Mjerenje uspješnosti investicijskih fondova

Priprema podataka

Prilikom proučavanja podataka primjetili smo da vrijednost fonda ErsteAdriaticEquity za 24.1.2016. poprilično odskače od okolnih datuma. Pretragom na stranici Erste grupe ustvrdili smo pogrešku u unosu podataka te smo ručno ispravili vrijednost.

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

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

Priprema i analiza podataka

Podjela prema tipovima fondova

```
investment_funds <- c("ERSTEAdriaticEquity", "OTPMeridian20", "ZBAktiv")
pension_funds <- c("RaiffeisenDMF", "ERSTEPlaviEXPERT", "ERSTEPlaviPROTECT")
all_funds <- c(investment_funds, pension_funds)
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.returns <- to_time_series_diff_df(xs, data_columns, diff_function_log)
#Postavljanje velikih skokova u 0
#xs.returns$ERSTEAdriaticEquity[2211:2212] <- 0

#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)
```

Sažeci

```
xs.summary <- summary(xs.funds)
xs.returns.summary <- summary(xs.returns[data_columns] * 365)
# xs.log_returns.summary <- summary(xs.log_returns[data_columns])
```

```
df_summary <- function(summary) {
  return(data.frame(unclass(summary), check.names = FALSE, stringsAsFactors = FALSE))
}

df_summary(xs.returns.summary)
```

```
##        RaiffeisenDMF   ERSTEPlaviEXPERT  ERSTEPlaviPROTECT
## 1 Min.   :-5.79209   Min.   :-5.73634   Min.   :-2.06945
## 2 1st Qu.:-0.18757   1st Qu.:-0.19025   1st Qu.:-0.05239
## 3 Median : 0.02441   Median : 0.02279   Median : 0.04456
## 4 Mean   : 0.06451   Mean   : 0.07278   Mean   : 0.06709
## 5 3rd Qu.: 0.31443   3rd Qu.: 0.39346   3rd Qu.: 0.20759
## 6 Max.   : 8.91872   Max.   : 4.58776   Max.   : 3.22798
##   ERSTEAdriaticEquity       OTPMeridian20             ZBAktiv
## 1 Min.   :-18.08756   Min.   :-23.51025   Min.   :-13.47776
## 2 1st Qu.: -0.48492   1st Qu.: -0.35673   1st Qu.: -0.41271
## 3 Median :  0.00000   Median :  0.00000   Median :  0.00000
## 4 Mean   :  0.01423   Mean   :  0.01395   Mean   :  0.03645
## 5 3rd Qu.:  0.50246   3rd Qu.:  0.63048   3rd Qu.:  0.61738
## 6 Max.   : 21.67018   Max.   : 13.60614   Max.   : 34.35281
##               CROBEX
## 1 Min.   :-17.43339
## 2 1st Qu.: -0.58382
## 3 Median :  0.00000
## 4 Mean   : -0.00203
## 5 3rd Qu.:  0.67653
## 6 Max.   : 31.25453
```

Mjere raspršenosti

```
apply(xs.returns[all_funds] * 365, 2, var, na.rm=T)
```

```
## ERSTEAdriaticEquity       OTPMeridian20             ZBAktiv
##           2.6042430           2.9791195           2.9481469
##       RaiffeisenDMF    ERSTEPlaviEXPERT   ERSTEPlaviPROTECT
##           0.4614040           0.5900631           0.1230300
```

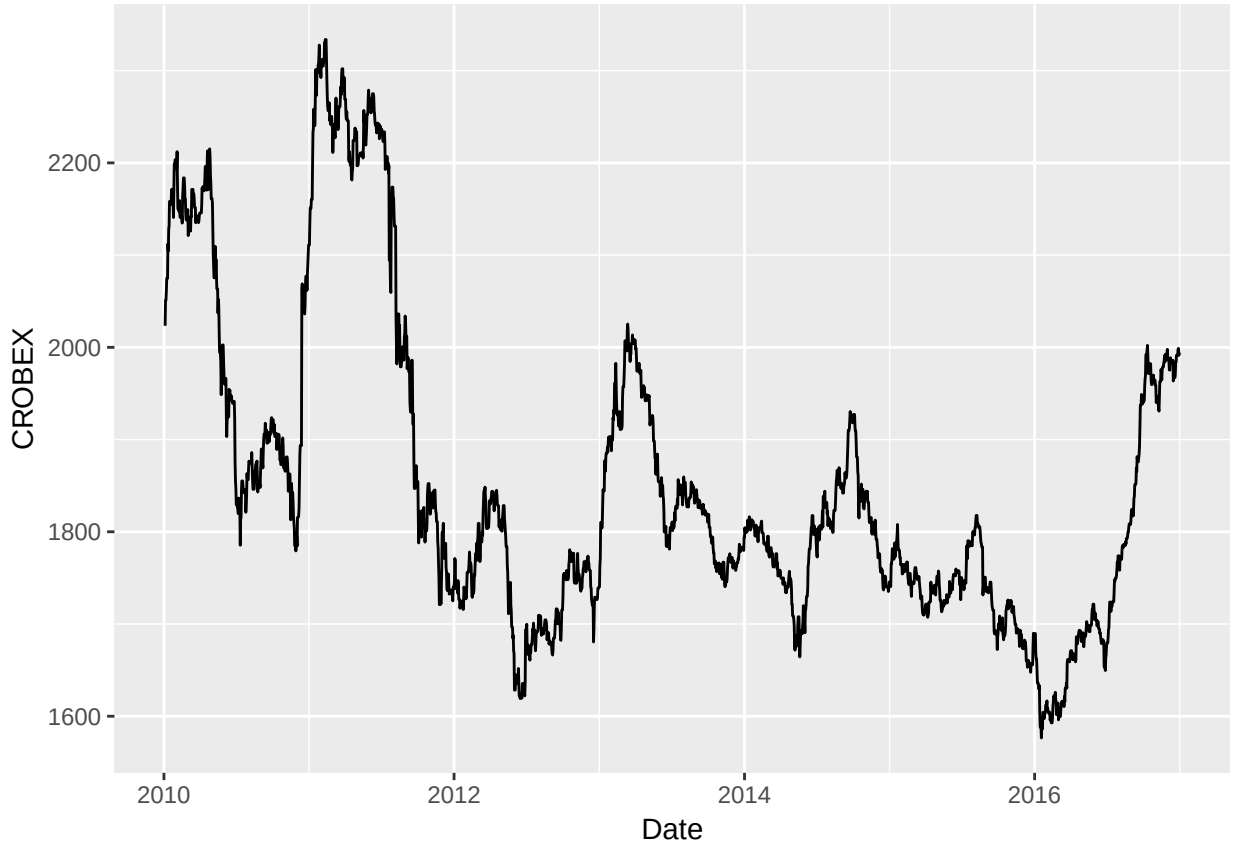
```
apply(xs.returns[all_funds] * sqrt(365), 2, sd, na.rm=T)
```

```
## ERSTEAdriaticEquity       OTPMeridian20             ZBAktiv
##          0.08446841          0.09034363          0.08987277
##       RaiffeisenDMF    ERSTEPlaviEXPERT   ERSTEPlaviPROTECT
##          0.03555447          0.04020710          0.01835943
```

Grafički prikaz podataka

Prikaz vrijednosti CROBEX-a po danima

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



Prikaz vrijednosti investicijskih i mirovinskih fondova po danima

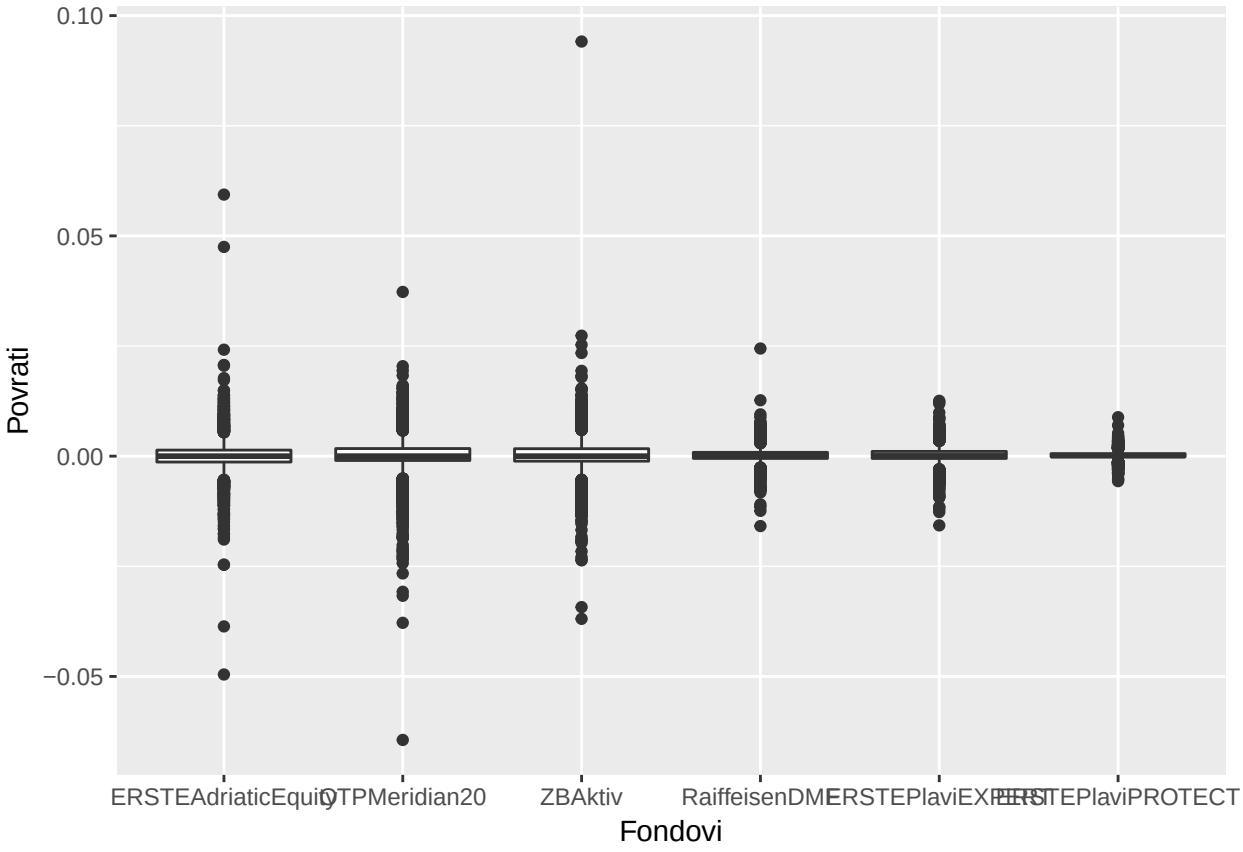
```
df <- melt(xs[c("Date", investment_funds, pension_funds)],
           id.vars = 'Date',
           variable.name = 'Fondovi')
ggplot(df, aes(Date, value)) + geom_line(aes(colour = Fondovi))
```

Prikaz boxplotova za sve fondove

Iz ovih se grafova vidi kako su investicijski fondovi (prva tri stupca) podložniji većim promjenama vrijednosti od mirovinskih na dnevnoj bazi.

```
df.returns <- melt(xs.returns[c("Date", investment_funds, pension_funds)],
                   id.vars = 'Date',
                   variable.name = 'Fondovi')
```

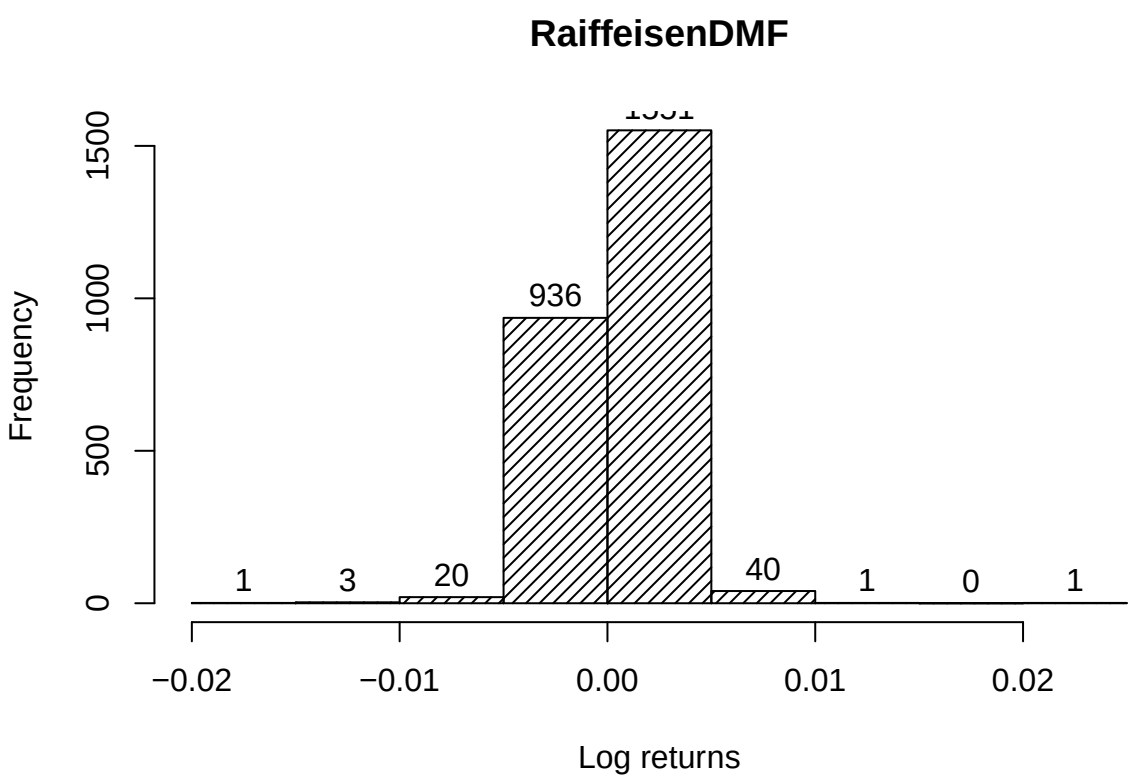
```
ggplot(df.returns, aes(Date, value)) +
  geom_boxplot(aes(Fondovi)) +
  xlab("Fondovi") +
  ylab("Povrati")
```

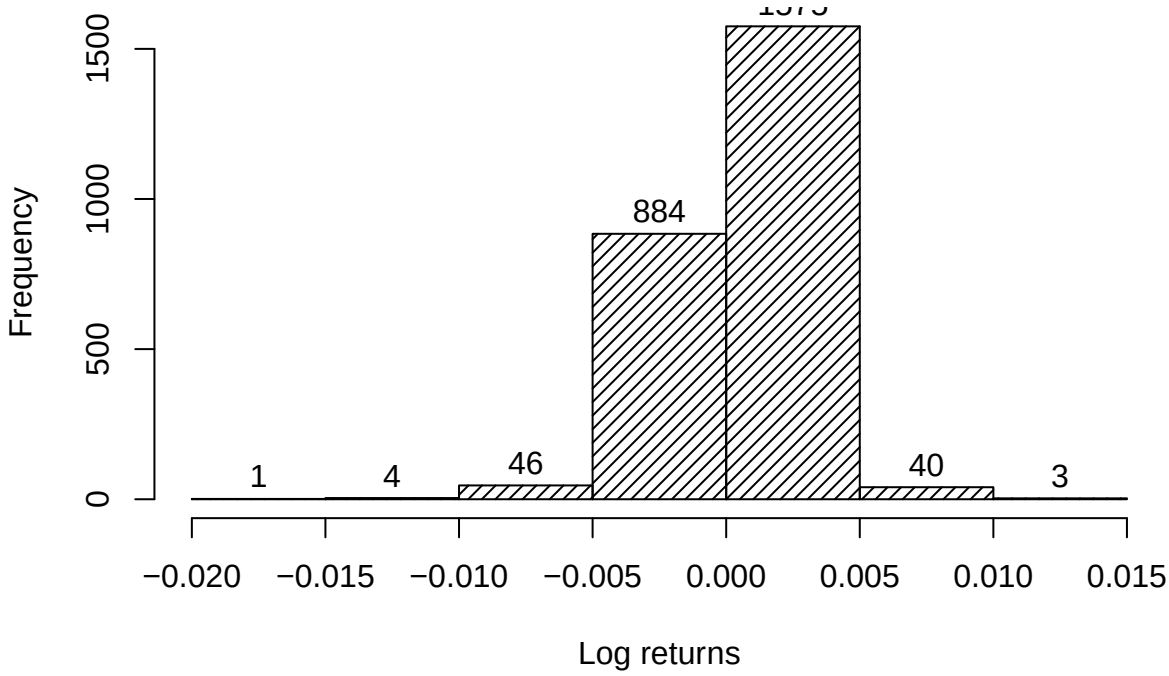


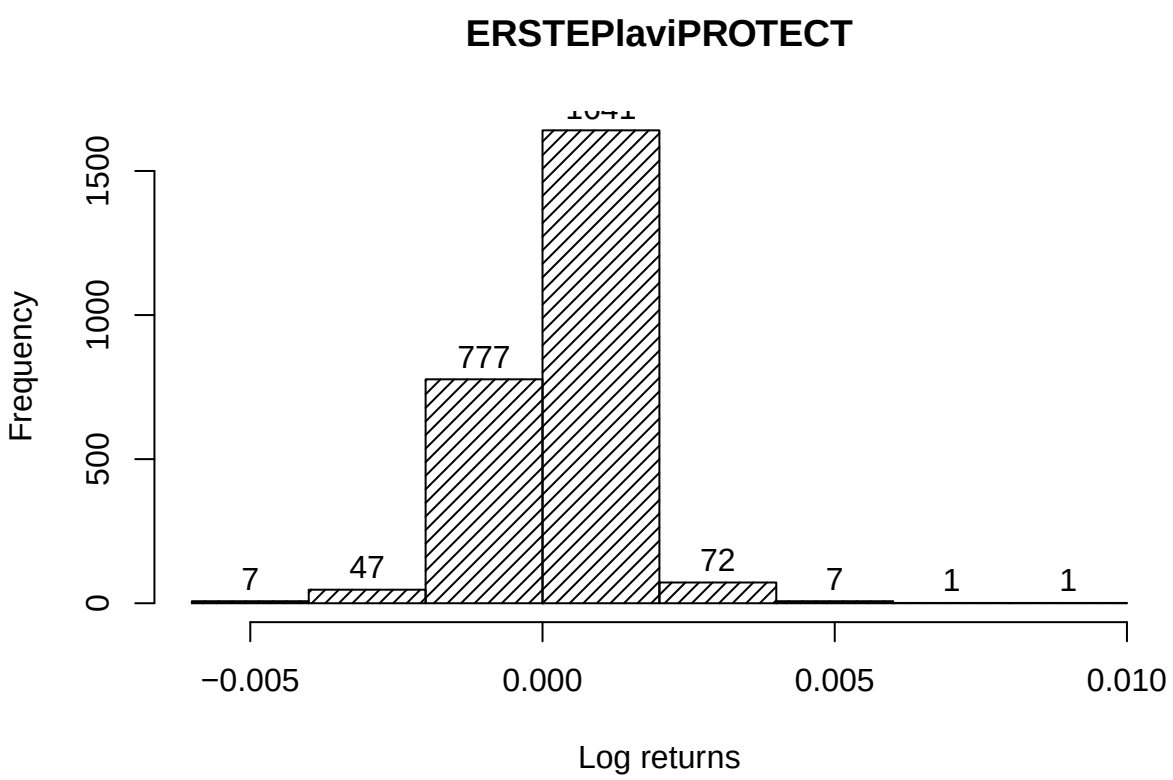
Provjera normalnosti

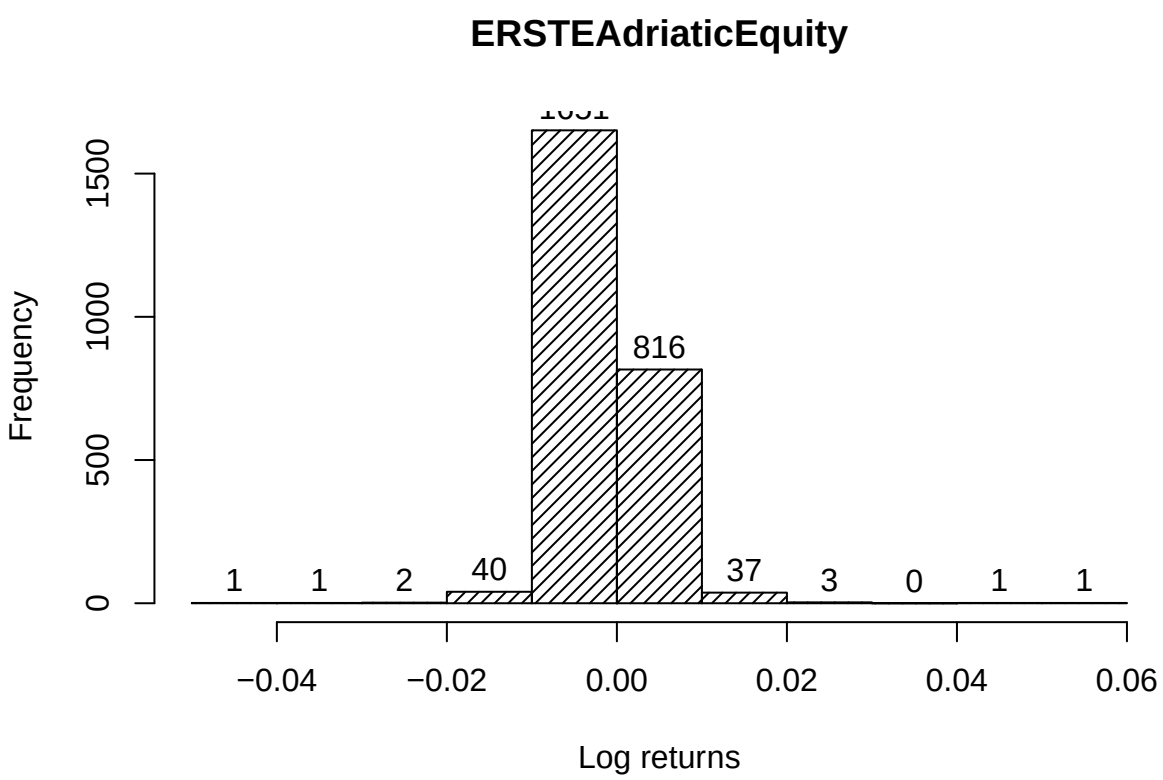
Sljedećim q-q plotom želimo ispitati normalnost distribucije burzovnog indeksa. Iz prvog grafa vidimo kako podaci nisu u potpunosti normalni, a iz sljedećeg, gdje su isti podaci prikazani na histogramu, jasno je i zašto. Teške repove primjećujemo radi velike granulacije, tj. dnevnog računanja prinosa; u tako kratkom roku zna se dogoditi da pojedina dionica ili naglo naraste ili naglo padne u vrijednosti.

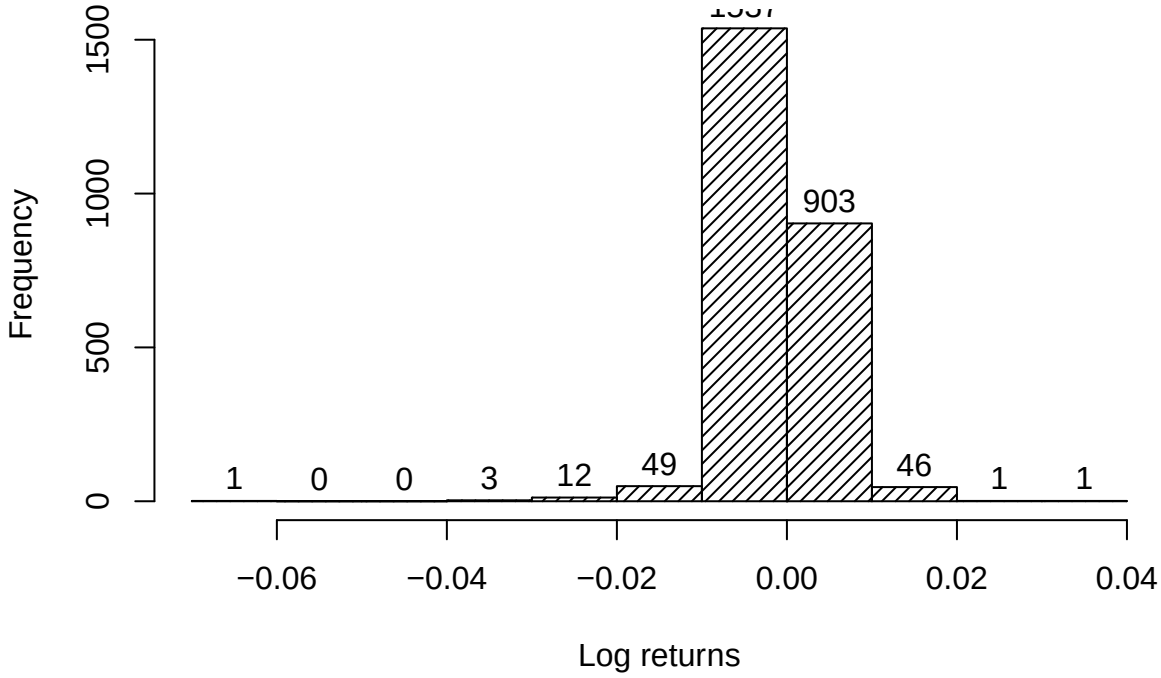
```
library(magrittr)
plot_returns <- function(fund.returns, fund.name) hist(fund.returns,
                                                       main = fund.name,
                                                       density=20,
                                                       xlab='Log returns',
                                                       labels=TRUE,
                                                       breaks=10)
mapply(plot_returns,
       c(xs.returns[c(pension_funds, investment_funds)]),
       c(pension_funds, investment_funds)) %>%
  invisible
```

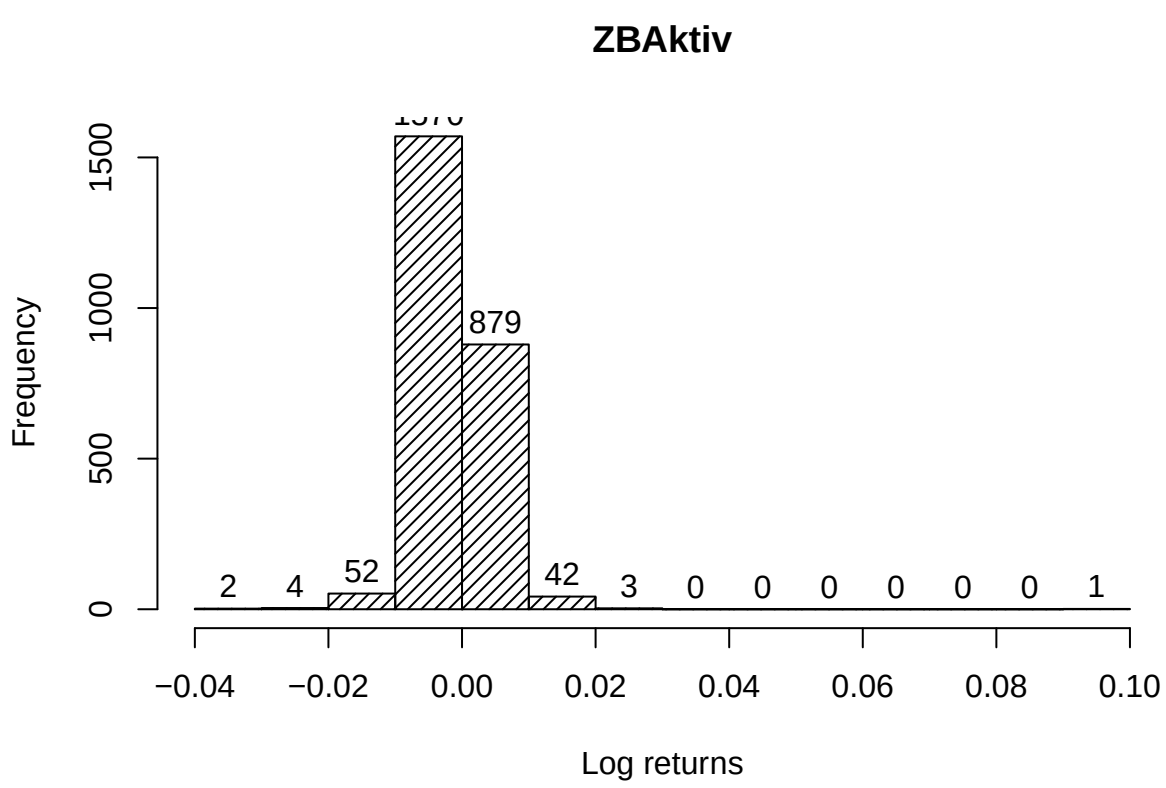

RaiffeisenDMF
Frequency
0
500
1000
1500
1
3
20
936
1551
40
1
0
1
−0.02
−0.01
0.00
0.01
0.02
Log returns


ERSTEPlaviEXPERT
Frequency
0
500
1000
1500
1
4
46
884
40
3
−0.020
−0.015
−0.010
−0.005
0.000
0.005
0.010
0.015
Log returns


ERSTEPlaviPROTECT
Frequency
0
500
1000
1500
7
47
777
1041
72
7
1
1
−0.005
0.000
0.005
0.010
Log returns


ERSTEAdriaticEquity
Frequency
0
500
1000
1500
1
1
2
40
816
37
3
0
1
1
−0.04
−0.02
0.00
0.02
0.04
0.06
Log returns

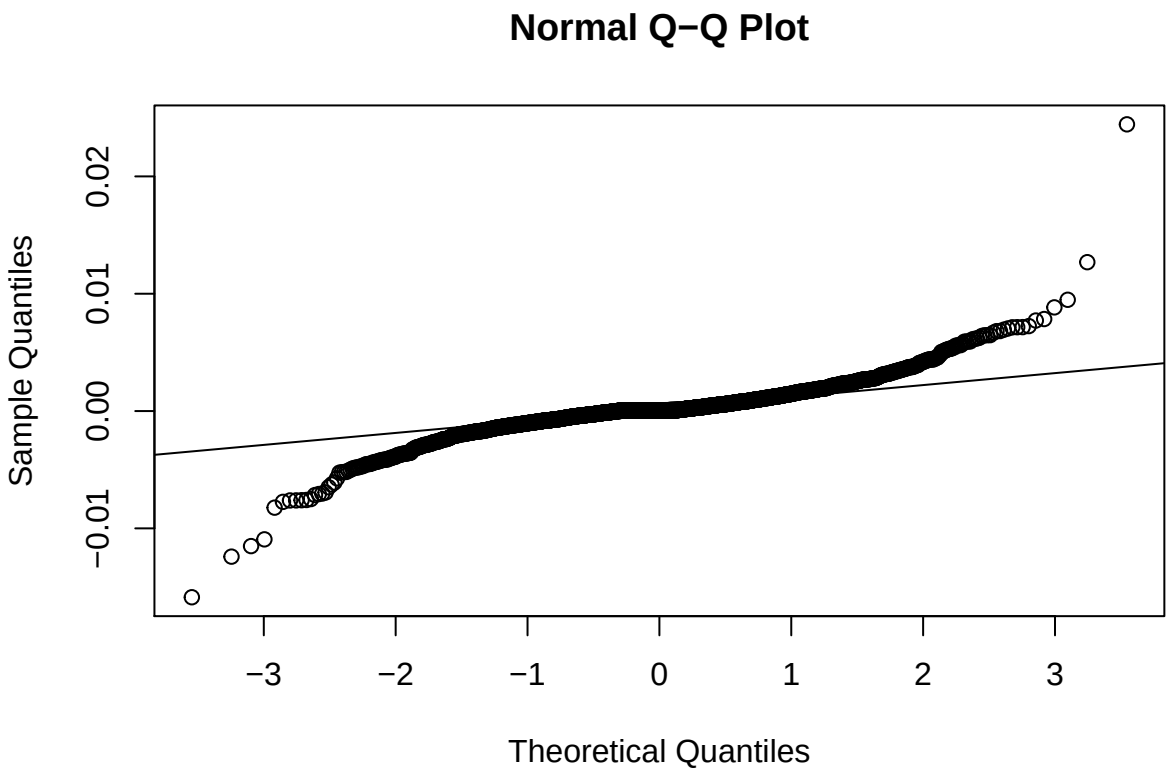

OTPMeridian20
Frequency
0
500
1000
1500
1
0
0
3
12
49
903
46
1
1
−0.06
−0.04
−0.02
0.00
0.02
0.04
Log returns

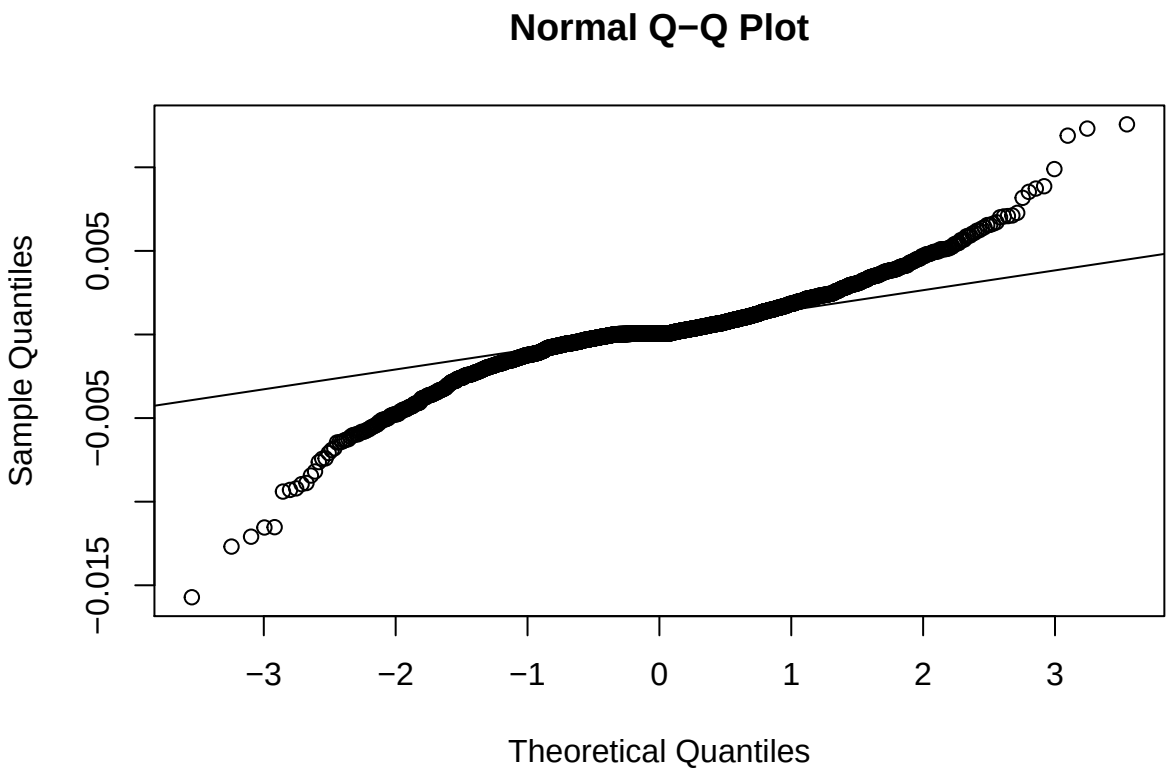


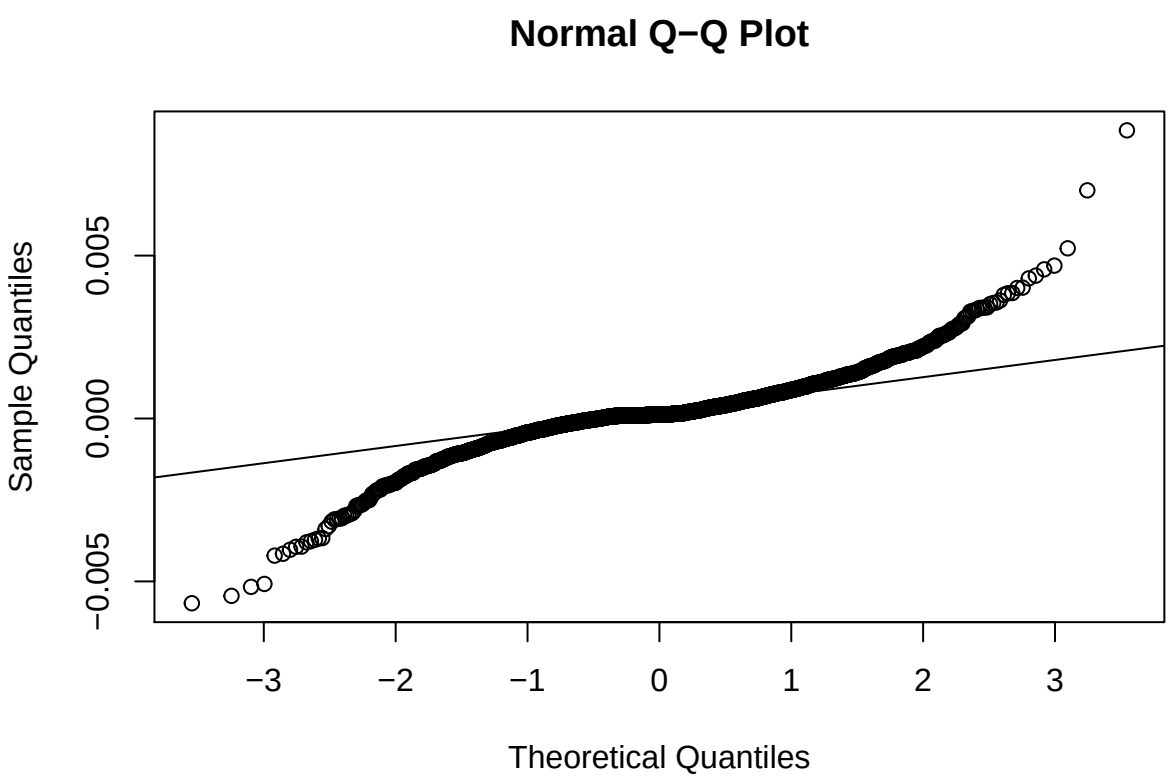
Sljedećim grafom htjela se ispitati normalnost jednog mirovinskog fonda. Vidimo kako ni on nema baš normalnu distribuciju.

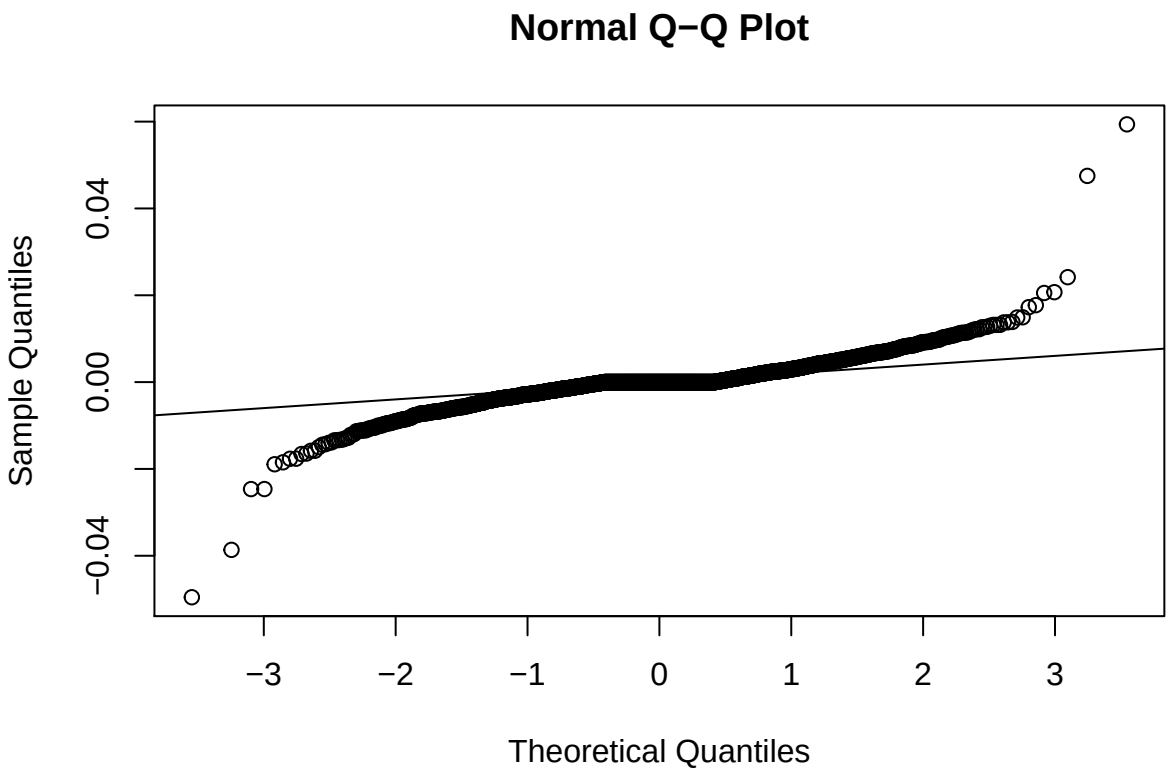
TODO: Kolmogorov-smirnov

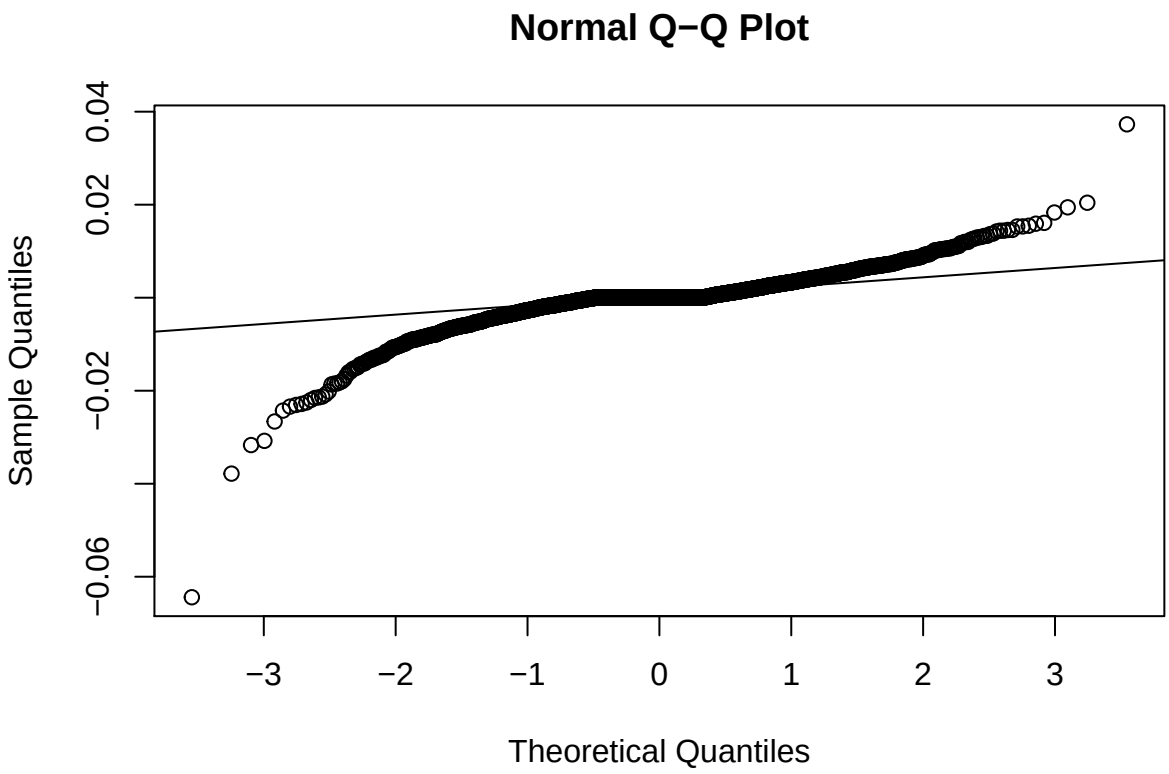
```
qqplots <- function(fund.returns, fund.name) {
  qqnorm(fund.returns)
  qqline(fund.returns)
}

mapply(qqplots,
       c(xs.returns[c(pension_funds, investment_funds)]),
       c(pension_funds, investment_funds)) %>%
  invisible
```

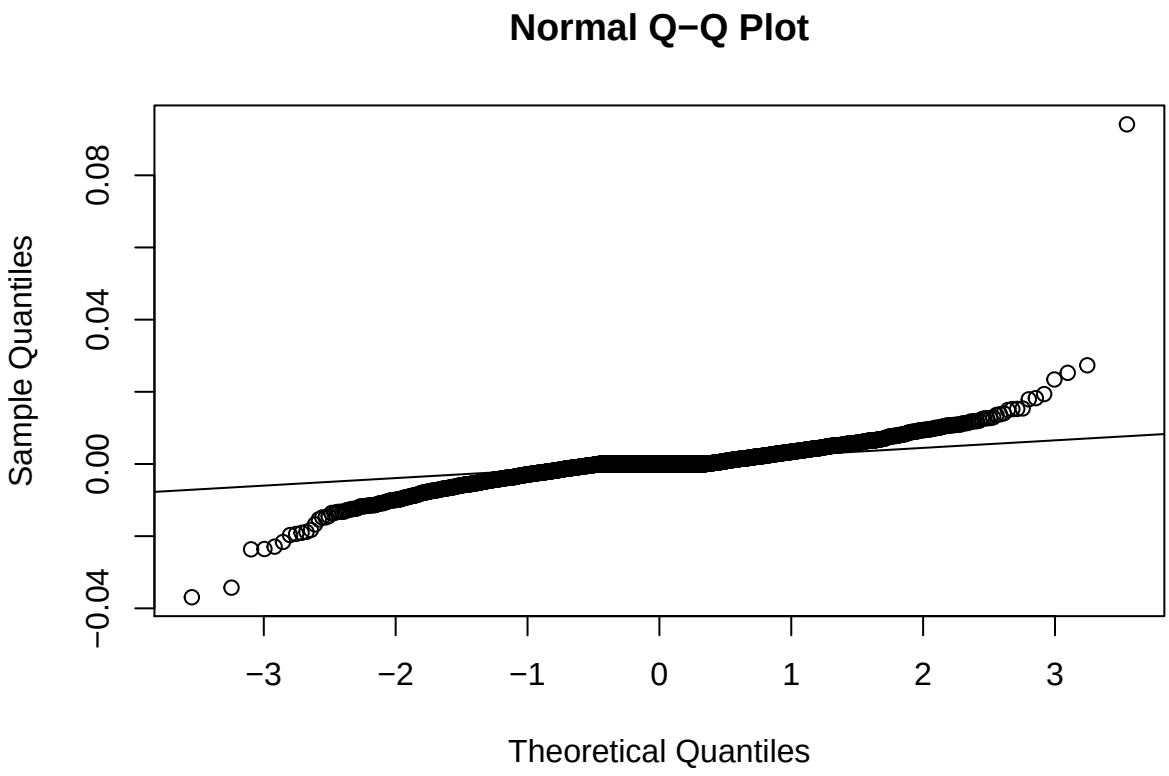

Normal Q−Q Plot
Sample Quantiles
−0.01
0.00
0.01
0.02
−3
−2
−1
0
1
2
3
Theoretical Quantiles


Normal Q−Q Plot
Sample Quantiles
0.005
−0.005
−0.015
−3
−2
−1
0
1
2
3
Theoretical Quantiles


Normal Q−Q Plot
Sample Quantiles
0.005
0.000
−0.005
−3
−2
−1
0
1
2
3
Theoretical Quantiles


Normal Q−Q Plot
Sample Quantiles
0.04
0.00
−0.04
−3
−2
−1
0
1
2
3
Theoretical Quantiles


Normal Q−Q Plot
Sample Quantiles
0.04
0.02
−0.02
−0.06
−3
−2
−1
0
1
2
3
Theoretical Quantiles




```
#qqnorm(xs.returns$ZBAktiv)
#qqline(xs.returns$ZBAktiv)

#qqnorm(apply.weekly(xts(xs.returns$ZBAktiv, order.by = xs.returns$Date), mean))
#qqline(apply.weekly(xts(xs.returns$ZBAktiv, order.by = xs.returns$Date), mean))

#PerformanceAnalytics::chart.QQPlot(xs.returns$ZBAktiv)
#PerformanceAnalytics::chart.Regression(zbaktiv.ts, capm.m.ts, capm.rf.2010,
#                                       excess.returns = TRUE, fit = c("loess", "linear"))
#PerformanceAnalytics::SharpeRatio(capm.m.ts)

# xs.log_returns <- lapply( xs[columns_to_log_normalize], function(list) time_series_diff(list, diff_fu
# xs.log_returns <- data.frame( c(xs[2:nrow(xs), !(colnames(xs) %in% columns_to_log_normalize)], xs.log

#xs.xts <- xts(xs['CROBEX'], order.by = xs$Date)
#head( PerformanceAnalytics::Return.calculate(xs.xts) )
#head( xs.log_returns$CROBEX )

#xs.returns[xs.returns$CROBEX > 50, c('Date', 'CROBEX')]

#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 fondova

Iako QQ grafovi pokazuju da povrati nisu normalno raspodijeljeni, radimo tu pretpostavku s obzirom na robusnost T-testa. Jasno je da globalni događaji (kriza, teroristički napadi,...) često utječu na cijelo tržište odjednom, pa koristimo T-testove za uparene podatke.

Testovi povrata investicijskih fondova u odnosu na CROBEX

```
compare.to.index <- function(index) function(fund.returns) t.test(index, fund.returns, paired = TRUE)
mapply(compare.to.index(xs.returns$CROBEX), xs.returns[investment_funds])
```

```
##             ERSTEAdriaticEquity      OTPMeridian20
## statistic   -0.4774079               -0.4286687
## parameter   2552                     2552
## p.value     0.6331126                0.6682005
## conf.int    Numeric,2                Numeric,2
## estimate    -4.454166e-05            -4.377476e-05
## null.value  0                        0
## alternative "two.sided"              "two.sided"
## method      "Paired t-test"          "Paired t-test"
## data.name   "index and fund.returns" "index and fund.returns"
##             ZBAktiv
## statistic   -0.8207028
## parameter   2552
## p.value     0.4118922
## conf.int    Numeric,2
## estimate    -0.0001054245
## null.value  0
## alternative "two.sided"
## method      "Paired t-test"
## data.name   "index and fund.returns"
```

Testovi povrata mirovinskih fondova u odnosu na CROBEX

```
mapply(compare.to.index(xs.returns$CROBEX), xs.returns[pension_funds])
```

```
##             RaiffeisenDMF            ERSTEPlaviEXPERT
## statistic   -1.789106                -2.125481
## parameter   2552                     2552
## p.value     0.07371632               0.03364232
## conf.int    Numeric,2                Numeric,2
## estimate    -0.0001823123            -0.0002049503
## null.value  0                        0
## alternative "two.sided"              "two.sided"
## method      "Paired t-test"          "Paired t-test"
## data.name   "index and fund.returns" "index and fund.returns"
##             ERSTEPlaviPROTECT
## statistic   -1.711485
## parameter   2552
## p.value     0.08711319
## conf.int    Numeric,2
```

```
## estimate    -0.0001893649
## null.value  0
## alternative "two.sided"
## method      "Paired t-test"
## data.name   "index and fund.returns"
```

Test povrata investicijskih fondova u odnosu na mirovinske fondove

Izračunate su sredine mirovinskih i investicijskih fondova pa je sproveden test njihovih vrijednosti. Dobivamo izrazito malu p-vrijednost, stoga uz relativno veliku sigurnost zaključujemo da možemo odbaciti nul-hipotezu koja tvrdi da 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, paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  grouped.return.means$MeansPension and grouped.return.means$MeansInvestment
## t = 2.1921, df = 2552, p-value = 0.02846
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.346169e-05 2.417960e-04
## sample estimates:
## mean of the differences
##            0.0001276289
```

CAPM model

```
dates <- xs.returns$Date

year <- function(date) format(date, "%Y")
get_for_year <- function(df, dates, desired_year) df[year(dates) == desired_year, ]

xs.2010 <- get_for_year(xs.returns, xs.returns$Date, 2010)

zbaktiv.2010 <- xs.2010$ZBAktiv #xs.2010[c('Date', 'ZBAktiv')]
capm.market.2010 <- xs.2010$CROBEX #xs.2010[c('Date', 'CROBEX')]
capm.risk_free.2010 <- xs.2010$InterestRate.daily #[c('Date', 'InterestRate.daily')]
zbaktiv.model <- lm(formula = (zbaktiv.2010 - capm.risk_free.2010) ~ (capm.market.2010 - capm.risk_free
head(zbaktiv.model)
```

```
## $coefficients
##      (Intercept) capm.market.2010
##     8.227786e-05     2.194613e-01
##
## $residuals
##             1             2             3             4             5
##  3.025737e-03 -4.470165e-04 -1.125709e-03 -4.469784e-03  5.749055e-03
```

```
##             6             7             8             9            10
## -1.422779e-04 -4.060959e-03 -1.413468e-02  1.628328e-03  1.153703e-03
##            11            12            13            14            15
## -3.923409e-03  1.799371e-03 -1.422779e-04 -1.148207e-04  3.090839e-03
##            16            17            18            19            20
## -9.275865e-03 -1.312774e-02 -1.015904e-03 -6.830567e-03 -1.422779e-04
##            21            22            23            24            25
##  1.360527e-03 -3.813505e-03 -3.062942e-03  4.800227e-03 -4.606474e-03
##            26            27            28            29            30
##  1.163421e-02 -1.422779e-04  7.209681e-04  4.670183e-03 -5.655227e-03
##            31            32            33            34            35
## -1.558577e-02  6.086355e-04  2.601787e-03 -1.422779e-04  1.641154e-04
##            36            37            38            39            40
##  2.547114e-03  3.003235e-03  7.063579e-03 -3.612323e-03  2.360591e-03
##            41            42            43            44            45
## -1.422779e-04  2.683753e-04  3.523494e-03 -9.437075e-04 -3.287487e-03
##            46            47            48            49            50
##  3.689455e-03  6.840831e-04 -1.422779e-04  7.620623e-04 -8.011311e-03
##            51            52            53            54            55
##  3.911053e-03 -5.823963e-04  8.150183e-03  6.414179e-05 -1.422779e-04
##            56            57            58            59            60
## -8.340212e-04  3.518260e-03  9.003503e-04 -6.551485e-03  4.532554e-03
##            61            62            63            64            65
##  5.709594e-03 -1.422779e-04 -2.551600e-04 -2.693673e-03  1.644888e-03
##            66            67            68            69            70
## -3.936817e-03 -2.757829e-03 -2.199680e-03 -1.422779e-04 -1.311595e-04
##            71            72            73            74            75
##  3.144101e-03  2.084115e-03 -6.736422e-03  1.892815e-03  4.760239e-04
##            76            77            78            79            80
## -1.422779e-04  1.554342e-03  2.222416e-04 -5.274909e-04  3.821001e-03
##            81            82            83            84            85
##  2.621817e-03  5.466834e-03 -1.422779e-04  4.284530e-04 -2.880095e-03
##            86            87            88            89            90
##  2.930759e-03  9.567567e-03 -6.452707e-04  4.175215e-03 -1.422779e-04
##            91            92            93            94            95
## -1.422779e-04 -9.864963e-04  5.257048e-03  3.830297e-03  5.113058e-03
##            96            97            98            99           100
## -5.477205e-03 -1.422779e-04  3.265466e-04 -8.945669e-03  1.245684e-02
##           101           102           103           104           105
## -1.753043e-03 -4.178301e-03 -2.520872e-03 -1.422779e-04  2.327119e-03
##           106           107           108           109           110
##  4.479376e-03 -2.213307e-03  5.564066e-03  4.111644e-03  9.326233e-04
##           111           112           113           114           115
## -1.422779e-04 -2.355763e-03 -6.856218e-03  2.781178e-03  9.708215e-03
##           116           117           118           119           120
## -3.532648e-03  2.400760e-03 -1.422779e-04  3.436363e-04 -1.081434e-02
##           121           122           123           124           125
## -6.628933e-03 -8.098720e-03 -9.129489e-03  2.720435e-02 -1.422779e-04
##           126           127           128           129           130
## -3.705188e-03 -9.529607e-03  2.195334e-02 -2.896920e-03 -5.148515e-03
##           131           132           133           134           135
## -5.711107e-03 -1.422779e-04  2.663304e-03 -4.233461e-03 -1.211006e-02
##           136           137           138           139           140
## -6.356160e-03 -3.078393e-03 -4.673230e-03 -1.422779e-04  1.063729e-03
```

```
##           141           142           143           144           145
## -7.666737e-03  8.450477e-03  1.350024e-02 -1.992360e-03 -6.670915e-03
##           146           147           148           149           150
## -1.422779e-04  1.633695e-03  4.627718e-04  1.518149e-02 -1.921379e-02
##           151           152           153           154           155
## -8.263972e-04 -6.857526e-03 -1.422779e-04  4.507199e-03  5.261117e-03
##           156           157           158           159           160
##  1.842133e-03  6.062512e-03  1.037744e-03  3.683170e-04 -1.422779e-04
##           161           162           163           164           165
## -3.524443e-03  2.227869e-03  2.789750e-03 -1.465069e-03 -6.280174e-03
##           166           167           168           169           170
##  6.389691e-03 -1.422779e-04  5.236598e-04 -1.345533e-02  1.088195e-04
##           171           172           173           174           175
## -1.804282e-04  4.177383e-03 -1.422779e-04 -1.422779e-04  1.946542e-03
##           176           177           178           179           180
## -1.433795e-02  5.475015e-03 -3.573459e-03  3.947895e-03 -1.372501e-02
##           181           182           183           184           185
## -1.422779e-04  2.827835e-04  1.012240e-03  1.256244e-03  1.602491e-04
##           186           187           188           189           190
##  2.919647e-03 -2.147027e-03 -1.422779e-04  4.575906e-03  4.245051e-03
##           191           192           193           194           195
##  4.731801e-03 -1.045075e-02 -1.311676e-02 -8.247260e-03 -1.422779e-04
##           196           197           198           199           200
##  6.078356e-04  6.072006e-03 -3.854281e-03  1.192621e-02  5.319148e-03
##           201           202           203           204           205
## -3.726342e-05 -1.422779e-04  2.539422e-03 -2.526232e-03 -6.536442e-03
##           206           207           208           209           210
## -1.104574e-03  4.254821e-04  1.025097e-02 -1.422779e-04 -1.705335e-03
##           211           212           213           214           215
## -5.434077e-03 -2.436291e-03 -1.194577e-03 -1.422779e-04  1.330631e-03
##           216           217           218           219           220
## -1.422779e-04 -4.137103e-04 -8.891545e-03 -5.873309e-03  8.942820e-03
##           221           222           223           224           225
##  6.892917e-03  9.606738e-03 -1.422779e-04 -1.660525e-04  4.668321e-03
##           226           227           228           229           230
##  4.298550e-03  1.887936e-03  3.795401e-03  8.813685e-04 -1.422779e-04
##           231           232           233           234           235
## -5.437598e-04 -3.940435e-03 -1.326203e-03 -1.502456e-03  4.632617e-03
##           236           237           238           239           240
##  3.242167e-03 -1.422779e-04  2.152822e-04  2.483562e-03  8.607901e-03
##           241           242           243           244           245
## -4.497131e-05 -2.835148e-04 -5.700936e-03 -1.422779e-04  1.408947e-03
##           246           247           248           249           250
## -7.952797e-03  6.378684e-03  2.539374e-03  1.801488e-03  5.979473e-03
##           251           252           253           254           255
## -1.422779e-04 -1.491068e-03  8.590525e-04 -1.488771e-03 -5.489203e-03
##           256           257           258           259           260
## -3.639121e-03  3.394330e-03 -1.422779e-04 -7.560073e-04 -1.369226e-03
##           261           262           263           264           265
## -1.585540e-03 -1.103781e-02  4.775733e-03  6.709783e-04 -1.422779e-04
##           266           267           268           269           270
## -1.191407e-03  1.195004e-03  8.979011e-04 -4.279850e-03  1.921430e-03
##           271           272           273           274           275
## -3.803051e-03 -1.422779e-04  1.103877e-03  1.125771e-02 -2.868345e-03
```

```
##           276           277           278           279           280
## -6.645688e-03 -4.475437e-04 -1.422779e-04 -1.422779e-04 -5.374225e-04
##           281           282           283           284           285
##  2.288253e-03  1.156389e-02 -4.725935e-03 -4.903897e-03  3.093971e-03
##           286           287           288           289           290
## -1.422779e-04  3.744887e-05 -3.066246e-03  8.768418e-03  3.482126e-03
##           291           292           293           294           295
## -9.970657e-03  9.641450e-03 -1.422779e-04 -1.645404e-04 -3.434870e-03
##           296           297           298           299           300
## -4.409031e-03  5.384932e-03 -1.997990e-03 -1.453621e-03 -1.422779e-04
##           301           302           303           304           305
## -1.422779e-04  3.007639e-04 -1.689232e-03  2.917322e-03 -7.627164e-03
##           306           307           308           309           310
##  3.701935e-03 -1.422779e-04  5.693470e-04  4.465995e-03  2.048680e-03
##           311           312           313           314           315
##  4.475803e-03 -8.079041e-03 -3.776443e-03 -1.422779e-04  2.090019e-03
##           316           317           318           319           320
## -9.689355e-03  1.309399e-03  1.868545e-02 -3.265047e-03 -2.151925e-03
##           321           322           323           324           325
## -1.422779e-04  1.186260e-03 -1.156389e-02  1.124880e-02  9.888699e-03
##           326           327           328           329           330
## -6.115202e-03  1.971143e-03 -1.422779e-04  5.559793e-04 -2.423560e-03
##           331           332           333           334           335
##  1.422789e-02  4.458778e-03  5.019436e-03  4.157123e-03 -1.422779e-04
##           336           337           338           339           340
## -3.464611e-04 -6.119012e-03 -9.105849e-03  5.169520e-03  3.956129e-03
##           341           342           343           344           345
## -1.600784e-03 -1.422779e-04 -1.063484e-04 -1.050462e-02 -5.344082e-03
##           346           347           348           349           350
##  5.311828e-03  6.023031e-04 -7.996102e-03 -1.422779e-04  4.155997e-04
##           351           352           353           354           355
##  7.826397e-03 -3.884351e-03 -2.913583e-03 -1.270480e-03 -2.762494e-03
##           356           357           358           359           360
## -1.422779e-04  1.475022e-03  8.852416e-04  8.396256e-04  5.108636e-03
##           361
## -2.232326e-03
##
## $effects
##      (Intercept) capm.market.2010
##    -2.052668e-03     3.259172e-02    -1.291820e-03    -4.646801e-03
##
##     5.600903e-03    -2.904293e-04    -4.280671e-03    -1.426820e-02
##
##     1.433846e-03     1.001206e-03    -4.121939e-03     1.651220e-03
##
##    -2.904293e-04    -2.624708e-04     2.947742e-03    -9.448987e-03
##
##    -1.328114e-02    -1.134418e-03    -6.978718e-03    -2.904293e-04
##
##     1.239819e-03    -4.017206e-03    -3.262512e-03     4.656307e-03
##
##    -4.767359e-03     1.148606e-02    -2.904293e-04     5.885807e-04
##
##     4.524972e-03    -5.838021e-03    -1.567252e-02     5.127553e-04
```

```
##
##     2.453636e-03    -2.904293e-04     2.155908e-05     2.377000e-03
##
##     2.883789e-03     6.921115e-03    -3.768629e-03     2.212440e-03
##
##    -2.904293e-04     1.277229e-04     3.387209e-03    -1.144381e-03
##
##    -3.451395e-03     3.518574e-03     5.359316e-04    -2.904293e-04
##
##     6.304253e-04    -8.132671e-03     3.762846e-03    -6.987358e-04
##
##     8.011542e-03    -8.400969e-05    -2.904293e-04    -9.948049e-04
##
##     3.361727e-03     8.050524e-04    -6.709185e-03     4.362279e-03
##
##     5.561443e-03    -2.904293e-04    -4.053728e-04    -2.817244e-03
##
##     1.465679e-03    -4.083060e-03    -2.961252e-03    -2.347832e-03
##
##    -2.904293e-04    -2.791080e-04     3.012763e-03     1.927909e-03
##
##    -6.877315e-03     1.764878e-03     3.278724e-04    -2.904293e-04
##
##     1.437173e-03     5.818563e-05    -6.657587e-04     3.668279e-03
##
##     2.473647e-03     5.318682e-03    -2.904293e-04     2.907238e-04
##
##    -3.031754e-03     2.771820e-03     9.413995e-03    -7.934222e-04
##
##     4.027063e-03    -2.904293e-04    -2.904293e-04    -1.150064e-03
##
##     5.074420e-03     3.687610e-03     4.956216e-03    -5.625356e-03
##
##    -2.904293e-04     1.869565e-04    -9.101995e-03     1.229056e-02
##
##    -1.923410e-03    -4.324390e-03    -2.669023e-03    -2.904293e-04
##
##     2.224062e-03     4.265842e-03    -2.374100e-03     5.493145e-03
##
##     3.922954e-03     7.844718e-04    -2.904293e-04    -2.544336e-03
##
##    -6.990922e-03     2.670248e-03     9.577305e-03    -3.649952e-03
##
##     2.252608e-03    -2.904293e-04     2.043582e-04    -1.090953e-02
##
##    -6.724769e-03    -8.225312e-03    -9.251043e-03     2.705620e-02
##
##    -2.904293e-04    -3.918403e-03    -9.626882e-03     2.178107e-02
##
##    -3.018206e-03    -5.261761e-03    -5.859258e-03    -2.904293e-04
##
##     2.566386e-03    -4.410740e-03    -1.224157e-02    -6.450590e-03
##
##    -3.182858e-03    -4.821381e-03    -2.904293e-04     9.376011e-04
```

```
##
##    -7.743787e-03     8.252617e-03     1.332250e-02    -2.170583e-03
##
##    -6.819066e-03    -2.904293e-04     1.517975e-03     3.443682e-04
##
##     1.505680e-02    -1.936194e-02    -9.870417e-04    -7.005677e-03
##
##    -2.904293e-04     4.443953e-03     5.158713e-03     1.658636e-03
##
##     5.896534e-03     8.980793e-04     2.201655e-04    -2.904293e-04
##
##    -3.734357e-03     2.085750e-03     2.637555e-03    -1.596528e-03
##
##    -6.432279e-03     6.241539e-03    -2.904293e-04     3.876693e-04
##
##    -1.360348e-02    -3.474665e-05    -3.330412e-04     4.029232e-03
##
##    -2.904293e-04    -2.904293e-04     1.836535e-03    -1.438574e-02
##
##     5.370285e-03    -3.704074e-03     3.838113e-03    -1.387316e-02
##
##    -2.904293e-04     1.423942e-04     8.658224e-04     1.120099e-03
##
##    -2.484161e-05     2.798515e-03    -2.295178e-03    -2.904293e-04
##
##     4.513915e-03     4.034846e-03     4.579121e-03    -1.066105e-02
##
##    -1.328972e-02    -8.395411e-03    -2.904293e-04     4.733822e-04
##
##     5.937883e-03    -4.003977e-03     1.177150e-02     5.176515e-03
##
##    -1.854149e-04    -2.904293e-04     2.440242e-03    -2.691051e-03
##
##    -6.707016e-03    -1.305012e-03     2.915525e-04     1.010282e-02
##
##    -2.904293e-04    -1.882029e-03    -5.596669e-03    -2.580297e-03
##
##    -1.342729e-03    -2.904293e-04     1.182480e-03    -2.904293e-04
##
##    -5.668185e-04    -9.058782e-03    -5.988236e-03     8.824628e-03
##
##     6.767129e-03     9.458586e-03    -2.904293e-04    -3.146381e-04
##
##     4.505436e-03     4.121952e-03     1.737359e-03     3.634800e-03
##
##     7.332170e-04    -2.904293e-04    -6.992428e-04    -4.054896e-03
##
##    -1.435750e-03    -1.662245e-03     4.470074e-03     3.094016e-03
##
##    -2.904293e-04     7.366020e-05     2.344140e-03     8.424685e-03
##
##    -2.171699e-04    -4.618736e-04    -5.849087e-03    -2.904293e-04
##
##     1.289123e-03    -8.085584e-03     6.189768e-03     2.366320e-03
```

```
##
##     1.640975e-03     5.831322e-03    -2.904293e-04    -1.663851e-03
##
##     7.291866e-04    -1.635915e-03    -5.641447e-03    -3.757099e-03
##
##     3.246178e-03    -2.904293e-04    -9.153663e-04    -1.530571e-03
##
##    -1.713917e-03    -1.118430e-02     4.611225e-03     5.228268e-04
##
##    -2.904293e-04    -1.358717e-03     1.030494e-03     7.465402e-04
##
##    -4.410862e-03     1.760850e-03    -3.951202e-03    -2.904293e-04
##
##     9.784822e-04     1.111791e-02    -3.036812e-03    -6.766412e-03
##
##    -5.956952e-04    -2.904293e-04    -2.904293e-04    -6.927898e-04
##
##     2.177054e-03     1.139692e-02    -4.860317e-03    -5.081747e-03
##
##     2.945819e-03    -2.904293e-04    -1.074206e-04    -3.184631e-03
##
##     8.646433e-03     3.330433e-03    -1.010497e-02     9.493299e-03
##
##    -2.904293e-04    -3.130984e-04    -3.626645e-03    -4.574457e-03
##
##     5.255072e-03    -2.095545e-03    -1.601773e-03    -2.904293e-04
##
##    -2.904293e-04     1.607029e-04    -1.856414e-03     2.758772e-03
##
##    -7.779216e-03     3.553784e-03    -2.904293e-04     4.341907e-04
##
##     4.341251e-03     1.944215e-03     4.292897e-03    -8.232812e-03
##
##    -3.924594e-03    -2.904293e-04     1.982632e-03    -9.770171e-03
##
##     1.085118e-03     1.852727e-02    -3.391571e-03    -2.300076e-03
##
##    -2.904293e-04     1.062369e-03    -1.167840e-02     1.111427e-02
##
##     9.753256e-03    -6.220363e-03     1.822992e-03    -2.904293e-04
##
##     4.205789e-04    -2.589489e-03     1.406124e-02     4.335009e-03
##
##     4.802087e-03     4.008971e-03    -2.904293e-04    -4.983412e-04
##
##    -6.285272e-03    -9.319001e-03     4.962510e-03     3.784971e-03
##
##    -1.748935e-03    -2.904293e-04    -2.538437e-04    -1.099594e-02
##
##    -5.504223e-03     5.222611e-03     4.430402e-04    -8.144254e-03
##
##    -2.904293e-04     2.776358e-04     7.683870e-03    -4.049609e-03
##
##    -3.103495e-03    -1.439234e-03    -2.910645e-03    -2.904293e-04
```

```
##
##     1.356405e-03     7.026966e-04     6.722866e-04     4.938450e-03
##
##    -2.399337e-03
##
## $rank
## [1] 2
##
## $fitted.values
##             1             2             3             4             5
##  3.026752e-03  8.227786e-05  1.065709e-03  1.662949e-03  8.227786e-05
##             6             7             8             9            10
##  8.227786e-05  4.000959e-03 -7.192389e-04  2.619371e-03  3.202746e-04
##            11            12            13            14            15
##  2.841019e-03  8.227786e-05  8.227786e-05  5.482073e-05 -1.945191e-04
##            16            17            18            19            20
##  1.449630e-03  3.694846e-04 -1.540716e-03  8.227786e-05  8.227786e-05
##            21            22            23            24            25
## -1.420527e-03  3.124179e-03  2.898016e-03 -1.494100e-04  7.795969e-04
##            26            27            28            29            30
##  8.227786e-05  8.227786e-05 -7.809681e-04 -7.877117e-05  1.979334e-03
##            31            32            33            34            35
## -3.279636e-03 -2.780123e-03  8.227786e-05  8.227786e-05 -2.241154e-04
##            36            37            38            39            40
##  1.284965e-03 -1.489670e-03 -2.291616e-04  5.288101e-04  8.227786e-05
##            41            42            43            44            45
##  8.227786e-05 -3.283753e-04 -5.675281e-04  2.958397e-03  9.450918e-04
##            46            47            48            49            50
##  1.326961e-03  8.227786e-05  8.227786e-05 -8.220623e-04 -1.384856e-03
##            51            52            53            54            55
##  8.532556e-05 -1.659763e-03 -4.385260e-04  8.227786e-05  8.227786e-05
##            56            57            58            59            60
##  7.740212e-04  5.412107e-04 -2.812012e-03  6.051667e-04  1.293765e-03
##            61            62            63            64            65
##  8.227786e-05  8.227786e-05  1.951600e-04 -1.263767e-03  1.783011e-03
##            66            67            68            69            70
## -2.222362e-05  3.108971e-03  8.227786e-05  8.227786e-05  7.115952e-05
##            71            72            73            74            75
## -8.384530e-04  5.233736e-04 -3.151758e-04 -1.024645e-03  8.227786e-05
##            76            77            78            79            80
##  8.227786e-05 -1.614342e-03  9.532162e-04 -4.589593e-04  3.325609e-04
##            81            82            83            84            85
##  8.330302e-05  8.227786e-05  8.227786e-05 -4.884530e-04  2.743980e-04
##            86            87            88            89            90
##  6.729943e-04  3.790865e-04  8.227786e-05  8.227786e-05  8.227786e-05
##            91            92            93            94            95
##  8.227786e-05  9.264963e-04  1.970231e-03 -2.169251e-04  5.581828e-04
##            96            97            98            99           100
##  8.227786e-05  8.227786e-05 -3.865466e-04  5.299056e-04  1.075313e-03
##           101           102           103           104           105
##  1.298799e-03 -3.067263e-05  8.227786e-05  8.227786e-05 -2.387119e-03
##           106           107           108           109           110
##  3.662656e-03  7.745399e-04 -4.146888e-03  2.302141e-03  8.227786e-05
##           111           112           113           114           115
```

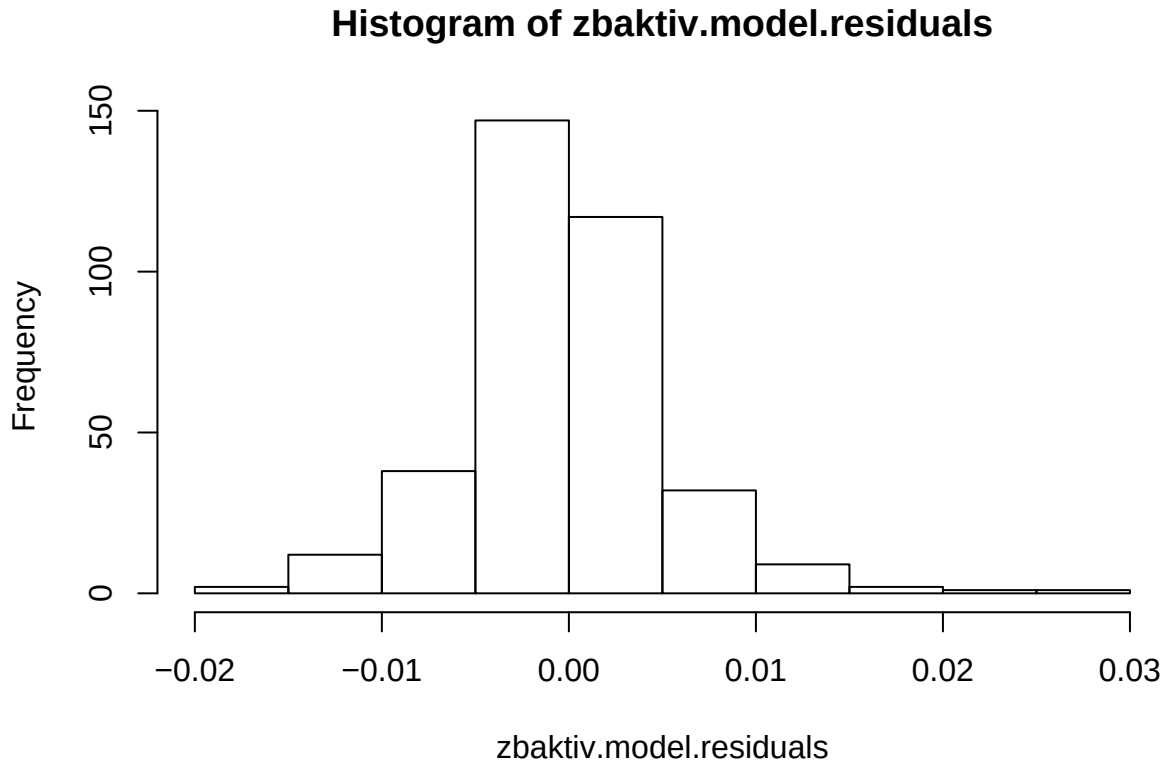
```
##  8.227786e-05  2.295763e-03 -6.540669e-04 -1.956004e-03 -8.618680e-04
##           116           117           118           119           120
## -1.606976e-03  8.227786e-05  8.227786e-05 -4.036363e-04 -2.817861e-03
##           121           122           123           124           125
## -2.782508e-03 -1.098348e-03 -1.374205e-03  8.227786e-05  8.227786e-05
##           126           127           128           129           130
##  3.645188e-03 -2.703762e-03  1.402753e-03 -1.388923e-03 -1.829192e-03
##           131           132           133           134           135
##  8.227786e-05  8.227786e-05 -2.723304e-03  1.677329e-03 -8.286803e-04
##           136           137           138           139           140
## -2.859550e-03 -2.310034e-03  8.227786e-05  8.227786e-05 -1.123729e-03
##           141           142           143           144           145
## -3.811282e-03  2.804327e-03  1.702539e-03  1.729025e-03  8.227786e-05
##           146           147           148           149           150
##  8.227786e-05 -1.693695e-03 -1.546733e-03 -1.202597e-03  8.227786e-05
##           151           152           153           154           155
##  7.663972e-04  8.227786e-05  8.227786e-05 -4.567199e-03 -2.422865e-03
##           156           157           158           159           160
##  2.017822e-03  1.058479e-03 -3.824727e-04  8.227786e-05  8.227786e-05
##           161           162           163           164           165
##  3.464443e-03 -2.480924e-04  3.037033e-04 -8.318406e-04  2.987681e-04
##           166           167           168           169           170
##  8.227786e-05  8.227786e-05 -5.836598e-04  8.227786e-05 -1.688195e-04
##           171           172           173           174           175
##  3.265925e-04  8.227786e-05  8.227786e-05  8.227786e-05 -2.006542e-03
##           176           177           178           179           180
## -5.413844e-03 -2.295553e-03 -8.780165e-04 -2.018886e-03  8.227786e-05
##           181           182           183           184           185
##  8.227786e-05 -3.427835e-04 -1.269295e-05 -5.752286e-04  2.105088e-03
##           186           187           188           189           190
## -1.397285e-03  8.227786e-05  8.227786e-05 -4.635906e-03  3.480365e-03
##           191           192           193           194           195
##  3.302506e-04  3.485516e-03  1.440999e-03  8.227786e-05  8.227786e-05
##           196           197           198           199           200
## -6.678356e-04 -6.858933e-04  1.668370e-04  4.415883e-04 -2.198843e-04
##           201           202           203           204           205
##  8.227786e-05  8.227786e-05 -2.599422e-03  9.950252e-04  1.310107e-03
##           206           207           208           209           210
##  2.945514e-03 -6.965194e-04  8.227786e-05  8.227786e-05  1.645335e-03
##           211           212           213           214           215
##  8.731007e-04 -1.447188e-04  8.227786e-05  8.227786e-05  8.227786e-05
##           216           217           218           219           220
##  8.227786e-05  3.537103e-04  1.127428e-03 -1.737107e-03 -1.558353e-03
##           221           222           223           224           225
## -1.142326e-03  8.227786e-05  8.227786e-05  1.060525e-04  8.890869e-04
##           226           227           228           229           230
##  1.640020e-03  2.151176e-04  7.640193e-04  8.227786e-05  8.227786e-05
##           231           232           233           234           235
##  4.837598e-04 -1.762631e-03 -2.031749e-03  7.195767e-04  8.703927e-04
##           236           237           238           239           240
##  8.227786e-05  8.227786e-05 -2.752822e-04 -3.957727e-04  2.002390e-03
##           241           242           243           244           245
##  1.399113e-03  1.736451e-03  8.227786e-05  8.227786e-05 -1.468947e-03
##           246           247           248           249           250
```

```
## -7.590964e-04  2.314552e-03  1.445939e-03  7.592170e-04  8.227786e-05
##           251           252           253           254           255
##  8.227786e-05  1.431068e-03 -9.190525e-04  2.708916e-05  3.063957e-04
##           256           257           258           259           260
## -1.570065e-03  8.227786e-05  8.227786e-05  6.960073e-04  8.047611e-04
##           261           262           263           264           265
## -1.000607e-03 -9.071603e-06  9.779406e-04  8.227786e-05  8.227786e-05
##           266           267           268           269           270
##  1.131407e-03  9.780465e-04  2.580277e-04 -8.563032e-04  7.628920e-04
##           271           272           273           274           275
##  8.227786e-05  8.227786e-05 -1.163877e-03 -3.753501e-04  1.194790e-03
##           276           277           278           279           280
## -1.419624e-03  8.227786e-05  8.227786e-05  8.227786e-05  4.774225e-04
##           281           282           283           284           285
## -1.941252e-03  1.112563e-03 -6.717083e-04  1.708622e-03  8.227786e-05
##           286           287           288           289           290
##  8.227786e-05 -9.744887e-05 -1.547726e-03 -1.350615e-03  2.762071e-04
##           291           292           293           294           295
## -6.757203e-04  8.227786e-05  8.227786e-05  1.045404e-04  2.471119e-03
##           296           297           298           299           300
##  1.028273e-03 -9.193549e-04 -2.688389e-03  8.227786e-05  8.227786e-05
##           301           302           303           304           305
##  8.227786e-05 -3.607639e-04  1.124411e-03  6.517138e-04  2.958735e-04
##           306           307           308           309           310
##  8.227786e-05  8.227786e-05 -6.293470e-04 -1.199546e-03 -2.309969e-03
##           311           312           313           314           315
##  1.985414e-03  3.900141e-04  8.227786e-05  8.227786e-05 -2.150019e-03
##           316           317           318           319           320
## -3.605084e-03  4.251177e-03  6.314844e-04 -1.102066e-03  8.227786e-05
##           321           322           323           324           325
##  8.227786e-05 -1.246260e-03 -1.760110e-03 -6.633952e-04 -6.136252e-04
##           326           327           328           329           330
## -2.271909e-03  8.227786e-05  8.227786e-05 -6.159793e-04  1.055779e-03
##           331           332           333           334           335
##  1.095488e-03 -1.252903e-03  3.871590e-03  8.227786e-05  8.227786e-05
##           336           337           338           339           340
##  2.864611e-04  1.073908e-03  3.641758e-03  3.305382e-03  1.342157e-03
##           341           342           343           344           345
##  8.227786e-05  8.227786e-05  4.634838e-05  1.887449e-02  7.388392e-04
##           346           347           348           349           350
## -3.144979e-03  6.907463e-04  8.227786e-05  8.227786e-05 -4.755997e-04
##           351           352           353           354           355
## -2.257532e-04  1.019029e-03  2.369110e-03  1.210480e-03  8.227786e-05
##           356           357           358           359           360
##  8.227786e-05 -1.535022e-03  1.965686e-03  1.132994e-03  1.288906e-03
##           361
##  1.114990e-03
##
## $assign
## [1] 0 1
```

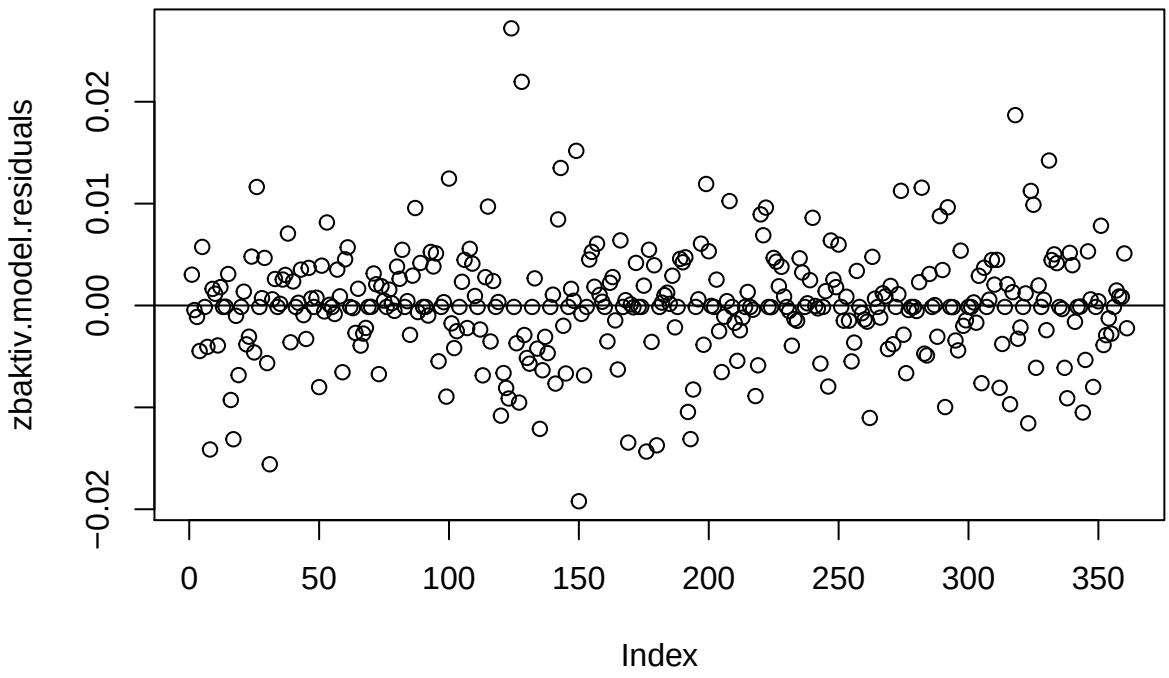
Provjera reziduala

TODO: regresija / vrijednosti i raspodjela reziduala

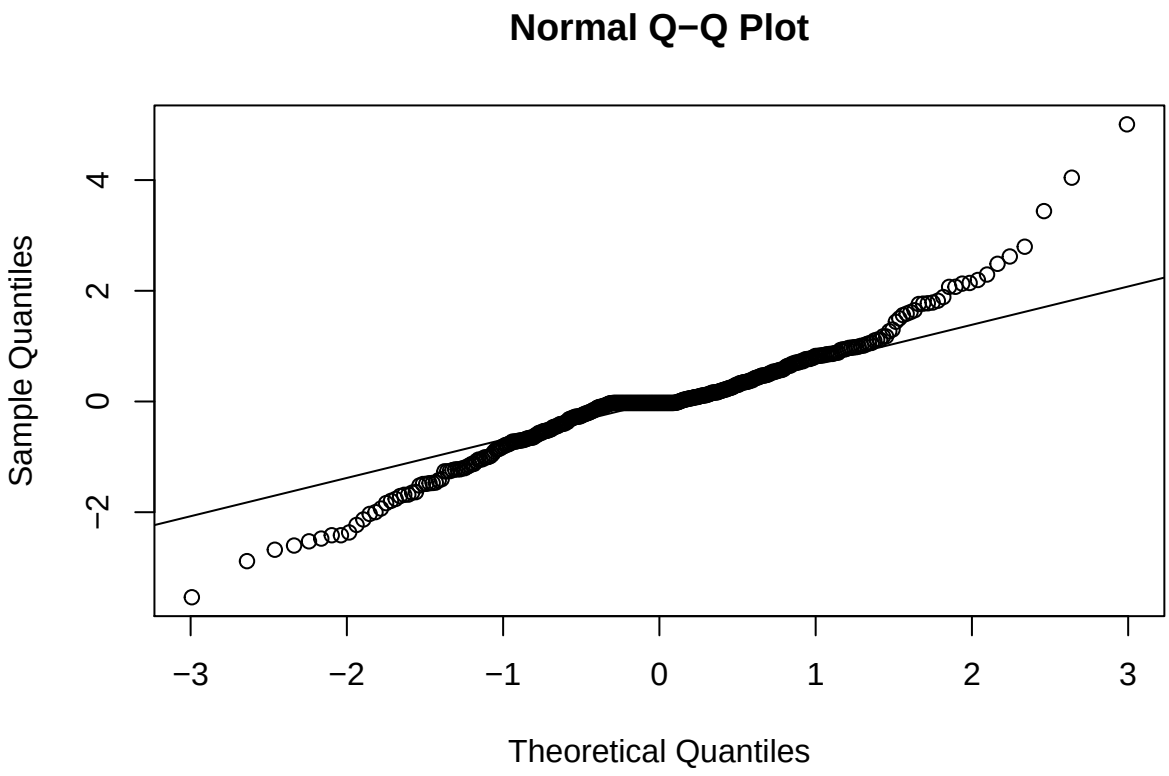
```
# https://www.r-bloggers.com/r-tutorial-series-simple-linear-regression/

zbaktiv.model.summary <- summary(zbaktiv.model)
zbaktiv.model.residuals <- zbaktiv.model.summary$residuals

hist(zbaktiv.model.residuals)
```




```
plot(zbaktiv.model.residuals)
abline(0,0)
```




```
qqnorm(rstandard(zbaktiv.model))
qqline(rstandard(zbaktiv.model))
```




```
ks.test(rstandard(zbaktiv.model), 'pnorm')
```

```
## Warning in ks.test(rstandard(zbaktiv.model), "pnorm"): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  rstandard(zbaktiv.model)
## D = 0.11279, p-value = 0.000205
## alternative hypothesis: two-sided
```

CAPM model 2

TODO: tablica modela (alpha / beta) <- VERIFY

```
require(quantmod)
```

```
## Loading required package: quantmod
```

```
## Loading required package: xts
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
```

```
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: TTR
```

```
## Version 0.4-0 included new data defaults. See ?getSymbols.
```

```
require(PerformanceAnalytics)
```

```
## Loading required package: PerformanceAnalytics
```

```
##
## Attaching package: 'PerformanceAnalytics'
```

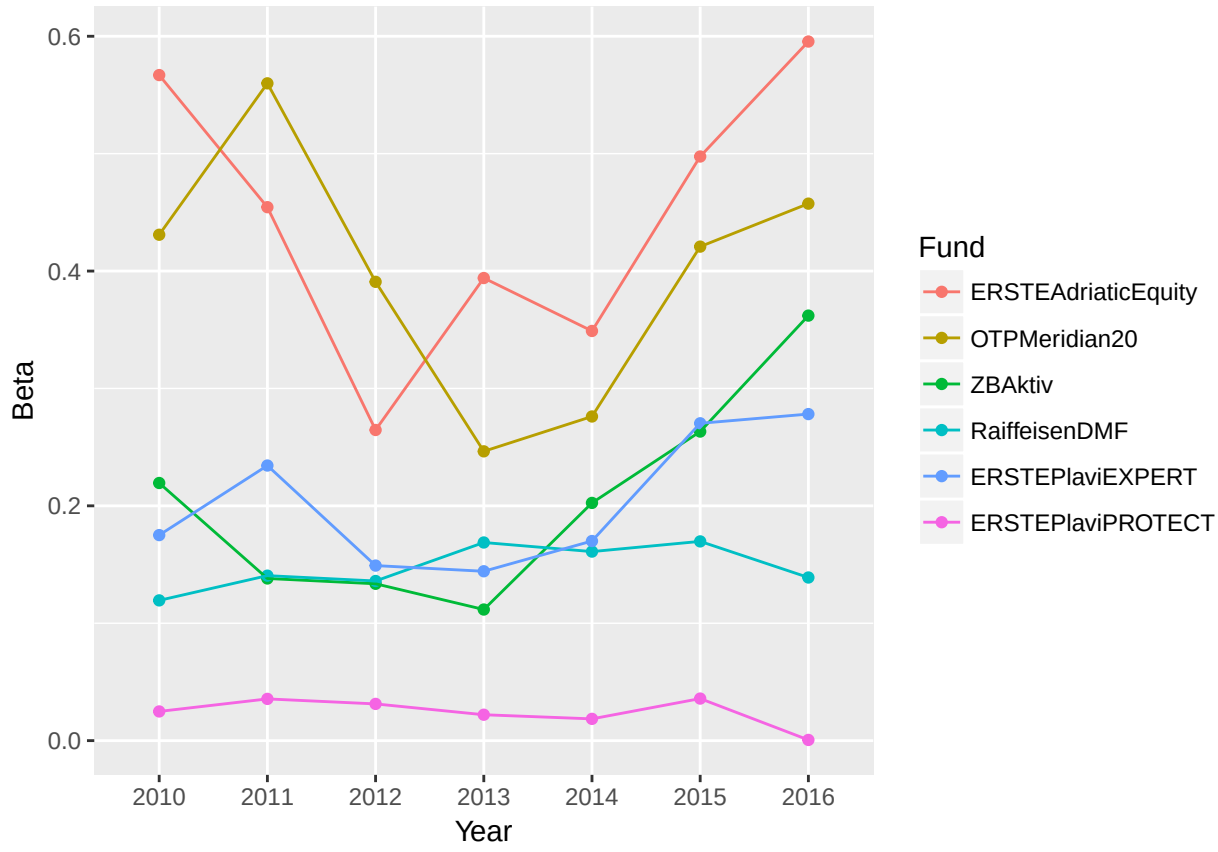
```
## The following object is masked from 'package:graphics':
##
##     legend
```

```
library(xts)

get_capm_for_year <- function(df, fund, desired_year){
  xs.year = get_for_year(df, df$Date, desired_year)

  fund.year <- xs.year[c('Date', fund)]
  fund.ts <- xts(fund.year[, -1], order.by=fund.year$Date)

  capm.index.year <- xs.year[c('Date', 'CROBEX')]
  capm.index.ts <-  xts(capm.index.year[, -1], order.by=capm.index.year$Date)

  capm.risk_free.year <- xs.year[c('Date', 'InterestRate.daily')]
  capm.risk_free.year <- capm.risk_free.year[1, -1]

  data.frame(fund, as.factor(desired_year),
             CAPM.alpha(fund.ts, capm.index.ts, capm.risk_free.year),
             CAPM.beta(fund.ts, capm.index.ts, capm.risk_free.year))
}

xs.years = seq(from = 2010, by = 1, length = 7)
xs.fund.names = c(investment_funds, pension_funds)
xs.capm <- data.frame(matrix(ncol = 3, nrow = 0))

for (i in 1:length(xs.fund.names)){
  for (j in 1:length(xs.years)){
    xs.capm <- rbind(xs.capm, get_capm_for_year(xs.returns, xs.fund.names[i], xs.years[j]))
  }
}

colnames(xs.capm) <- c("Fund", "Year", "Alpha", "Beta")
xs.capm
```

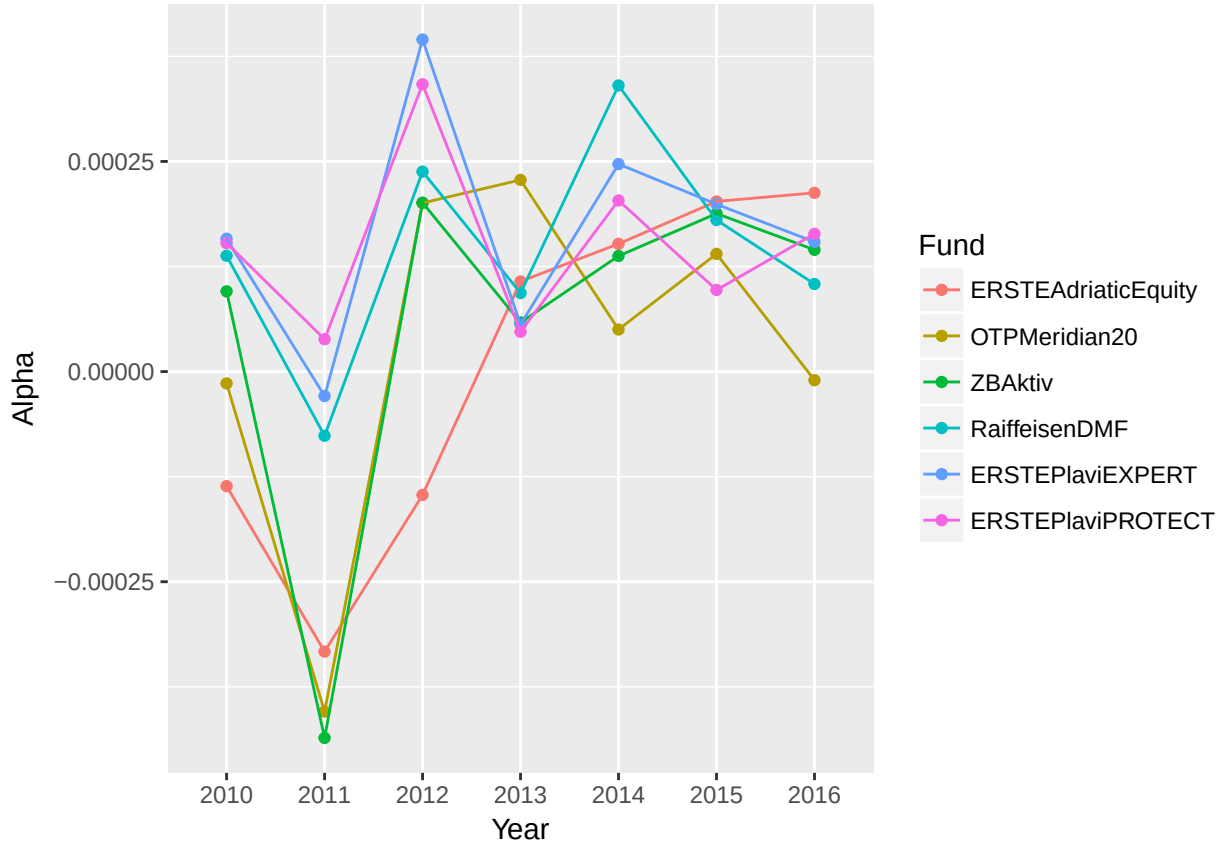
```
##                   Fund Year         Alpha         Beta
## 1  ERSTEAdriaticEquity 2010 -1.363158e-04 0.5669352275
## 2  ERSTEAdriaticEquity 2011 -3.331016e-04 0.4543998614
## 3  ERSTEAdriaticEquity 2012 -1.467188e-04 0.2646270122
## 4  ERSTEAdriaticEquity 2013  1.072103e-04 0.3940627807
## 5  ERSTEAdriaticEquity 2014  1.520230e-04 0.3489534496
## 6  ERSTEAdriaticEquity 2015  2.024548e-04 0.4975787045
```

```
## 7  ERSTEAdriaticEquity 2016  2.126424e-04 0.5955184335
## 8         OTPMeridian20 2010 -1.401558e-05 0.4309319208
## 9         OTPMeridian20 2011 -4.044461e-04 0.5599034422
## 10        OTPMeridian20 2012  2.005561e-04 0.3908358348
## 11        OTPMeridian20 2013  2.280547e-04 0.2464292424
## 12        OTPMeridian20 2014  5.006249e-05 0.2761167134
## 13        OTPMeridian20 2015  1.400398e-04 0.4208172130
## 14        OTPMeridian20 2016 -1.026420e-05 0.4574313828
## 15              ZBAktiv 2010  9.544554e-05 0.2194612955
## 16              ZBAktiv 2011 -4.358250e-04 0.1381375343
## 17              ZBAktiv 2012  2.009252e-04 0.1336074631
## 18              ZBAktiv 2013  5.840394e-05 0.1116804387
## 19              ZBAktiv 2014  1.375125e-04 0.2024930920
## 20              ZBAktiv 2015  1.880294e-04 0.2632705419
## 21              ZBAktiv 2016  1.448745e-04 0.3620458129
## 22        RaiffeisenDMF 2010  1.378239e-04 0.1194627941
## 23        RaiffeisenDMF 2011 -7.635330e-05 0.1405371249
## 24        RaiffeisenDMF 2012  2.378826e-04 0.1359857205
## 25        RaiffeisenDMF 2013  9.345165e-05 0.1687797266
## 26        RaiffeisenDMF 2014  3.404221e-04 0.1610284601
## 27        RaiffeisenDMF 2015  1.803462e-04 0.1697165854
## 28        RaiffeisenDMF 2016  1.041926e-04 0.1389678904
## 29     ERSTEPlaviEXPERT 2010  1.580814e-04 0.1750763495
## 30     ERSTEPlaviEXPERT 2011 -2.905792e-05 0.2343404356
## 31     ERSTEPlaviEXPERT 2012  3.950473e-04 0.1491048287
## 32     ERSTEPlaviEXPERT 2013  5.594323e-05 0.1442715157
## 33     ERSTEPlaviEXPERT 2014  2.469191e-04 0.1700392710
## 34     ERSTEPlaviEXPERT 2015  1.991195e-04 0.2703175563
## 35     ERSTEPlaviEXPERT 2016  1.542028e-04 0.2781643675
## 36    ERSTEPlaviPROTECT 2010  1.528344e-04 0.0248670367
## 37    ERSTEPlaviPROTECT 2011  3.855290e-05 0.0355562101
## 38    ERSTEPlaviPROTECT 2012  3.418137e-04 0.0312794690
## 39    ERSTEPlaviPROTECT 2013  4.735975e-05 0.0220619941
## 40    ERSTEPlaviPROTECT 2014  2.035929e-04 0.0185440353
## 41    ERSTEPlaviPROTECT 2015  9.710402e-05 0.0358210528
## 42    ERSTEPlaviPROTECT 2016  1.639057e-04 0.0005997816
```

```
ggplot(xs.capm, aes(Year, Beta, color= Fund, group = Fund)) +
  geom_point() + geom_line()
```




```
ggplot(xs.capm, aes(Year, Alpha, color= Fund, group = Fund)) +
  geom_point() + geom_line()
```



PROVJERA NORMALNOSTI REZIDUALA

```
nrows = nrow(xs.capm)
#for(i in 1:361) {
#  xs.capm[as.character(i)] <- as.vector(matrix(0,nrow=nrows))
#}
#
xs.capm["ks_p_val"] <- as.vector(0)
get_residuals_norm <- function(df, row) {
  xs.tmpYear <- get_for_year(xs.returns, xs.returns$Date, df[row,'Year'])
  fund <- as.character(df[row, 'Fund'])
  xs.tmpYearFund <- xs.tmpYear[,fund]

  capm.risk_free.year <- xs.tmpYear$InterestRate.daily #[c('Date', 'InterestRate.daily')]
  capm.market.year <- xs.tmpYear$CROBEX

  residuals.tmp <- vector(mode="numeric", length=length(xs.tmpYearFund))

  for (i in 1:length(xs.tmpYearFund)) {
    residuals.tmp[i] <- ((xs.tmpYearFund[i] - capm.risk_free.year[i]) -
    (df[row,3] + df[row, 4] * (capm.market.year[i] - capm.risk_free.year[i])))
  }
  x<-ks.test(residuals.tmp, 'pnorm')
```

```
  df[row, 'ks_p_val'] <- x$p.value

  return(df)
}

for(i in 1:nrows) {
  xs.capm <- get_residuals_norm(xs.capm, i)
}

xs.capm
```

```
##                   Fund Year         Alpha         Beta ks_p_val
## 1  ERSTEAdriaticEquity 2010 -1.363158e-04 0.5669352275        0
## 2  ERSTEAdriaticEquity 2011 -3.331016e-04 0.4543998614        0
## 3  ERSTEAdriaticEquity 2012 -1.467188e-04 0.2646270122        0
## 4  ERSTEAdriaticEquity 2013  1.072103e-04 0.3940627807        0
## 5  ERSTEAdriaticEquity 2014  1.520230e-04 0.3489534496        0
## 6  ERSTEAdriaticEquity 2015  2.024548e-04 0.4975787045        0
## 7  ERSTEAdriaticEquity 2016  2.126424e-04 0.5955184335        0
## 8        OTPMeridian20 2010 -1.401558e-05 0.4309319208        0
## 9        OTPMeridian20 2011 -4.044461e-04 0.5599034422        0
## 10       OTPMeridian20 2012  2.005561e-04 0.3908358348        0
## 11       OTPMeridian20 2013  2.280547e-04 0.2464292424        0
## 12       OTPMeridian20 2014  5.006249e-05 0.2761167134        0
## 13       OTPMeridian20 2015  1.400398e-04 0.4208172130        0
## 14       OTPMeridian20 2016 -1.026420e-05 0.4574313828        0
## 15             ZBAktiv 2010  9.544554e-05 0.2194612955        0
## 16             ZBAktiv 2011 -4.358250e-04 0.1381375343        0
## 17             ZBAktiv 2012  2.009252e-04 0.1336074631        0
## 18             ZBAktiv 2013  5.840394e-05 0.1116804387        0
## 19             ZBAktiv 2014  1.375125e-04 0.2024930920        0
## 20             ZBAktiv 2015  1.880294e-04 0.2632705419        0
## 21             ZBAktiv 2016  1.448745e-04 0.3620458129        0
## 22       RaiffeisenDMF 2010  1.378239e-04 0.1194627941        0
## 23       RaiffeisenDMF 2011 -7.635330e-05 0.1405371249        0
## 24       RaiffeisenDMF 2012  2.378826e-04 0.1359857205        0
## 25       RaiffeisenDMF 2013  9.345165e-05 0.1687797266        0
## 26       RaiffeisenDMF 2014  3.404221e-04 0.1610284601        0
## 27       RaiffeisenDMF 2015  1.803462e-04 0.1697165854        0
## 28       RaiffeisenDMF 2016  1.041926e-04 0.1389678904        0
## 29    ERSTEPlaviEXPERT 2010  1.580814e-04 0.1750763495        0
## 30    ERSTEPlaviEXPERT 2011 -2.905792e-05 0.2343404356        0
## 31    ERSTEPlaviEXPERT 2012  3.950473e-04 0.1491048287        0
## 32    ERSTEPlaviEXPERT 2013  5.594323e-05 0.1442715157        0
## 33    ERSTEPlaviEXPERT 2014  2.469191e-04 0.1700392710        0
## 34    ERSTEPlaviEXPERT 2015  1.991195e-04 0.2703175563        0
## 35    ERSTEPlaviEXPERT 2016  1.542028e-04 0.2781643675        0
## 36   ERSTEPlaviPROTECT 2010  1.528344e-04 0.0248670367        0
## 37   ERSTEPlaviPROTECT 2011  3.855290e-05 0.0355562101        0
## 38   ERSTEPlaviPROTECT 2012  3.418137e-04 0.0312794690        0
## 39   ERSTEPlaviPROTECT 2013  4.735975e-05 0.0220619941        0
## 40   ERSTEPlaviPROTECT 2014  2.035929e-04 0.0185440353        0
## 41   ERSTEPlaviPROTECT 2015  9.710402e-05 0.0358210528        0
## 42   ERSTEPlaviPROTECT 2016  1.639057e-04 0.0005997816        0
```

ANOVA