

# Mjerenje uspješnosti investicijskih fondova

## Priprema podataka

Prilikom proučavanja podataka primjetili smo da vrijednost fonda ErsteAdriaticEquity za 24.1.2016. poprilično odskaka 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
```

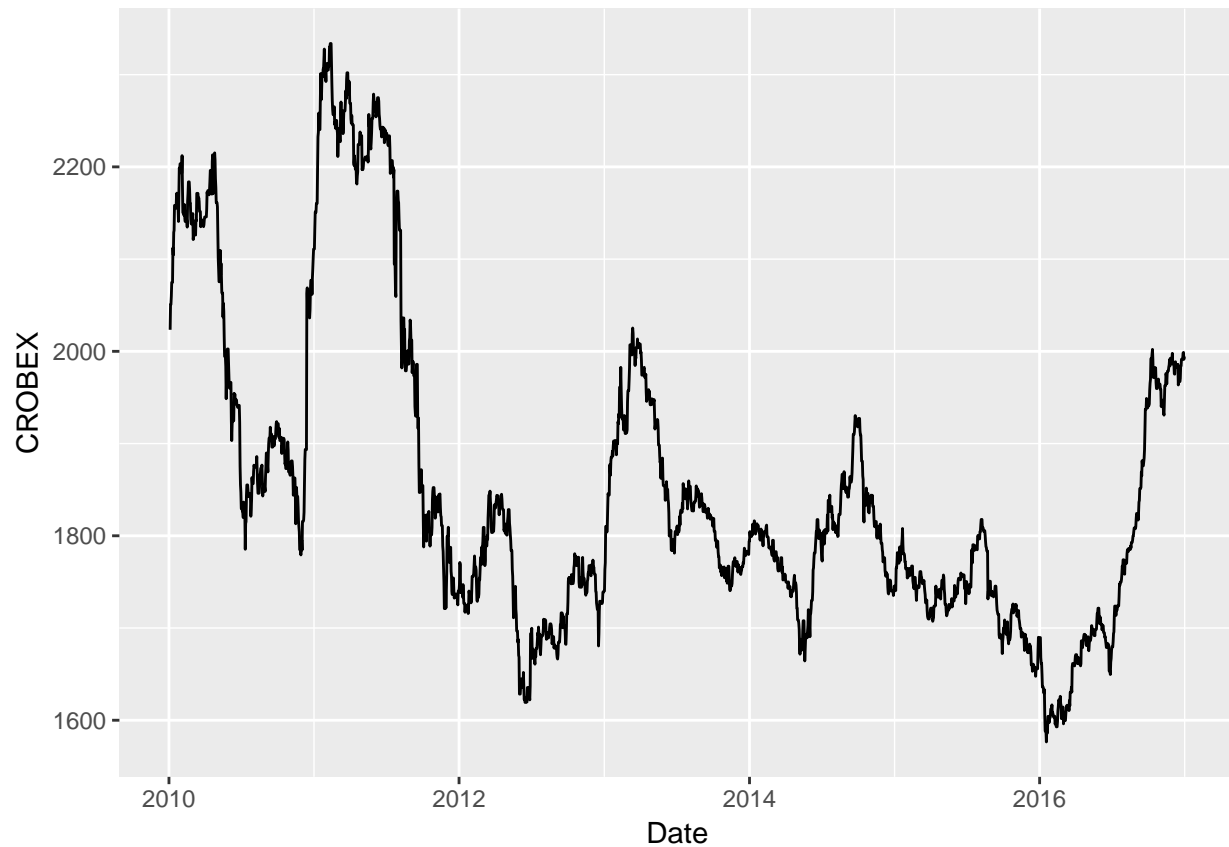
```
apply(xs.returns[all_funds] * sqrt(365), 2, sd, na.rm=T)
```

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

## Grafički prikaz podataka

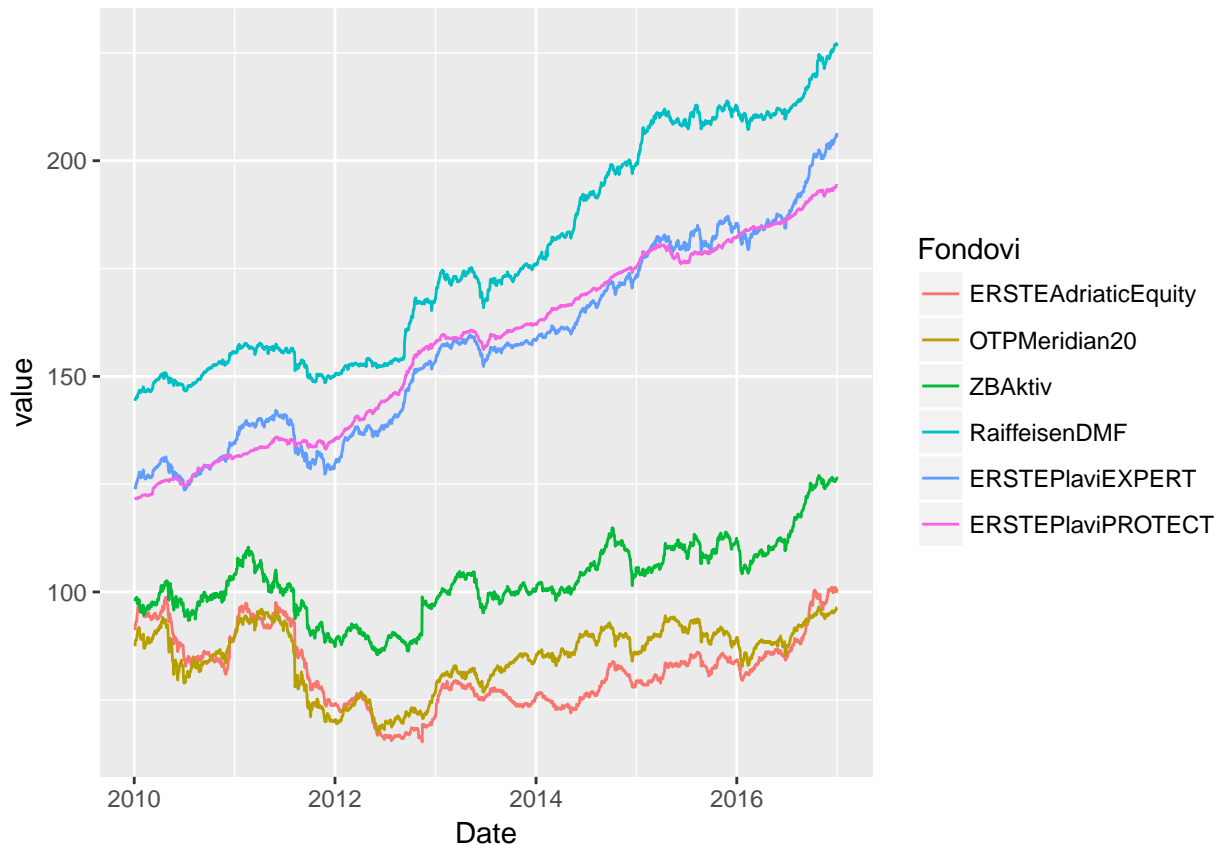
### Prikaz vrijednosti CROBEX-a po danima

```
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')
```

```
library(stringr)
```

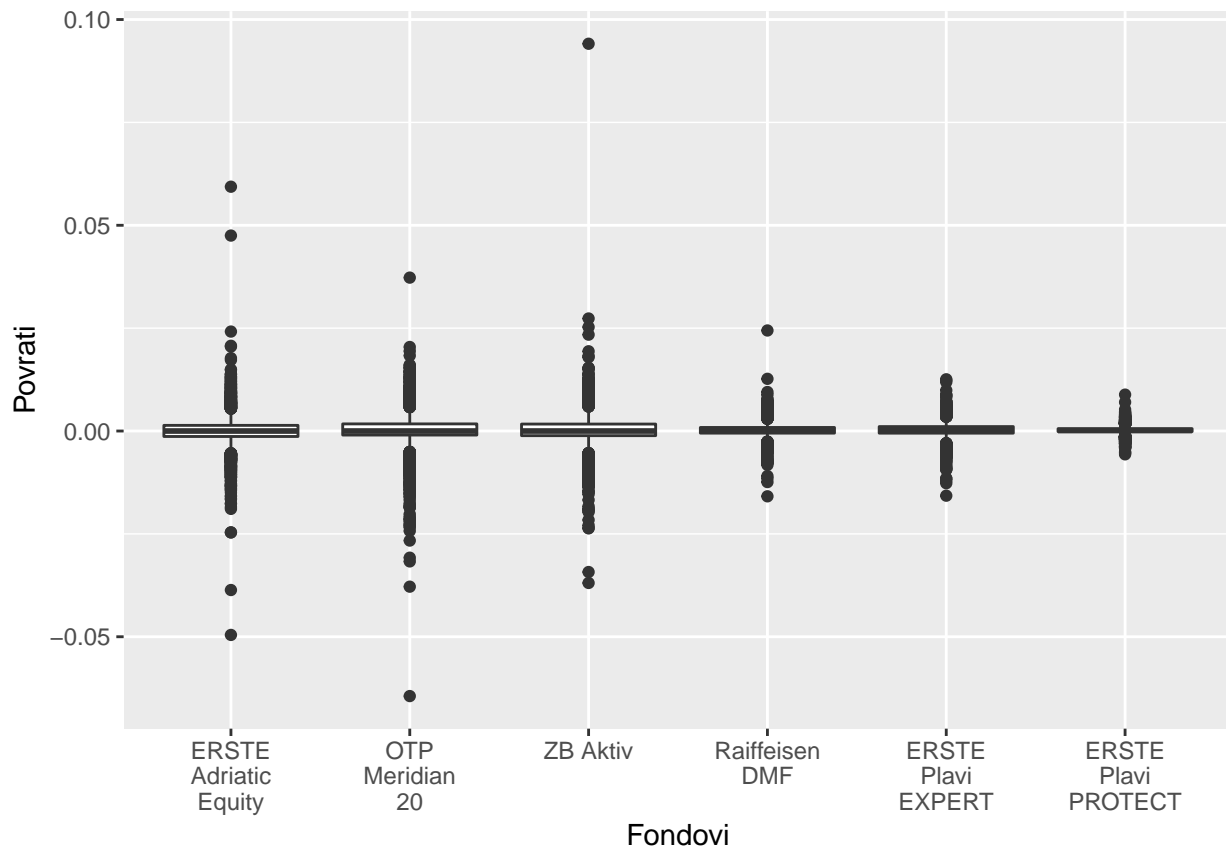
```
label_prettify <- function(label) {
  first_matches <- str_match(label, "(^[A-Z]+)([A-Z][a-z]+)(.*)")
  second_matches <- str_match(label, "(^[A-Z][a-z]+)([A-Z]+)")

  first_word <- ifelse(!is.na(first_matches[1, 1]), first_matches[1, 2], second_matches[1, 2])
  second_word <- ifelse(!is.na(first_matches[1, 1]), first_matches[1, 3], second_matches[1, 3])
  second_word <- ifelse(!is.na(first_matches[1, 4]), str_c(second_word, first_matches[1, 4], sep = " "))

  return(str_c(first_word, second_word, sep = " ") %>% str_wrap(width = 10))
}
```

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

```
scale_x_discrete(labels = function(labels) return(lapply(labels, label_prettify)))
```

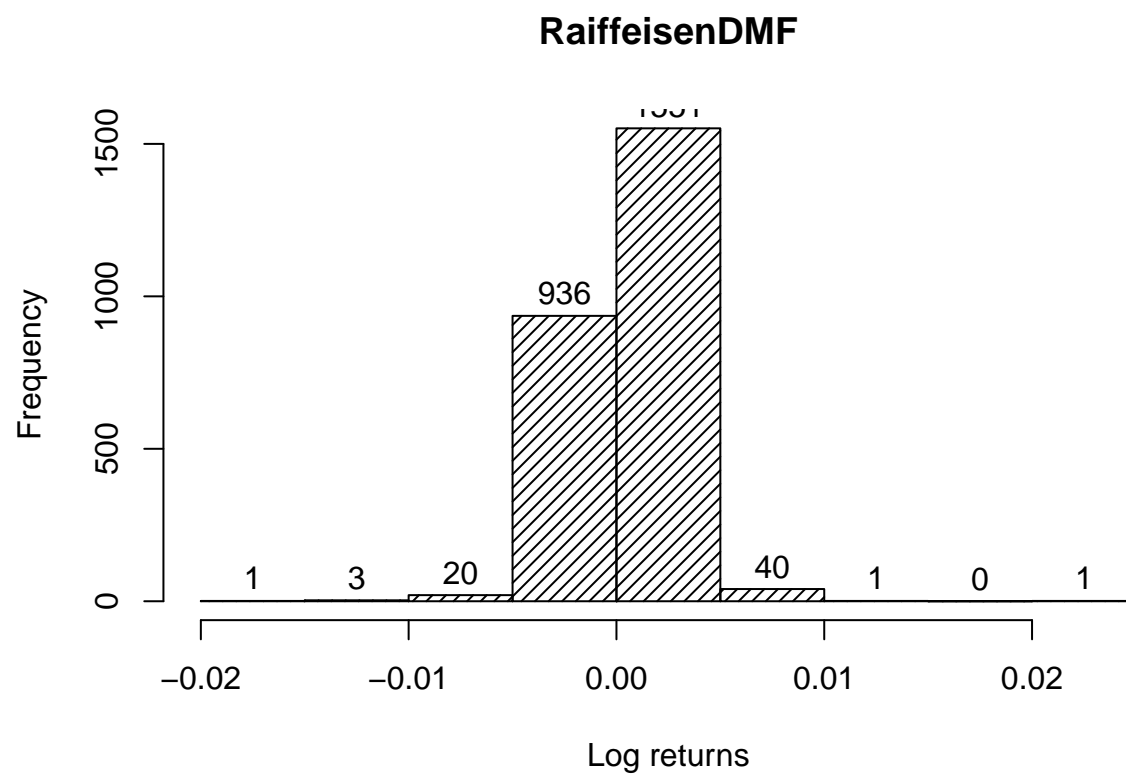


## Provjera normalnosti

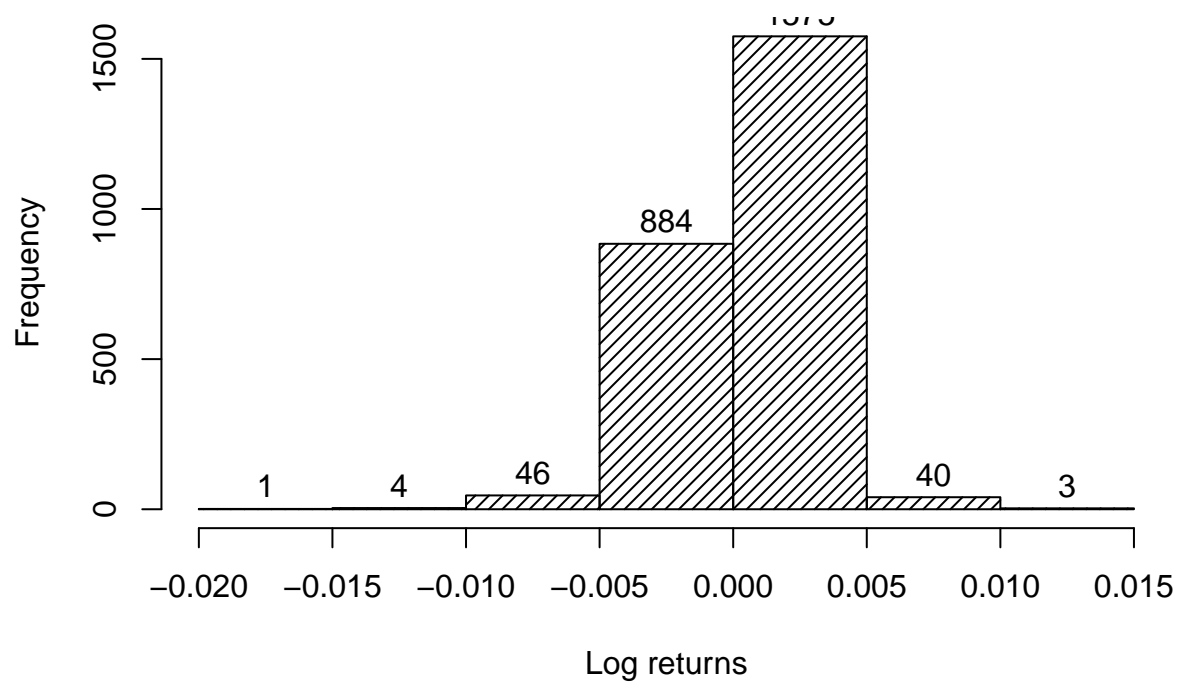
Sljedećim QQ grafovima želimo ispitati normalnost distribucije burzovnog indeksa. Iz QQ grafa vidimo kako podaci nisu u potpunosti normalni, a iz histograma jasno je i zašto. Teške repove primjećujemo radi sitne granulacije, tj. dnevnog računanja prinosa; u tako kratkom roku zna se dogoditi da pojedina dionica ili naglo naraste ili naglo padne u vrijednosti.

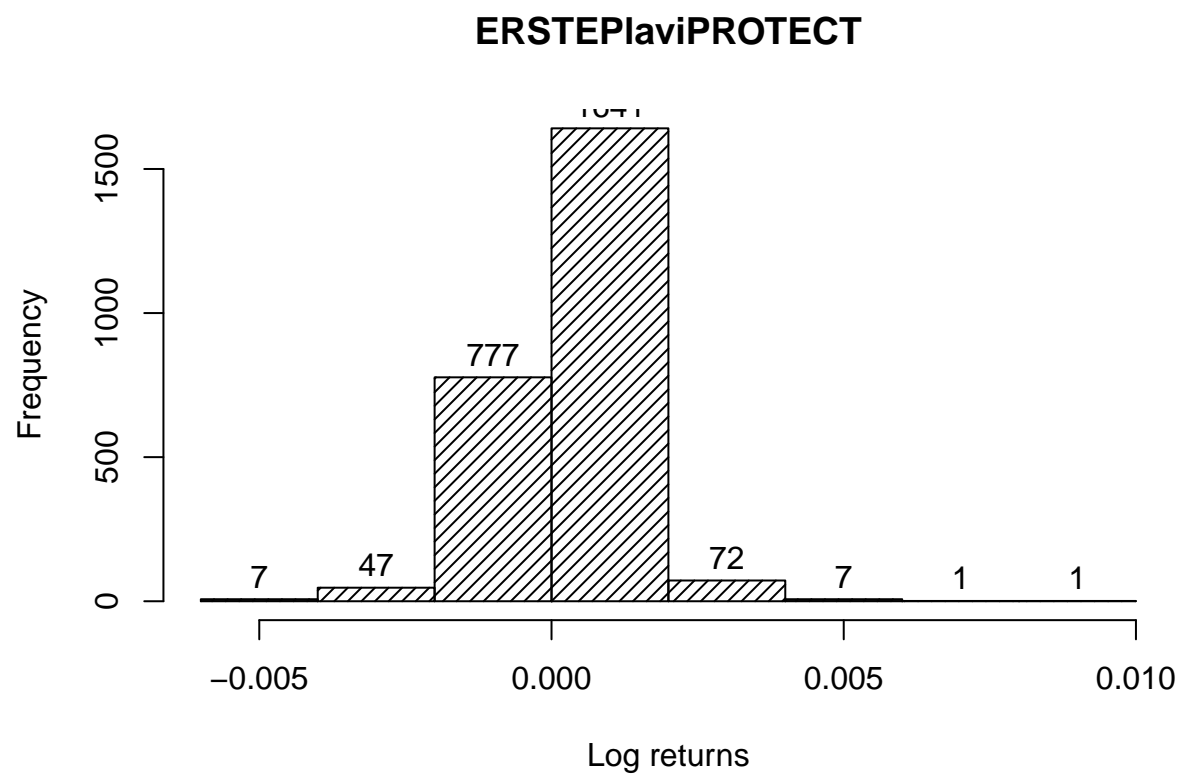
```
library(magrittr)
plot_returns <- function(fund.returns, fund.name) hist(fund.returns,
  main = fund.name,
  density=20,
  xlab='Log returns',
  labels=TRUE,
  breaks=10)

mapapply(plot_returns,
  c(xs.returns[c(pension_funds, investment_funds)]),
  c(pension_funds, investment_funds)) %>%
  invisible
```



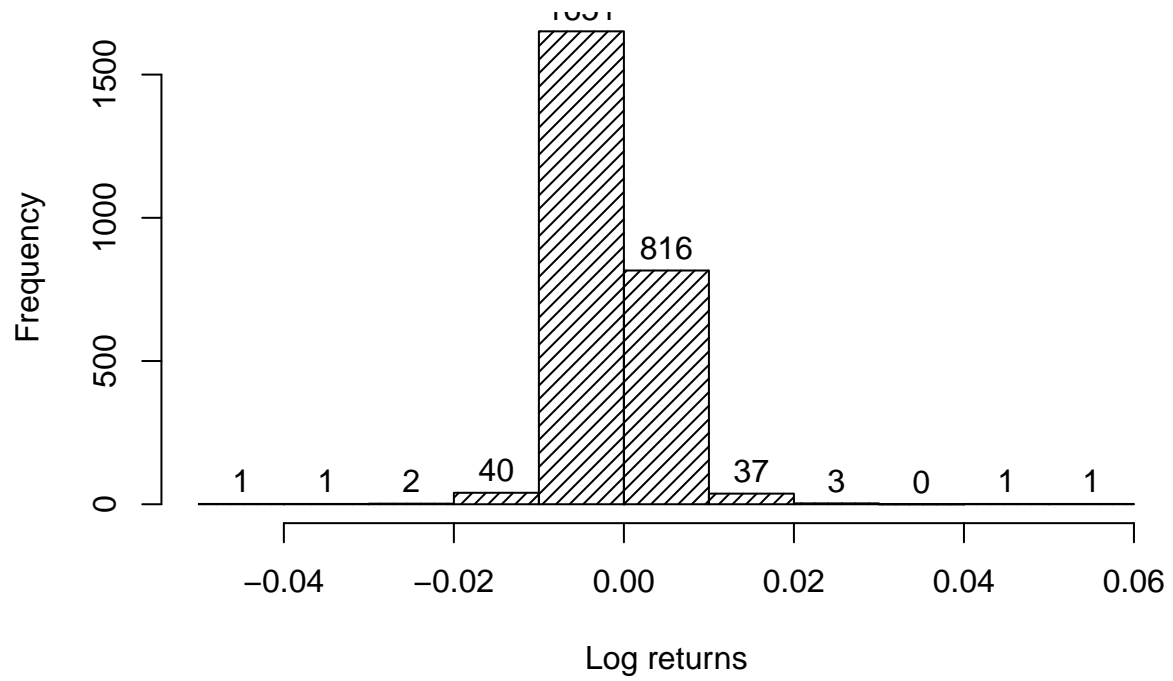
# ERSTEPlaviEXPERT

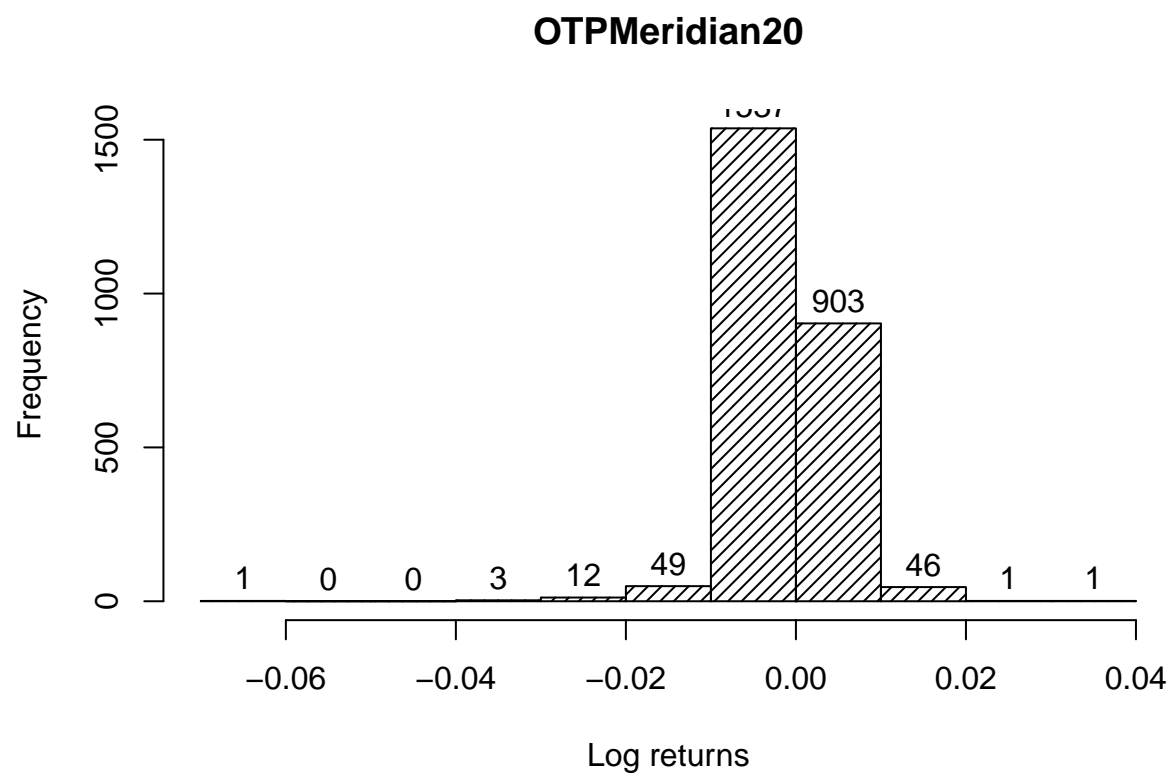


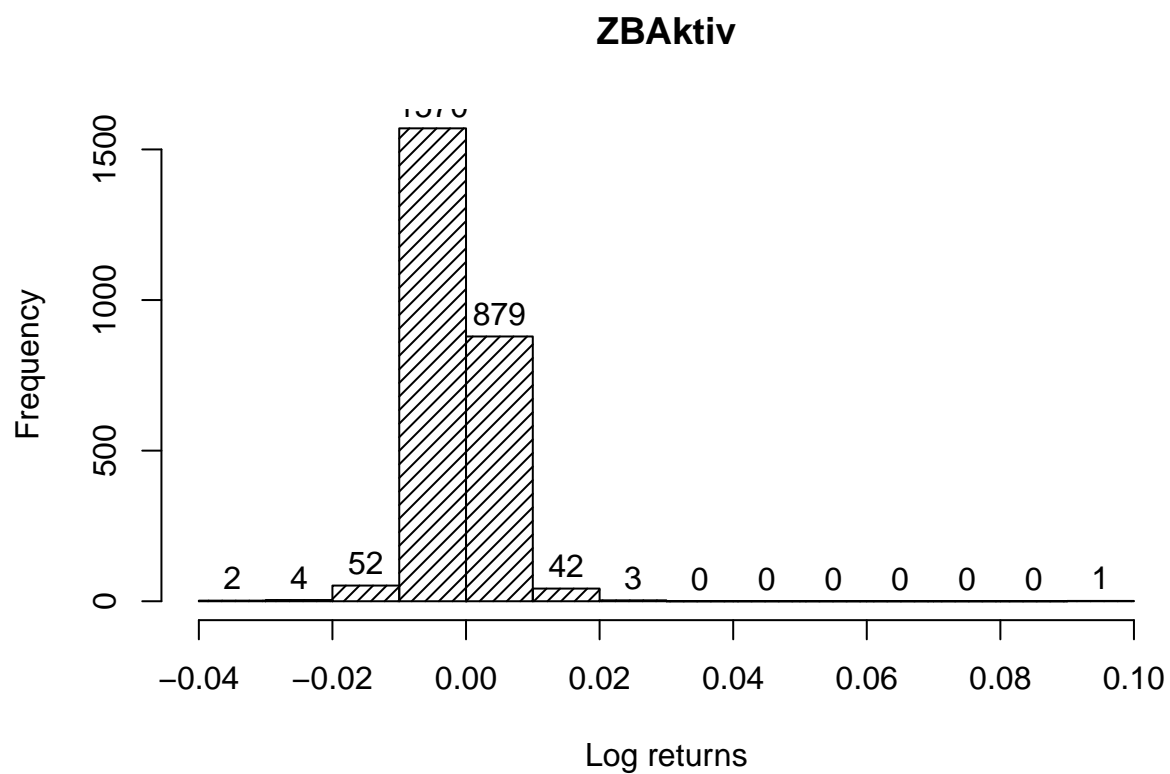




# ERSTAdriaticEquity





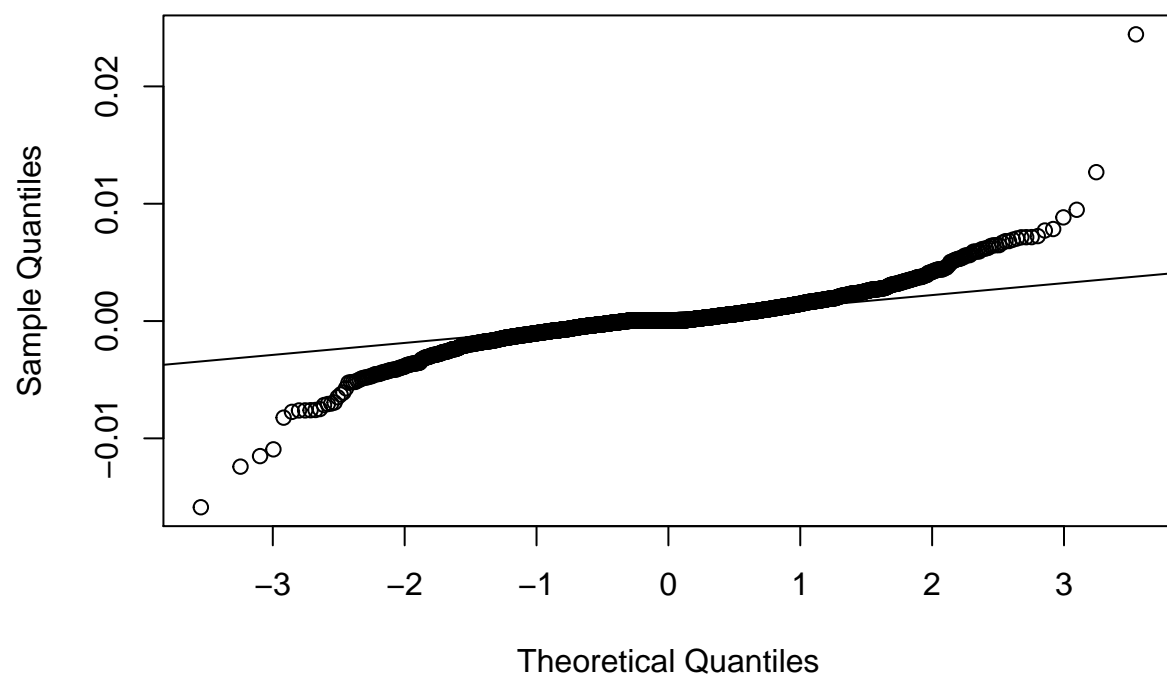


TODO: Kolmogorov-smirnov

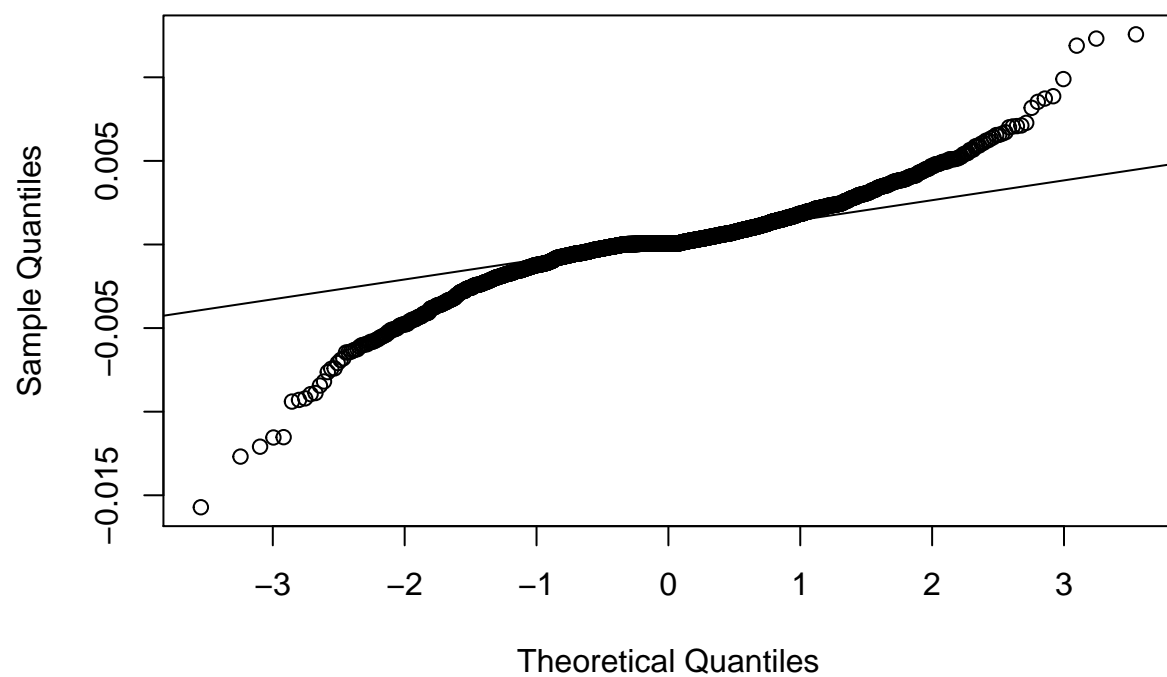
```
qqplots <- function(fund.returns, fund.name) {
  qqnorm(fund.returns, main = fund.name)
  qqline(fund.returns)
}

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

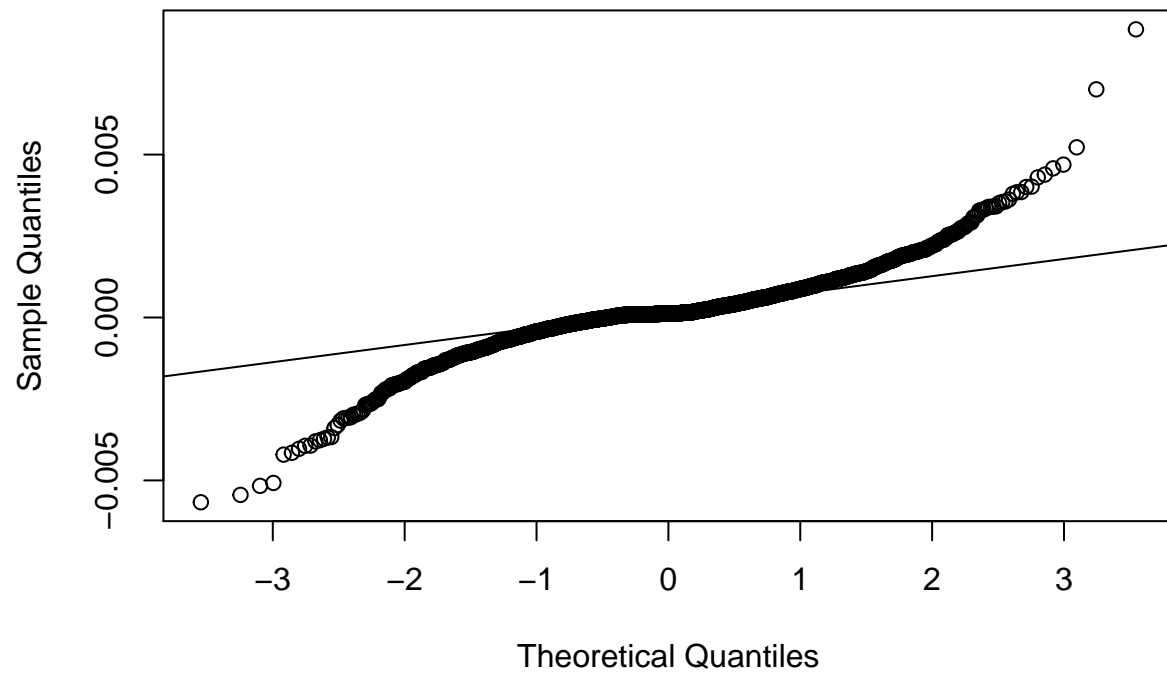
# RaiffeisenDMF



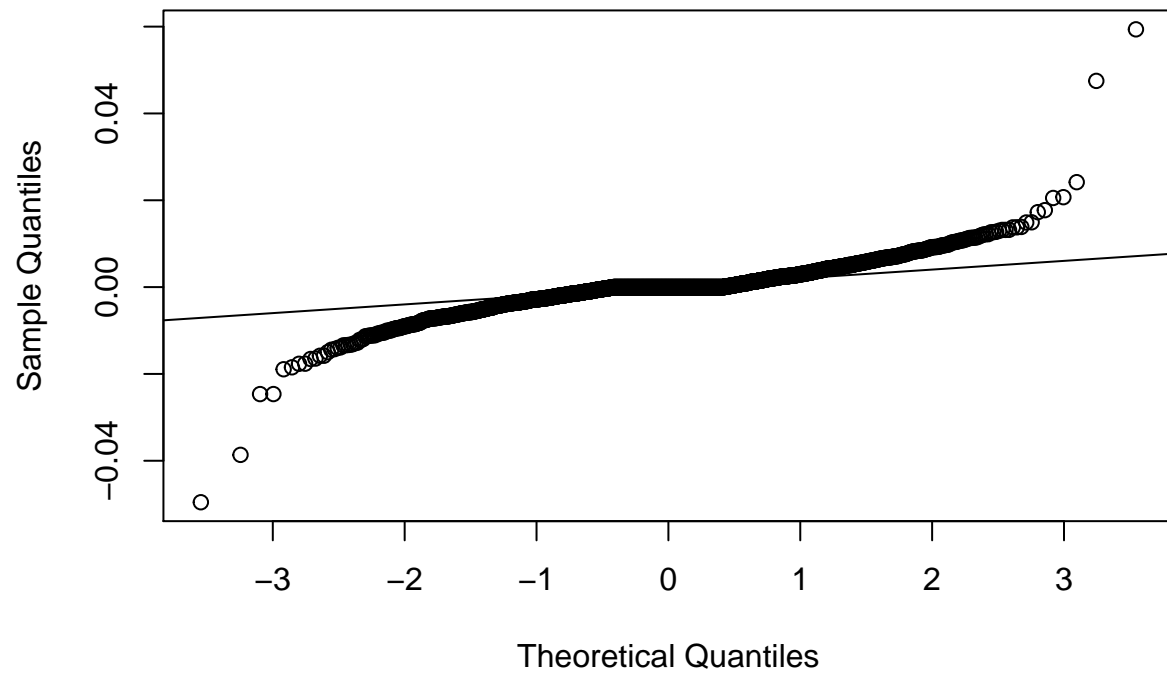
# ERSTEPlaviEXPERT

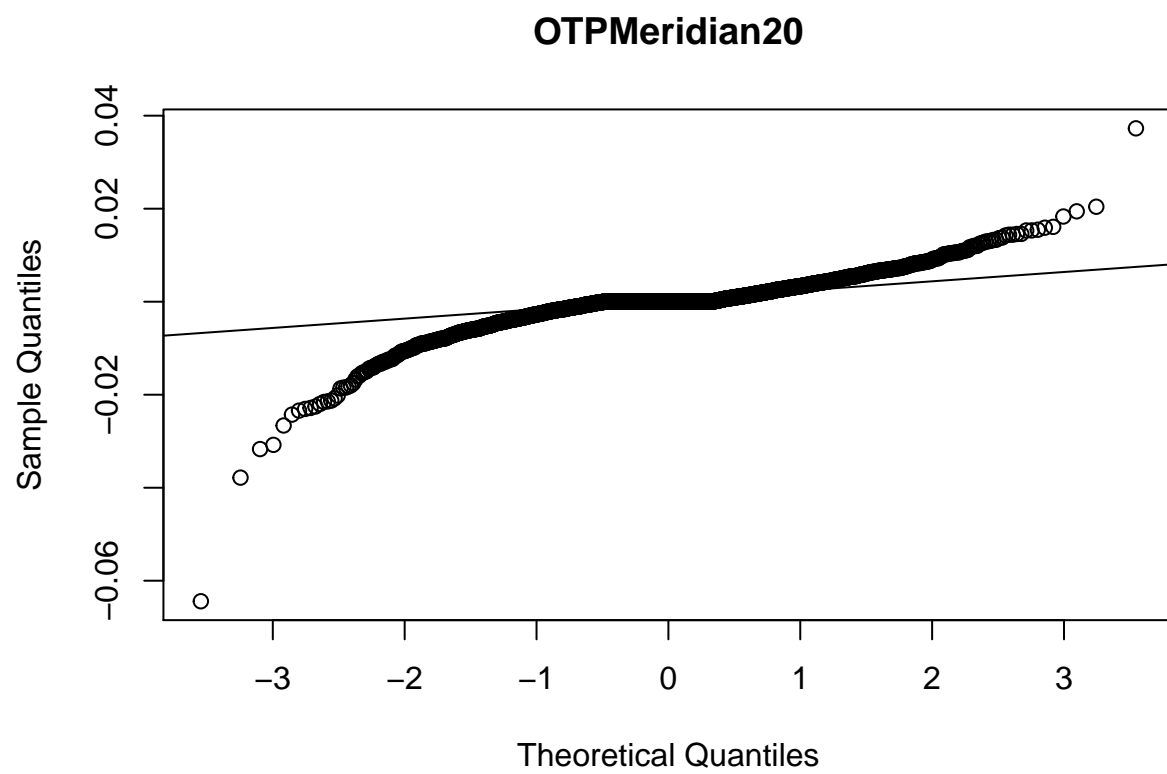


# ERSTEPlaviPROTECT



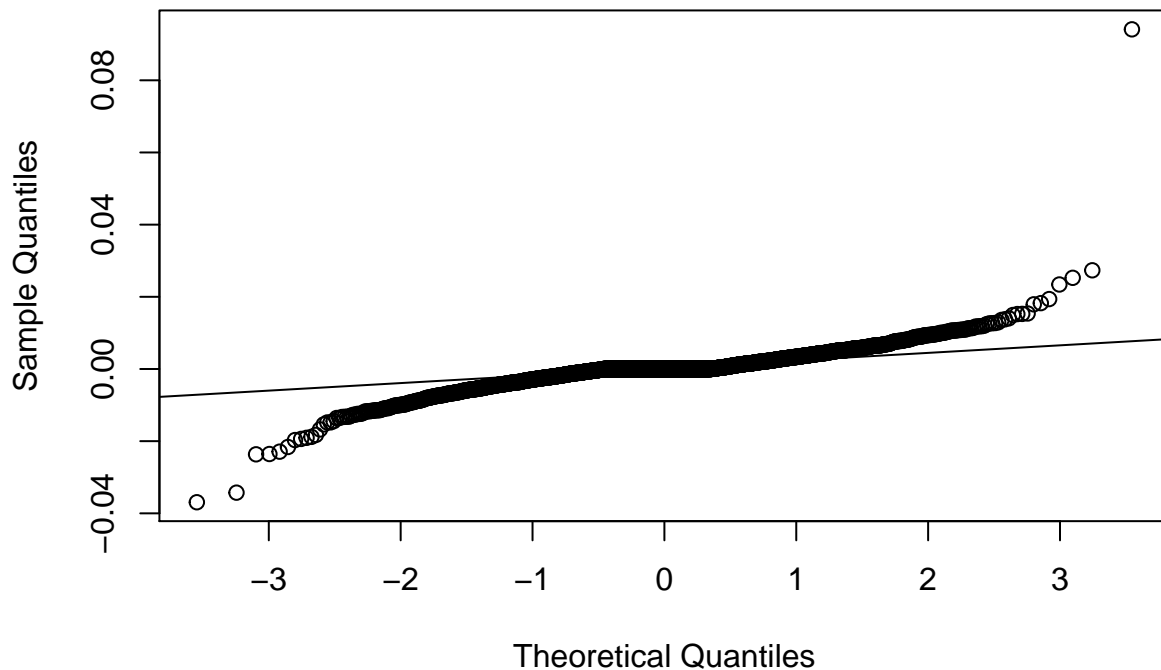
# ERSTAdriaticEquity







## ZBAktiv



```
#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_fun = log))
# xs.log_returns <- data.frame( c(xs[2:nrow(xs), !(colnames(xs) %in% columns_to_log_normalize)], xs.log_returns) )
#xs.xts <- xts(xs['CROBEX'], order.by = xs$date)
```

## 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)
mapapply(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$Date,
                                   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

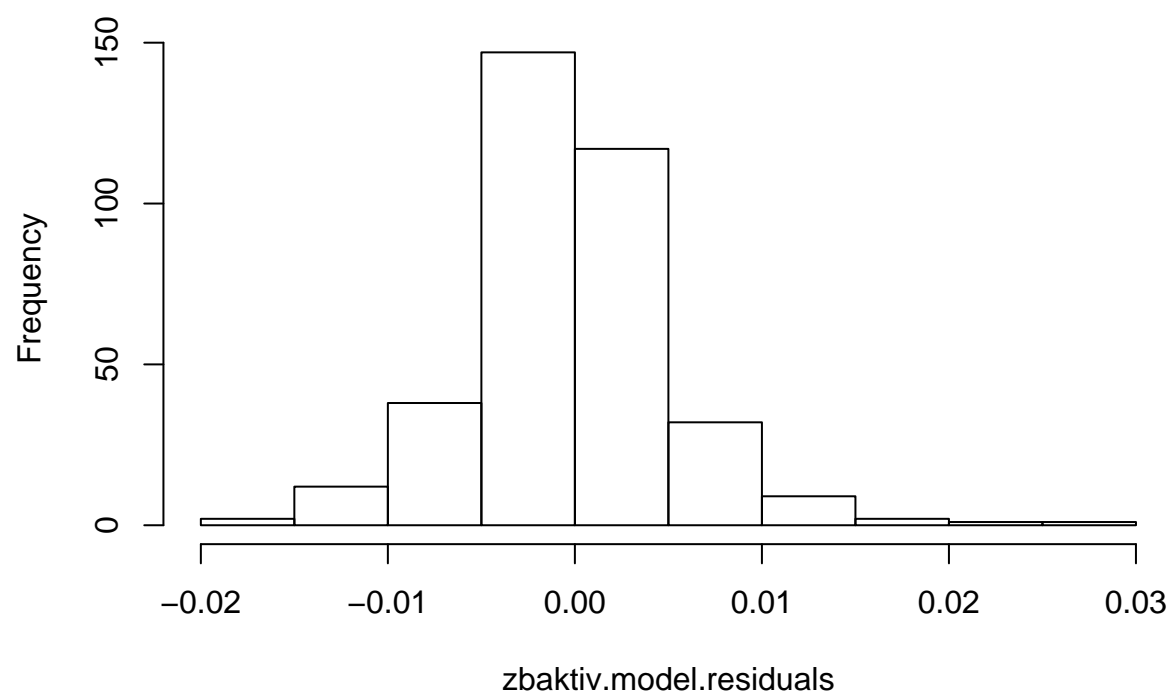
TODO: regresija / vrijednosti i raspodjela reziduala

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

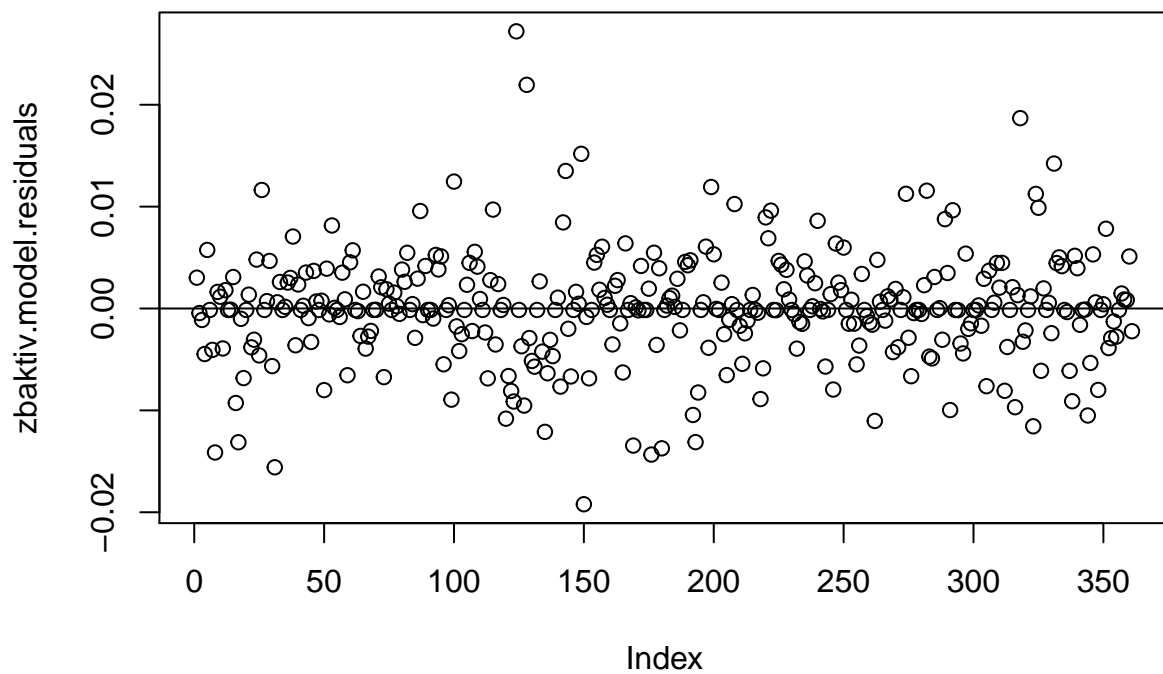
zbaktiv.model.summary <- summary(zbaktiv.model)
zbaktiv.model.residuals <- zbaktiv.model.summary$residuals

hist(zbaktiv.model.residuals)
```

**Histogram of zbaktiv.model.residuals**

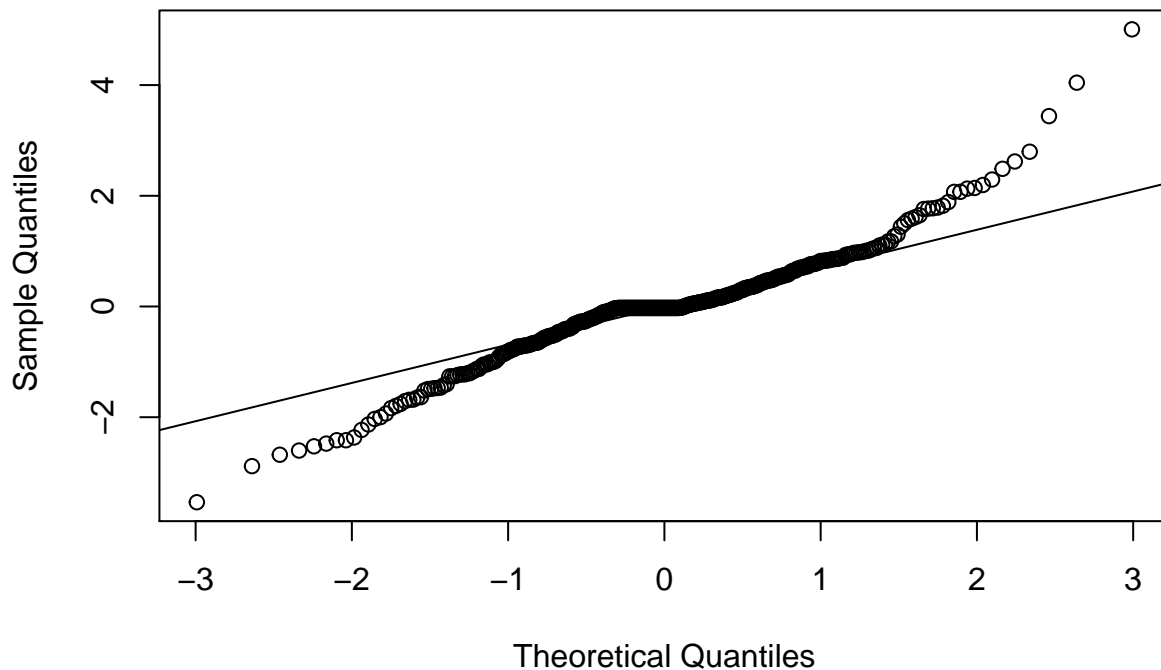


```
plot(zbaktiv.model.residuals)
abline(0,0)
```



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

## Normal Q-Q Plot



```
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 ERSTEA AdriaticEquity 2010 -1.363158e-04 0.5669352275
## 2 ERSTEA AdriaticEquity 2011 -3.331016e-04 0.4543998614
## 3 ERSTEA AdriaticEquity 2012 -1.467188e-04 0.2646270122
## 4 ERSTEA AdriaticEquity 2013  1.072103e-04 0.3940627807
## 5 ERSTEA AdriaticEquity 2014  1.520230e-04 0.3489534496
## 6 ERSTEA AdriaticEquity 2015  2.024548e-04 0.4975787045

```



```

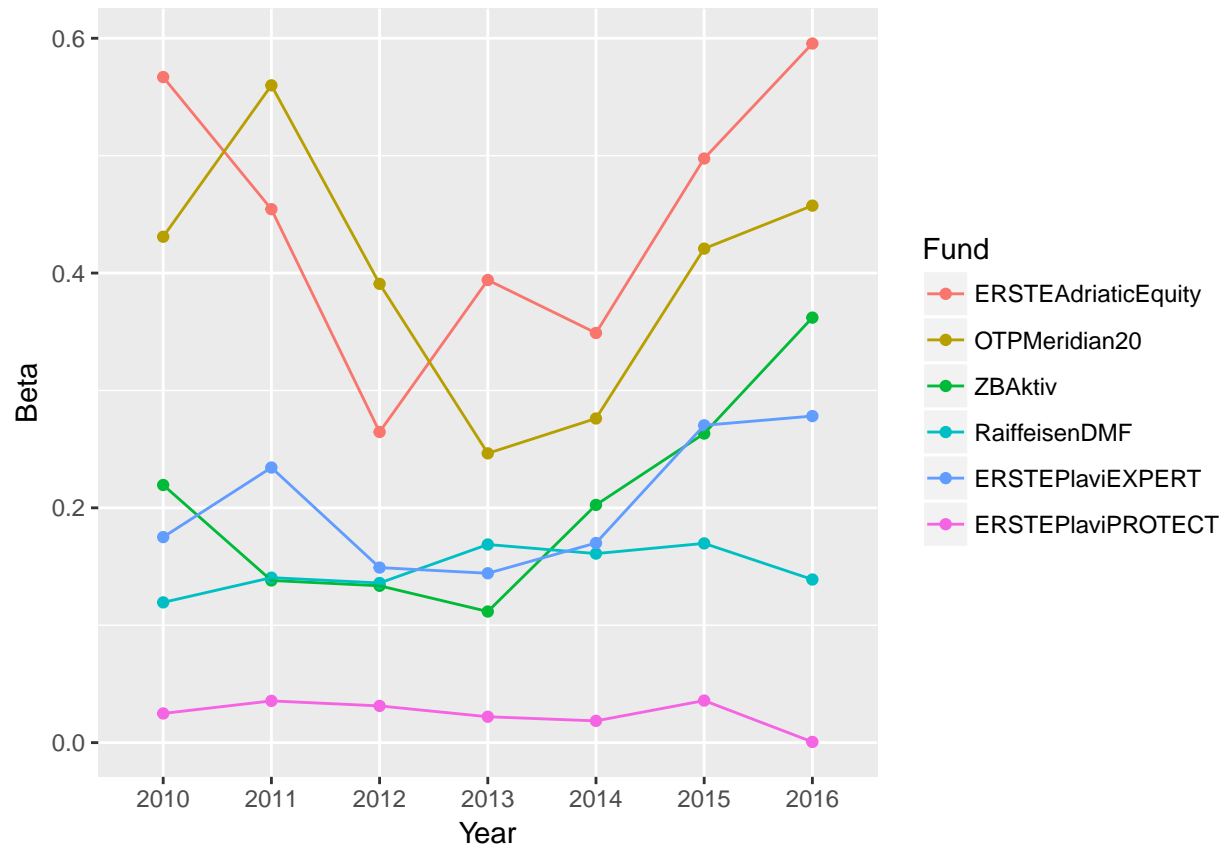
## 7  ERSTeAdriaticEquity 2016  2.126424e-04 0.5955184335
## 8      OTPMeridian20 2010 -1.401558e-05 0.4309319208
## 9      OTPMeridian20 2011 -4.044461e-04 0.5599034422
## 10     OTPMeridian20 2012  2.005561e-04 0.3908358348
## 11     OTPMeridian20 2013  2.280547e-04 0.2464292424
## 12     OTPMeridian20 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])))
  }

  scaled.residuals.tmp <- scale(residuals.tmp)
```

```

x<-ks.test(scaled.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	7.606159e-08	
## 2	ERSTEAdriaticEquity	2011	-3.331016e-04	0.4543998614	8.972995e-10	
## 3	ERSTEAdriaticEquity	2012	-1.467188e-04	0.2646270122	3.976819e-13	
## 4	ERSTEAdriaticEquity	2013	1.072103e-04	0.3940627807	3.095202e-11	
## 5	ERSTEAdriaticEquity	2014	1.520230e-04	0.3489534496	5.271628e-11	
## 6	ERSTEAdriaticEquity	2015	2.024548e-04	0.4975787045	2.888248e-09	
## 7	ERSTEAdriaticEquity	2016	2.126424e-04	0.5955184335	1.182900e-08	
## 8	OTPMeridian20	2010	-1.401558e-05	0.4309319208	2.925515e-10	
## 9	OTPMeridian20	2011	-4.044461e-04	0.5599034422	3.870977e-08	
## 10	OTPMeridian20	2012	2.005561e-04	0.3908358348	2.004861e-09	
## 11	OTPMeridian20	2013	2.280547e-04	0.2464292424	2.003044e-10	
## 12	OTPMeridian20	2014	5.006249e-05	0.2761167134	7.392093e-09	
## 13	OTPMeridian20	2015	1.400398e-04	0.4208172130	2.578632e-08	
## 14	OTPMeridian20	2016	-1.026420e-05	0.4574313828	5.335510e-12	
## 15	ZBAktiv	2010	9.544554e-05	0.2194612955	2.049980e-04	
## 16	ZBAktiv	2011	-4.358250e-04	0.1381375343	2.527614e-05	
## 17	ZBAktiv	2012	2.009252e-04	0.1336074631	1.354321e-10	
## 18	ZBAktiv	2013	5.840394e-05	0.1116804387	2.323343e-06	
## 19	ZBAktiv	2014	1.375125e-04	0.2024930920	6.164473e-06	
## 20	ZBAktiv	2015	1.880294e-04	0.2632705419	2.186302e-05	
## 21	ZBAktiv	2016	1.448745e-04	0.3620458129	1.539224e-04	
## 22	RaiffeisenDMF	2010	1.378239e-04	0.1194627941	2.717111e-03	
## 23	RaiffeisenDMF	2011	-7.635330e-05	0.1405371249	3.224060e-06	
## 24	RaiffeisenDMF	2012	2.378826e-04	0.1359857205	1.741118e-11	
## 25	RaiffeisenDMF	2013	9.345165e-05	0.1687797266	2.118944e-04	
## 26	RaiffeisenDMF	2014	3.404221e-04	0.1610284601	2.405696e-04	
## 27	RaiffeisenDMF	2015	1.803462e-04	0.1697165854	1.146525e-03	
## 28	RaiffeisenDMF	2016	1.041926e-04	0.1389678904	2.727515e-06	
## 29	ERSTEPlaviEXPERT	2010	1.580814e-04	0.1750763495	2.160262e-04	
## 30	ERSTEPlaviEXPERT	2011	-2.905792e-05	0.2343404356	1.988193e-04	
## 31	ERSTEPlaviEXPERT	2012	3.950473e-04	0.1491048287	7.504533e-05	
## 32	ERSTEPlaviEXPERT	2013	5.594323e-05	0.1442715157	3.300715e-04	
## 33	ERSTEPlaviEXPERT	2014	2.469191e-04	0.1700392710	2.902686e-03	
## 34	ERSTEPlaviEXPERT	2015	1.991195e-04	0.2703175563	3.123242e-03	
## 35	ERSTEPlaviEXPERT	2016	1.542028e-04	0.2781643675	7.591789e-05	
## 36	ERSTEPlaviPROTECT	2010	1.528344e-04	0.0248670367	1.210117e-05	
## 37	ERSTEPlaviPROTECT	2011	3.855290e-05	0.0355562101	4.594969e-05	
## 38	ERSTEPlaviPROTECT	2012	3.418137e-04	0.0312794690	1.652921e-05	
## 39	ERSTEPlaviPROTECT	2013	4.735975e-05	0.0220619941	8.751553e-07	

##	40	ERSTEPlaviPROTECT	2014	2.035929e-04	0.0185440353	3.416949e-03
##	41	ERSTEPlaviPROTECT	2015	9.710402e-05	0.0358210528	4.620251e-04
##	42	ERSTEPlaviPROTECT	2016	1.639057e-04	0.0005997816	2.693304e-05

## ANOVA