SAP - MJERENJE USPJEŠNOSTI INVESTICIJSKIH FONDOVA

Priprema podataka

```
source_eval <- function(file) source(file, print.eval = TRUE)
source_eval('uncommon.r')
```

Ekstrakcija i normalizacija podataka

```
source('data_extraction.r')
xs <- read_normalize(CSV_DATA)
```

Podjela prema tipovima fondova

```
investment_funds <- c("ERSTEAdriaticEquity", "OTPMeridian20", "ZBAktiv")
pension_funds <- c("RaiffeisenDMF", "ERSTEPlaviEXPERT", "ERSTEPlaviPROTECT")
market_portfolio <- c("CROBEX")

xs.market_portfolio <- to_data_frame(xs, market_portfolio, xs.market_portfolio)
xs.investment <- to_data_frame(xs, investment_funds, xs.investment)
xs.pension <- to_data_frame(xs, pension_funds, xs.pension)

data_columns <- c(pension_funds, investment_funds, market_portfolio)
xs.funds <- xs[, data_columns]
```

Povrati

Računanje dnevnih povrata

```
diff_function_log <- function(St, St_minus_one) log(St) - log(St_minus_one)
xs.log_returns <- to_time_series_diff_df(xs, data_columns, diff_function_log)

diff_function_sub <- function(St, St_minus_one) St - St_minus_one
xs.returns <- to_time_series_diff_df(xs, data_columns, diff_function_sub)

#weekly.returns <- to_week_returns(xs.returns, weekly.returns)
```

Sažeci

```
xs.summary <- summary(xs.funds)
xs.returns.summary <- summary(xs.returns[data_columns])
xs.log_returns.summary <- summary(xs.log_returns[data_columns])

df_summary <- function(summary) {
```

```
  return(data.frame(unclass(summary), check.names = FALSE, stringsAsFactors = FALSE))
}
```

Prikaz mjera vrijednosti po fondovima

```
df_summary(xs.summary)
```

```
##     RaiffeisenDMF ERSTEPlaviEXPERT ERSTEPlaviPROTECT ERSTEAdriaticEquity
## 1 Min.   :144.3    Min.   :123.6     Min.   :121.5      Min.   : 65.23
## 2 1st Qu.:153.2    1st Qu.:137.2     1st Qu.:135.0      1st Qu.: 75.46
## 3 Median :173.1    Median :157.3     Median :159.6      Median : 81.36
## 4 Mean   :178.2    Mean   :157.3     Mean   :157.5      Mean   : 81.76
## 5 3rd Qu.:208.5    3rd Qu.:179.9     3rd Qu.:178.3      3rd Qu.: 86.05
## 6 Max.   :227.2    Max.   :206.2     Max.   :194.3      Max.   :101.10
##     OTPMeridian20          ZBAktiv         CROBEX
## 1 Min.   :67.40   Min.   : 85.47   Min.   :1576
## 2 1st Qu.:80.79   1st Qu.: 97.29   1st Qu.:1739
## 3 Median :86.11   Median :101.44   Median :1805
## 4 Mean   :84.92   Mean   :102.54   Mean   :1852
## 5 3rd Qu.:90.54   3rd Qu.:108.71   3rd Qu.:1925
## 6 Max.   :96.56   Max.   :127.02   Max.   :2334
```

Prikaz mjera vrijednosti povrata po fondovima

```
df_summary(xs.returns.summary)
```

```
##        RaiffeisenDMF   ERSTEPlaviEXPERT ERSTEPlaviPROTECT
## 1 Min.   :-2.45070   Min.   :-2.29370   Min.   :-0.8897
## 2 1st Qu.:-0.08870   1st Qu.:-0.08020   1st Qu.:-0.0228
## 3 Median : 0.01150   Median : 0.00940   Median : 0.0173
## 4 Mean   : 0.03224   Mean   : 0.03219   Mean   : 0.0285
## 5 3rd Qu.: 0.15600   3rd Qu.: 0.16960   3rd Qu.: 0.0860
## 6 Max.   : 3.82210   Max.   : 1.72680   Max.   : 1.0905
##    ERSTEAdriaticEquity       OTPMeridian20            ZBAktiv
## 1 Min.   :-18.810000   Min.   :-5.355300   Min.   :-4.01201
## 2 1st Qu.: -0.110000   1st Qu.:-0.080400   1st Qu.:-0.12000
## 3 Median :  0.000000   Median : 0.000000   Median : 0.00000
## 4 Mean   :  0.003737   Mean   : 0.003509   Mean   : 0.01113
## 5 3rd Qu.:  0.110000   3rd Qu.: 0.151200   3rd Qu.: 0.17493
## 6 Max.   : 19.160000   Max.   : 3.268300   Max.   : 8.88000
##                 CROBEX
## 1 Min.   :-102.47000
## 2 1st Qu.:  -2.89000
## 3 Median :   0.00000
## 4 Mean   :  -0.01117
## 5 3rd Qu.:   3.36000
## 6 Max.   : 169.27000
```

Prikaz mjera vrijednosti logaritama povrata po fondovima

```
df_summary(xs.log_returns.summary)
```

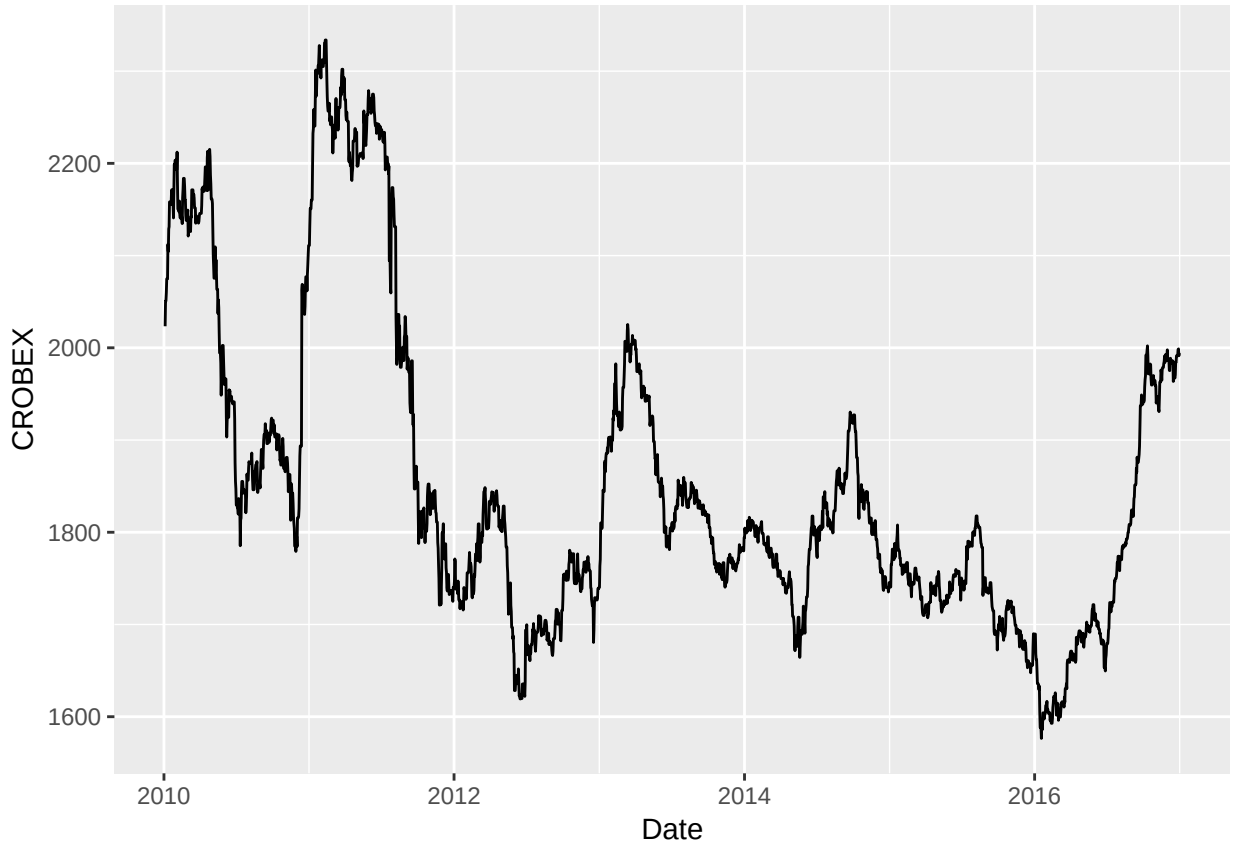
```
##          RaiffeisenDMF     ERSTEPlaviEXPERT    ERSTEPlaviPROTECT
## 1 Min.   :-1.587e-02   Min.   :-1.572e-02   Min.   :-0.0056697
## 2 1st Qu.:-5.139e-04   1st Qu.:-5.212e-04   1st Qu.:-0.0001435
## 3 Median : 6.687e-05   Median : 6.244e-05   Median : 0.0001221
## 4 Mean   : 1.768e-04   Mean   : 1.994e-04   Mean   : 0.0001838
```

```
## 5 3rd Qu.: 8.615e-04   3rd Qu.: 1.078e-03   3rd Qu.: 0.0005687
## 6 Max.   : 2.443e-02   Max.   : 1.257e-02   Max.   : 0.0088438
##    ERSTEAdriaticEquity        OTPMeridian20              ZBAktiv
## 1 Min.   :-2.109e-01   Min.   :-6.441e-02   Min.   :-3.693e-02
## 2 1st Qu.:-1.339e-03   1st Qu.:-9.773e-04   1st Qu.:-1.131e-03
## 3 Median : 0.000e+00   Median : 0.000e+00   Median : 0.000e+00
## 4 Mean   : 3.898e-05   Mean   : 3.821e-05   Mean   : 9.986e-05
## 5 3rd Qu.: 1.368e-03   3rd Qu.: 1.727e-03   3rd Qu.: 1.691e-03
## 6 Max.   : 2.153e-01   Max.   : 3.728e-02   Max.   : 9.412e-02
##                  CROBEX
## 1 Min.   :-4.776e-02
## 2 1st Qu.:-1.600e-03
## 3 Median : 0.000e+00
## 4 Mean   :-5.560e-06
## 5 3rd Qu.: 1.854e-03
## 6 Max.   : 8.563e-02
```

Grafički prikaz podataka

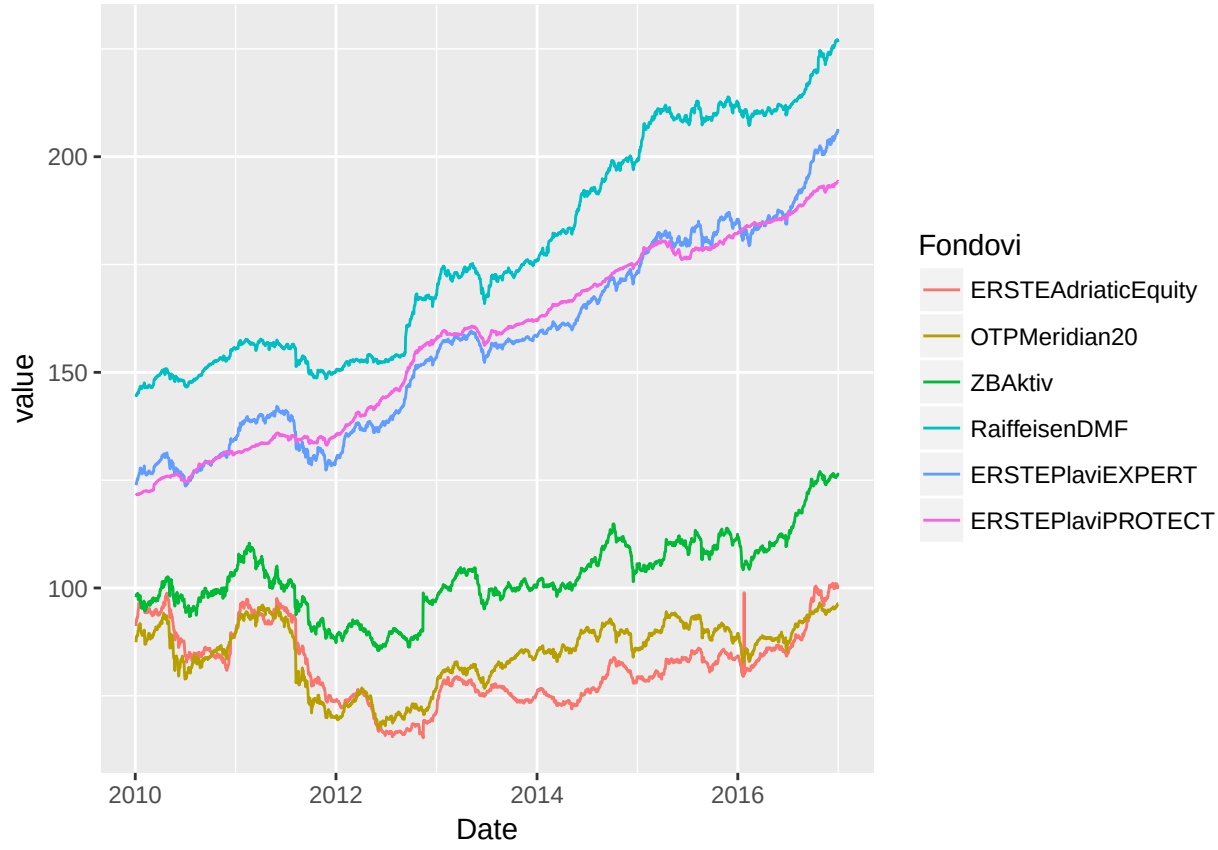
Prikaz vrijednosti CROBEX-a po danima

```
ggplot(xs, aes(Date, CROBEX)) + geom_line()
```



Prikaz vrijednosti investicijskih i mirovinskih fondova po danima

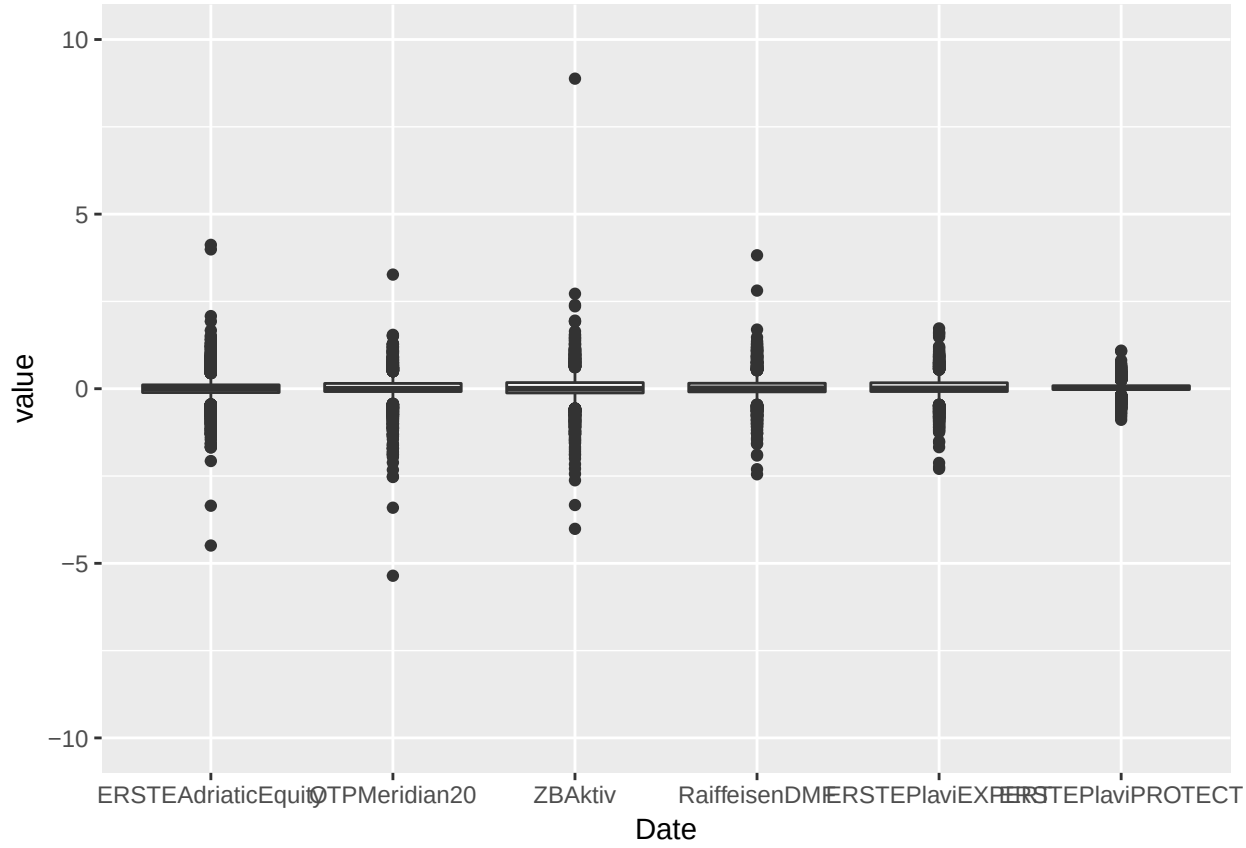
```
df <- melt(xs[c("Date", investment_funds, pension_funds)],
           id.vars = 'Date',
           variable.name = 'Fondovi')
ggplot(df, aes(Date, value)) + geom_line(aes(colour = Fondovi))
```



Prikaz boxplotova za sve fondove

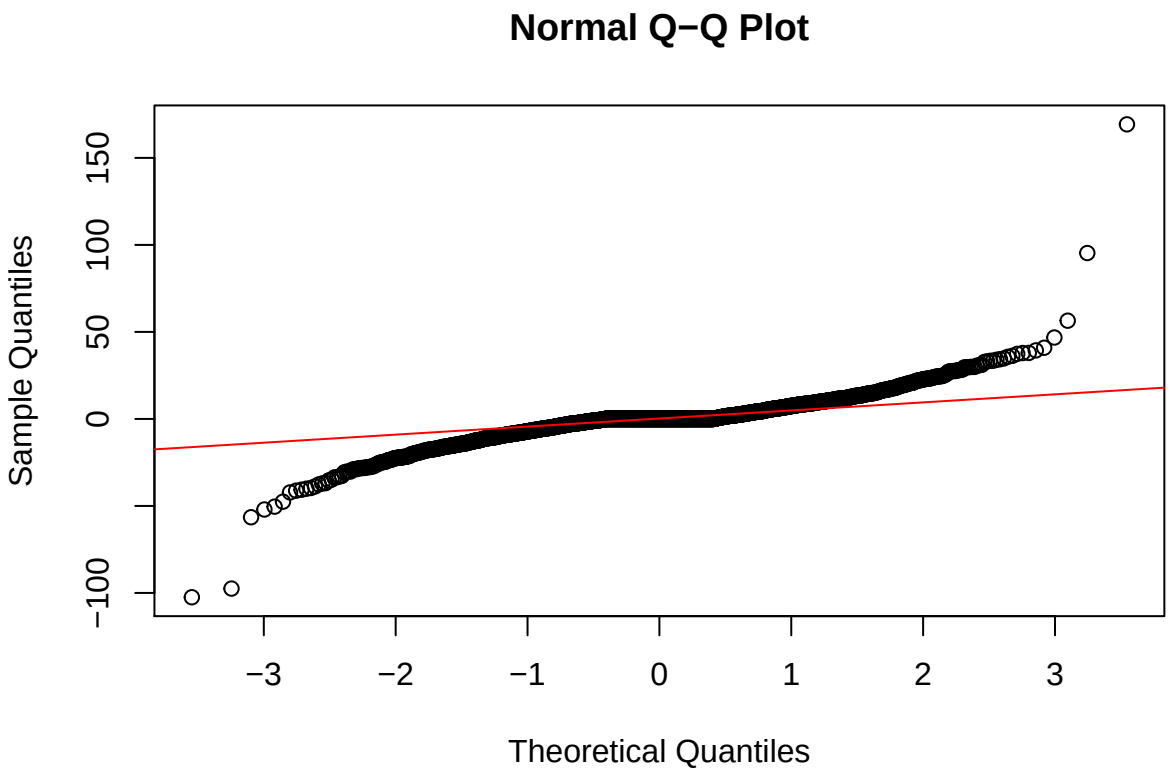
Iz ovih se grafova vidi kako investicijski fondovi(prva tri stupca) imaju puno više stršećih vrijednosti, odnosno podložniji su varijacijama.

```
df.returns <- melt(xs.returns[c("Date", investment_funds, pension_funds)],
                   id.vars = 'Date',
                   variable.name = 'Fondovi')
ggplot(df.returns, aes(Date, value)) + geom_boxplot(aes(Fondovi)) + ylim(c(-10, 10))
```

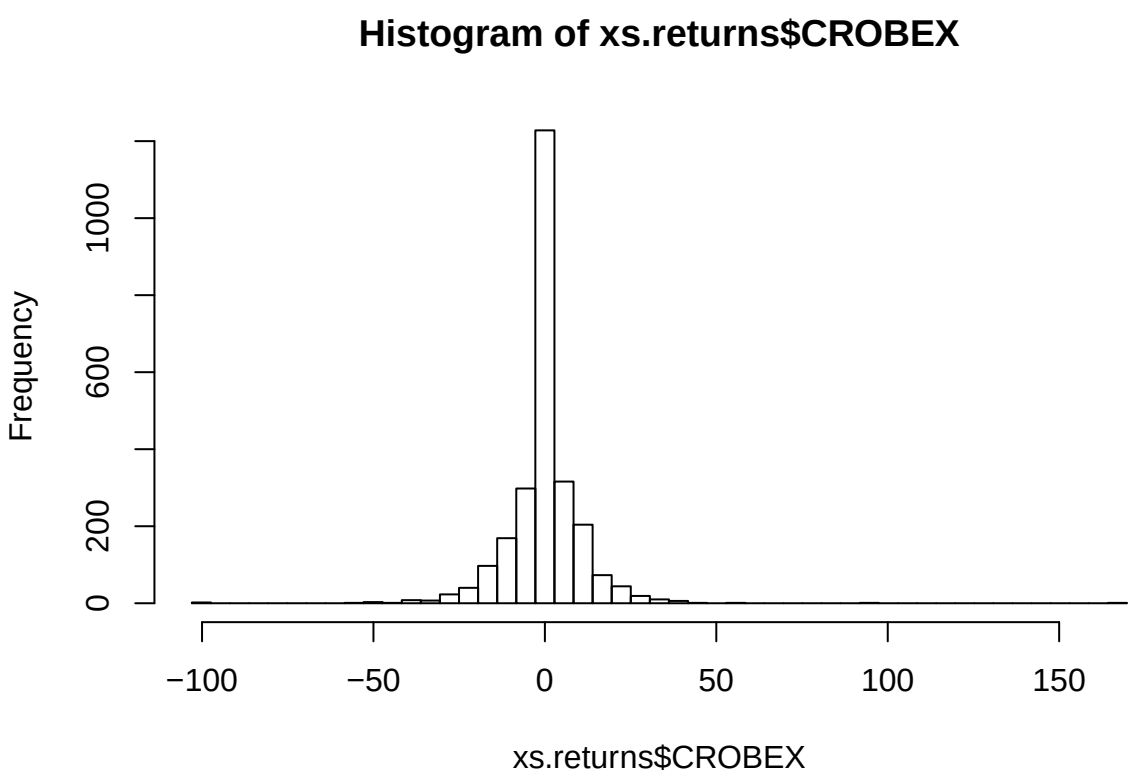


Sljedećim q-q plotom želimo ispitati normalnost distribucije burzovnog indeksa. Iz grafa vidimo kako podaci baš i nisu normalni, a iz sljedećeg grafa, gdje su isti podaci prikazani na histogramu se vidi i zašto. Pošto ima dosta stršećih vrijednosti, repovi su teški.

```
qqnorm(xs.returns$CROBEX)
qqline(xs.returns$CROBEX, col = "red")
```

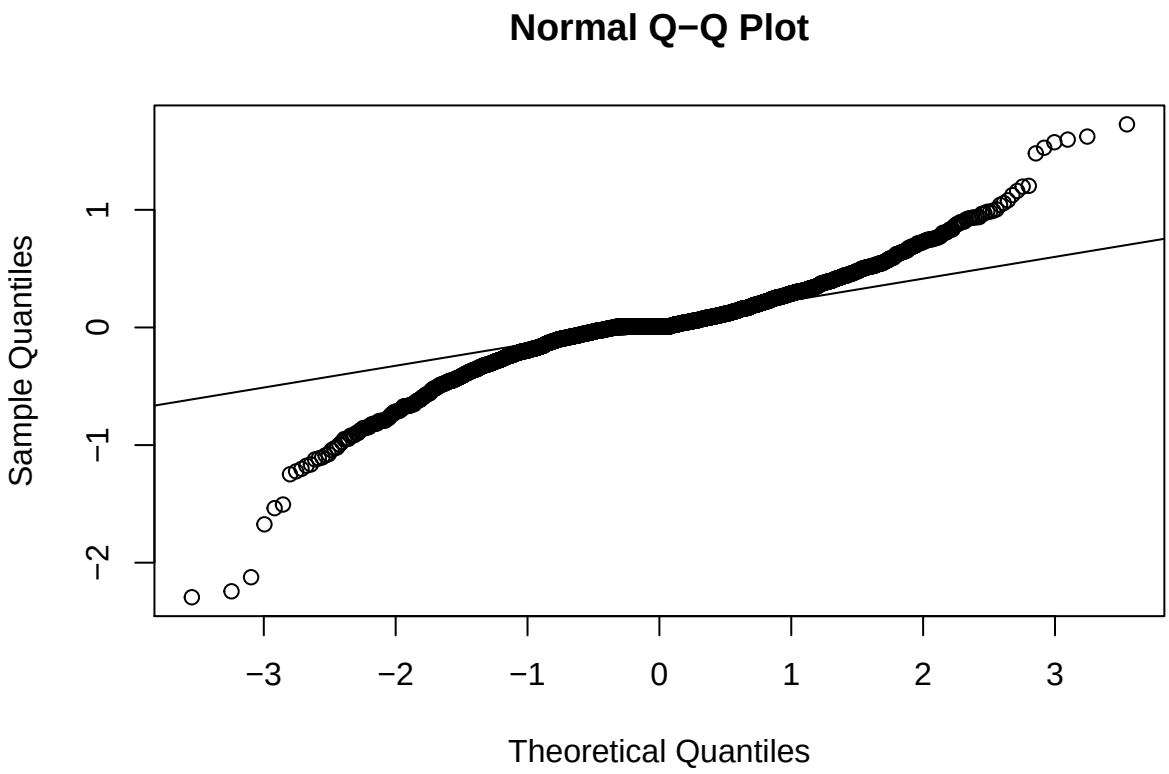



```
hist(xs.returns$CROBEX, breaks = seq(from = min(xs.returns$CROBEX) - 0.5, to = max(xs.returns$CROBEX) +
```



Sljedećim grafom htjela se ispitati normalnost jednog mirovinskog fonda. Vidimo kako ni on nema baš normalnu distribuciju.

```
qqnorm(xs.returns$ERSTEPlaviEXPERT)
qqline(xs.returns$ERSTEPlaviEXPERT)
```




```
#plot_timeseries(xs, xs$Date, xs$CROBEX)
#xs.graphs.timeseries <- mapply( function(data_col, name) plot_timeseries(xs, xs$Date, data_col, name),
#class(xs.graphs.timeseries)
#xs.graphs.boxplots <- boxplot(xs[get_data_cols_without_market_portfolio(xs)])
#xs.log_returns.graphs.boxplots <- boxplot(xs.log_returns[get_data_cols_without_market_portfolio(xs.log
```

TESTOVI NAD FONDOVIMA

Testovi povrata investicijskih fondova u odnosu na CROBEX

```
lapply(xs.returns[investment_funds], function(r) t.test(xs.returns$CROBEX, r))
```

```
## $ERSTEAdriaticEquity
##
##  Welch Two Sample t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.069516, df = 2570.3, p-value = 0.9446
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4354301  0.4056142
## sample estimates:
##   mean of x   mean of y
## -0.01117117  0.00373678
```

```
##
##
## $OTPMeridian20
##
##  Welch Two Sample t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.068529, df = 2558.8, p-value = 0.9454
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4347322  0.4053723
## sample estimates:
##    mean of x    mean of y
## -0.011171171  0.003508813
##
##
## $ZBAktiv
##
##  Welch Two Sample t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.10408, df = 2561.7, p-value = 0.9171
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4424737  0.3978685
## sample estimates:
##   mean of x   mean of y
## -0.01117117  0.01113147
```

Testovi povrata mirovinskih fondova u odnosu na CROBEX

```
lapply(xs.returns[pension_funds], function(r) t.test(xs.returns$CROBEX, r))
```

```
## $RaiffeisenDMF
##
##  Welch Two Sample t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.20268, df = 2556.8, p-value = 0.8394
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4633757  0.3765598
## sample estimates:
##   mean of x   mean of y
## -0.01117117  0.03223678
##
##
## $ERSTEPlaviEXPERT
##
##  Welch Two Sample t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.20246, df = 2556.5, p-value = 0.8396
```

```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4633176  0.3765981
## sample estimates:
##   mean of x   mean of y
## -0.01117117  0.03218860
##
##
## $ERSTEPlaviPROTECT
##
##  Welch Two Sample t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.1853, df = 2553, p-value = 0.853
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4594814  0.3801406
## sample estimates:
##   mean of x   mean of y
## -0.01117117  0.02849922
```

Test povrata investicijskih fondova u odnosu na mirovinske fondove

Izračunate su sredine mirovinskih i investicijskih fondova pa je sproveden test jednakosti dviju sredina. Dobivamo p-vrijednost 0.0039, i zaključujemo kako možemo odbaciti hipotezu kako su sredine jednake.

```
grouped.return.means = data.frame(Date = xs.returns[,1],
                                  MeansPension = rowMeans(xs.returns[pension_funds]),
                                  MeansInvestment = rowMeans(xs.returns[investment_funds]))

t.test(grouped.return.means$MeansPension, grouped.return.means$MeansInvestment)
```

```
##
##  Welch Two Sample t-test
##
## data:  grouped.return.means$MeansPension and grouped.return.means$MeansInvestment
## t = 2.8905, df = 4334.1, p-value = 0.003866
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.007994742 0.041703613
## sample estimates:
##   mean of x   mean of y
## 0.030974866 0.006125689
```