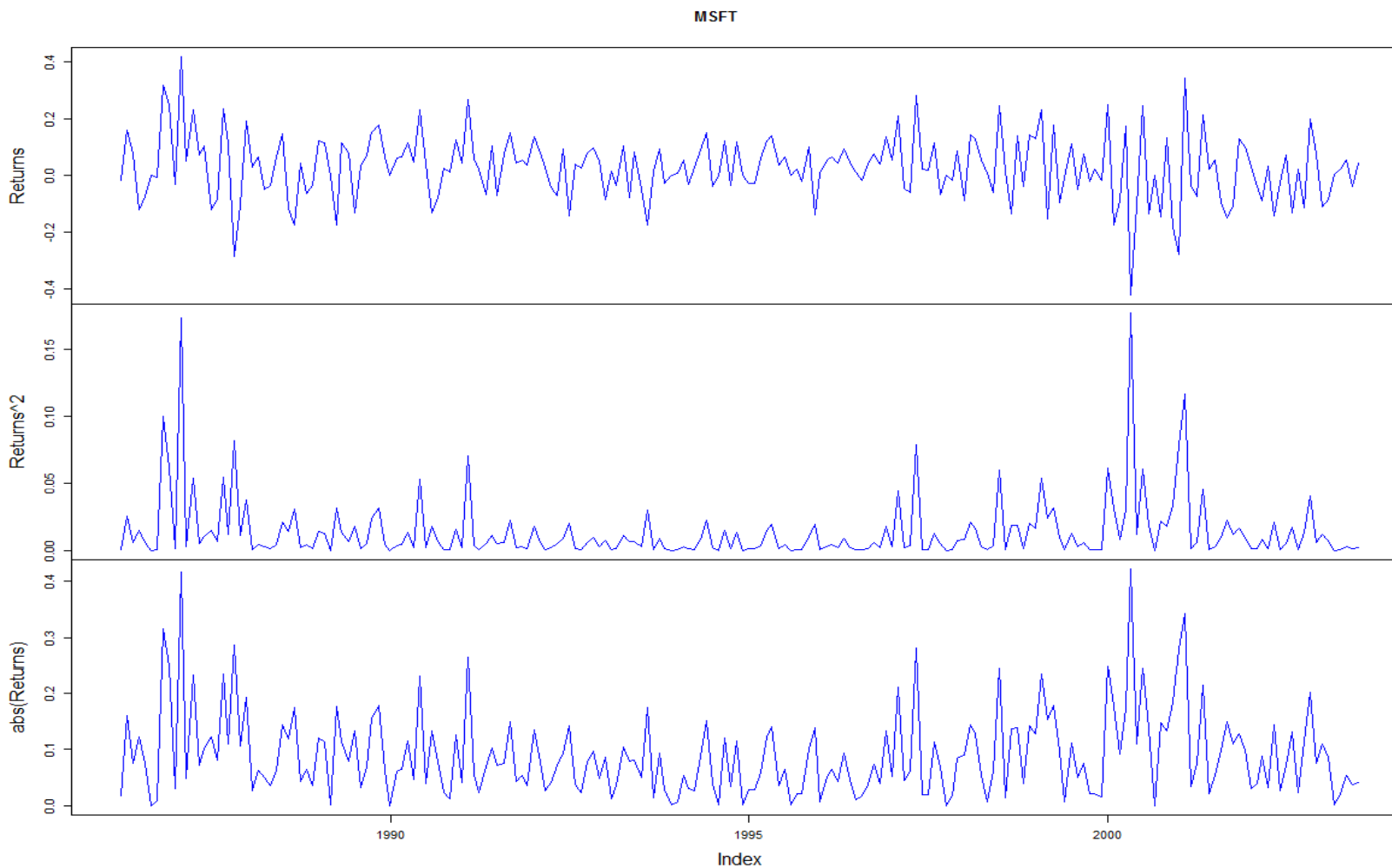
# SP500: Volatility Clustering



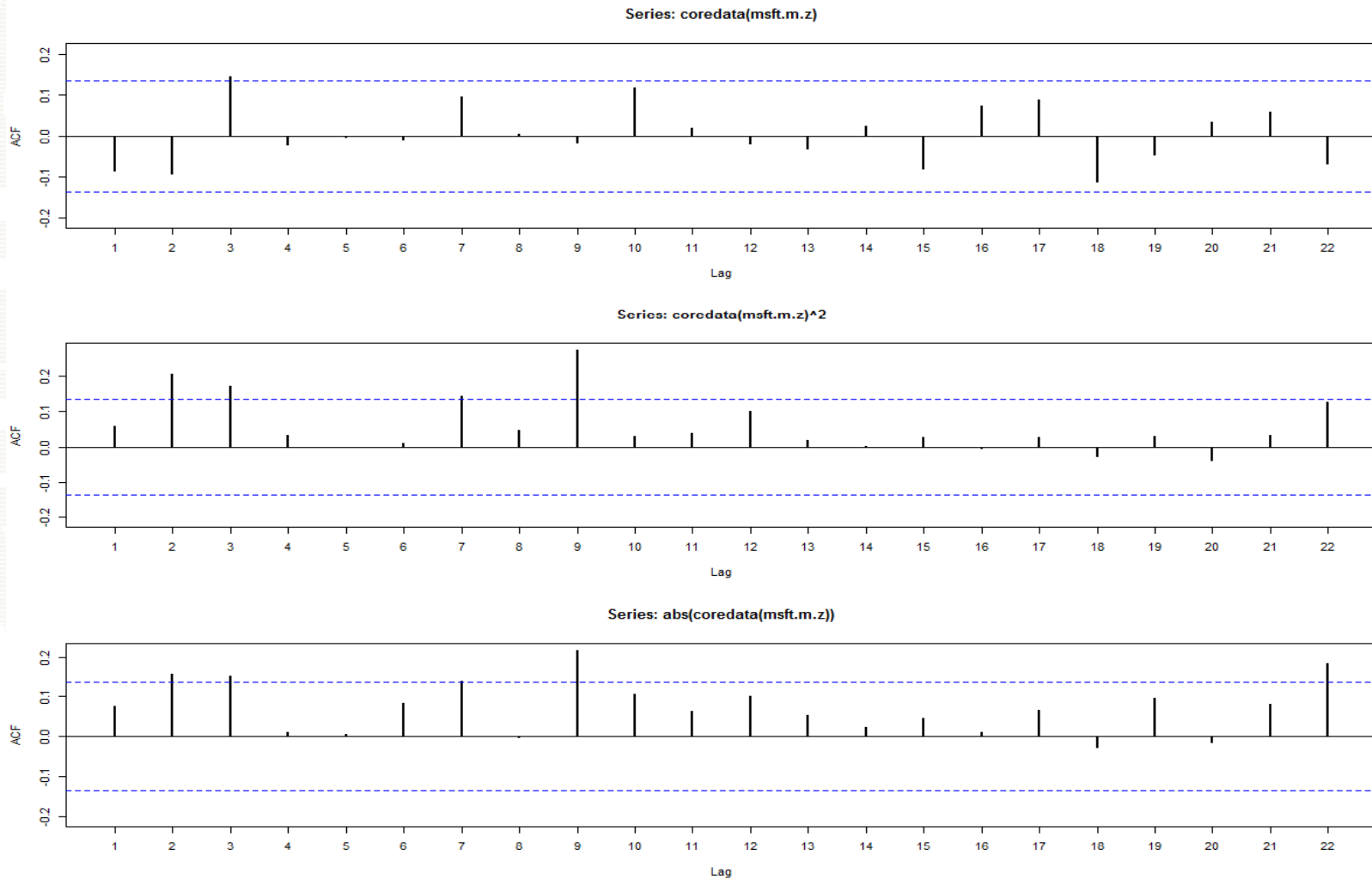
# SP500: Volatility is Autocorrelated



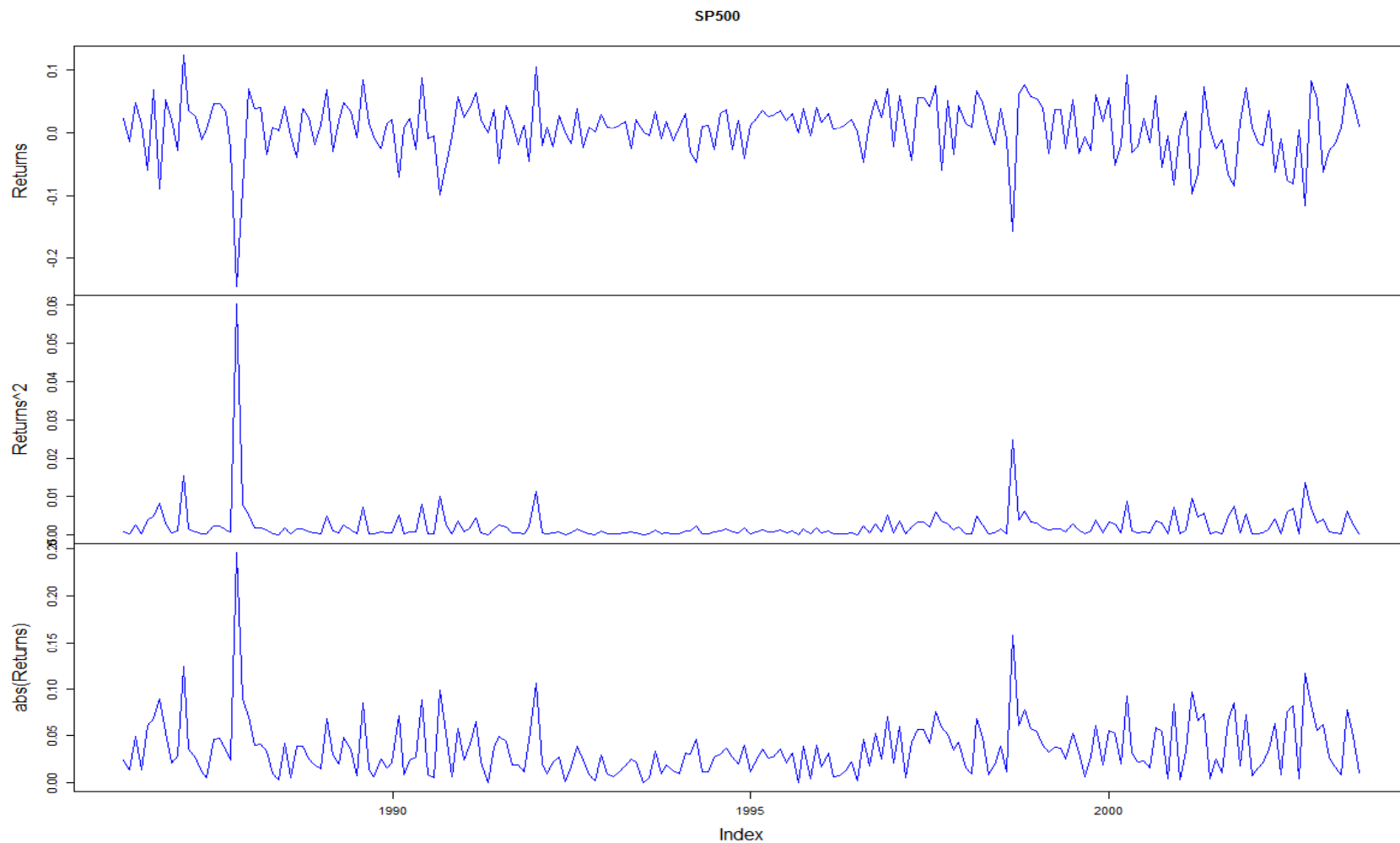
# Volatility Clustering: Monthly Returns



# Autocorrelations: MSFT Monthly Returns

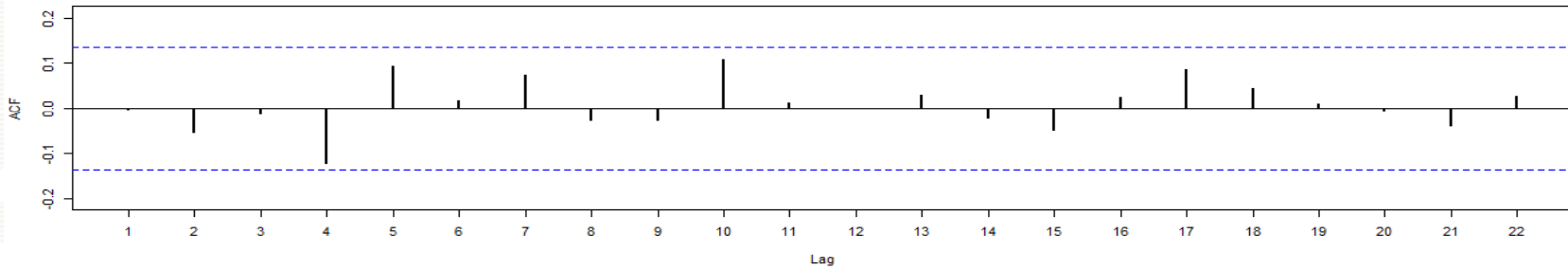


# Volatility Clustering: SP500 Monthly Returns

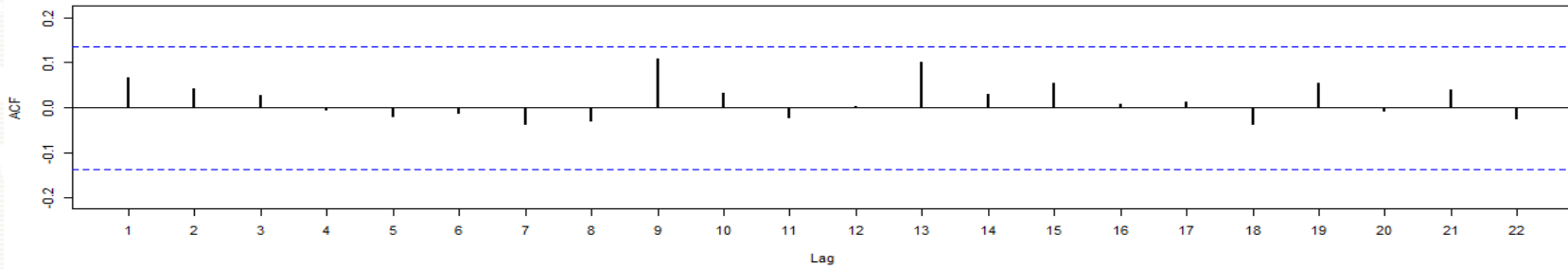


# Autocorrelations: SP500 Monthly Returns

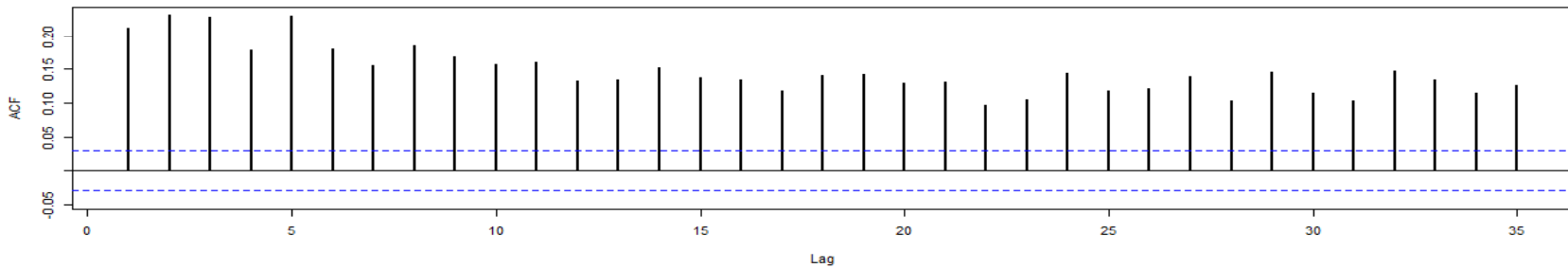
Series: coredata(sp500.m.z)



Series: coredata(sp500.m.z)^2

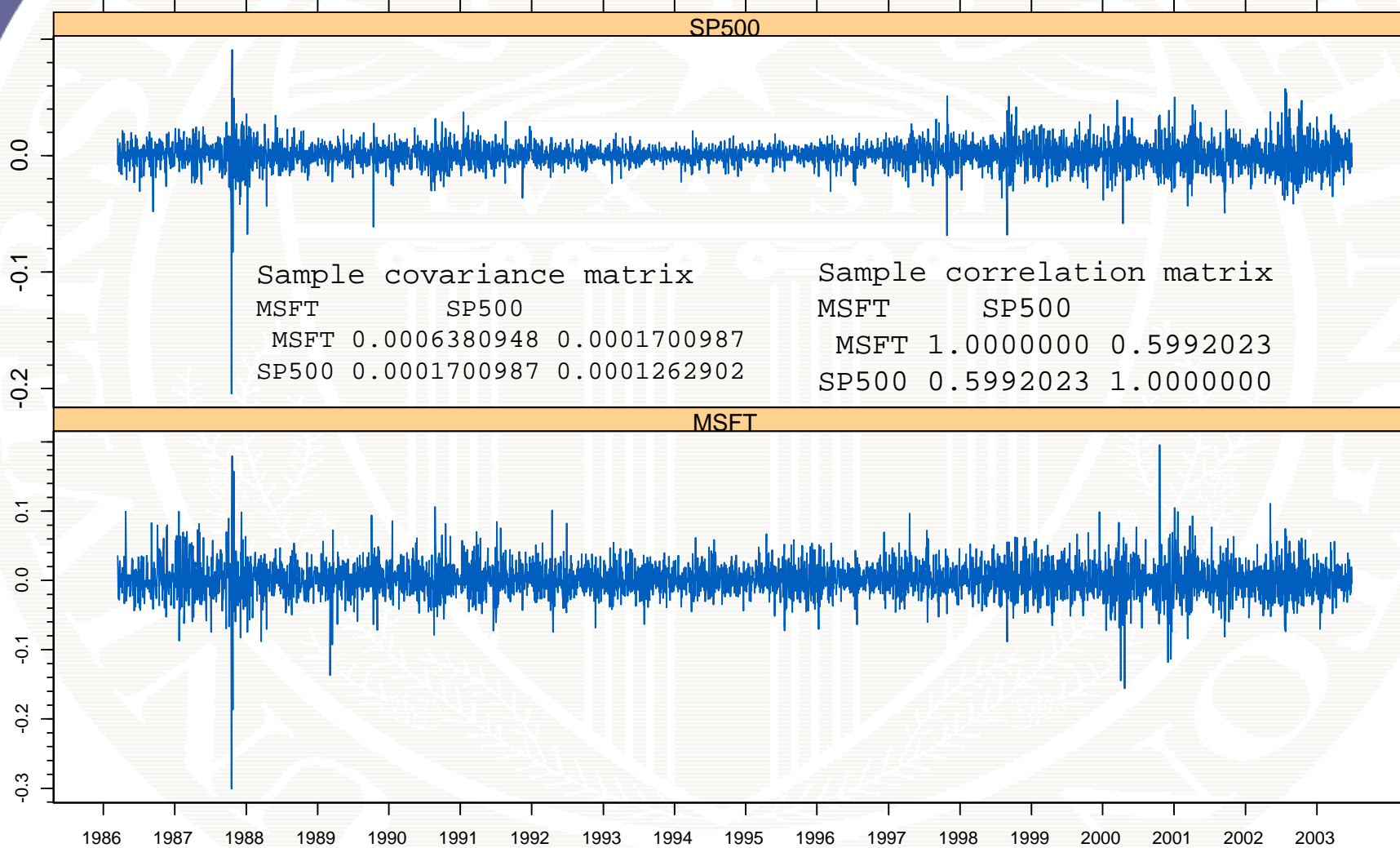


Series: abs(coredata(sp500))





# MSFT and S&P 500 Daily Returns



# EWMA Volatilities and Correlations

EWMA Conditional Volatilities

EWMA Conditional Correlation

