# Mjerenje uspješnosti investicijskih fondova

## Priprema podataka

```
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")
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.   :-18.0876   Min.   :-23.51025   Min.   :-13.47776
## 2  1st Qu.: -0.4849   1st Qu.: -0.35673   1st Qu.: -0.41271
## 3  Median :  0.0000   Median :  0.00000   Median :  0.00000
## 4  Mean   :  0.0136   Mean   :  0.01395   Mean   :  0.03645
## 5  3rd Qu.:  0.4958   3rd Qu.:  0.63048   3rd Qu.:  0.61738
## 6  Max.   : 21.6702   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[,-1:-3], 2, var, na.rm=T)
```

```
##      RaiffeisenDMF    ERSTEPlaviEXPERT  ERSTEPlaviPROTECT
##       3.463344e-06      4.429072e-06       9.234754e-07
## ERSTEAdriaticEquity    OTPMeridian20            ZBAktiv
##       1.954405e-05      2.236156e-05       2.212908e-05
##             CROBEX
##       3.207109e-05
```
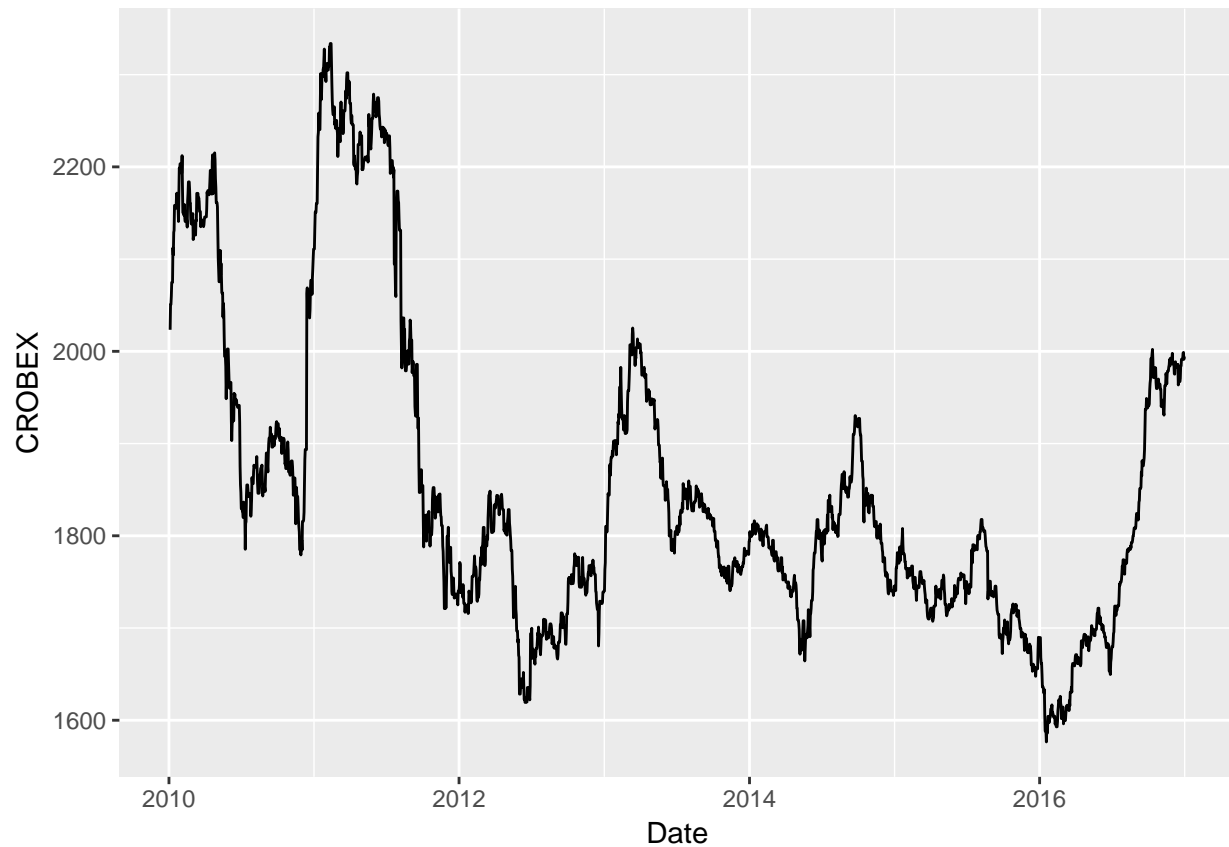
```
apply(xs.returns[,-1:-3], 2, sd, na.rm=T)
```

```
##      RaiffeisenDMF    ERSTEPlaviEXPERT  ERSTEPlaviPROTECT
##       0.0018610062      0.0021045360       0.0009609763
## ERSTEAdriaticEquity    OTPMeridian20            ZBAktiv
##       0.0044208655      0.0047288016       0.0047041558
##             CROBEX
##       0.0056631347
```
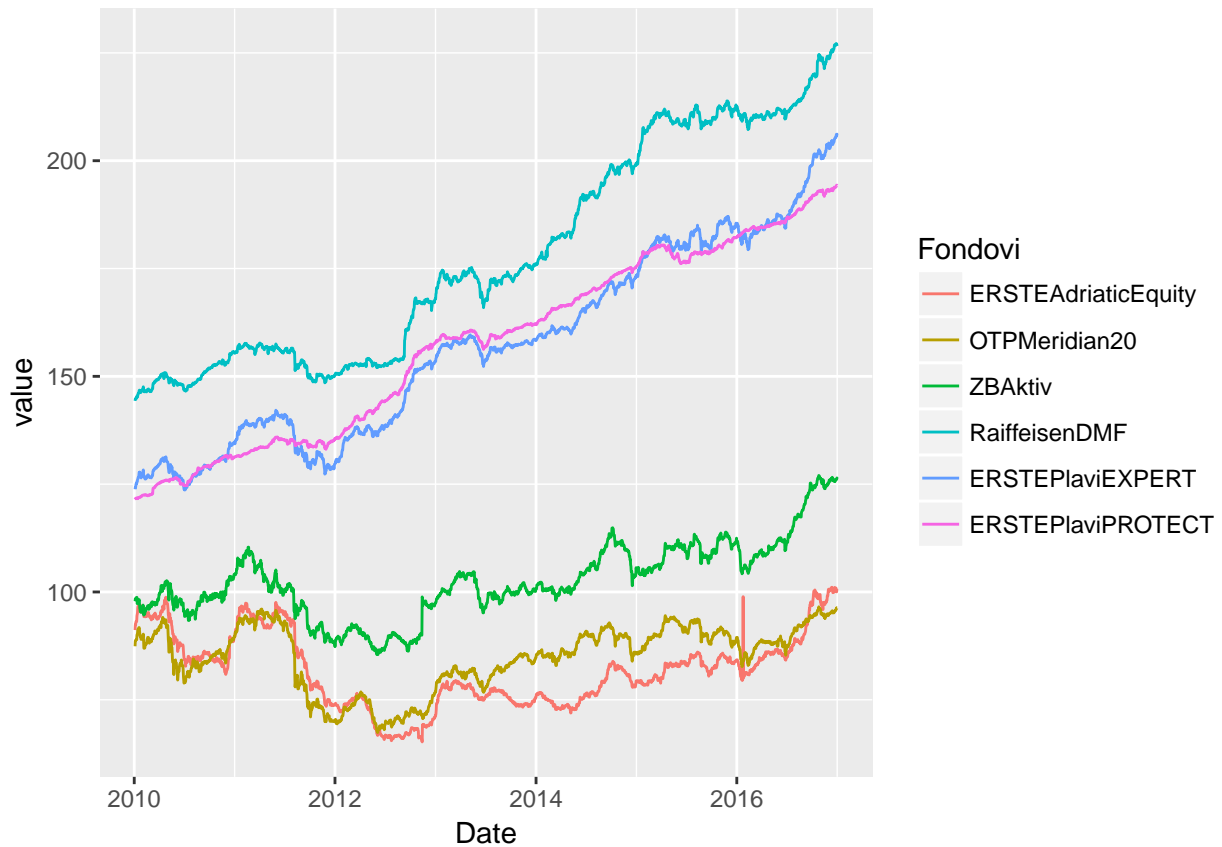
# Grafički prikaz podataka

## 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.

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

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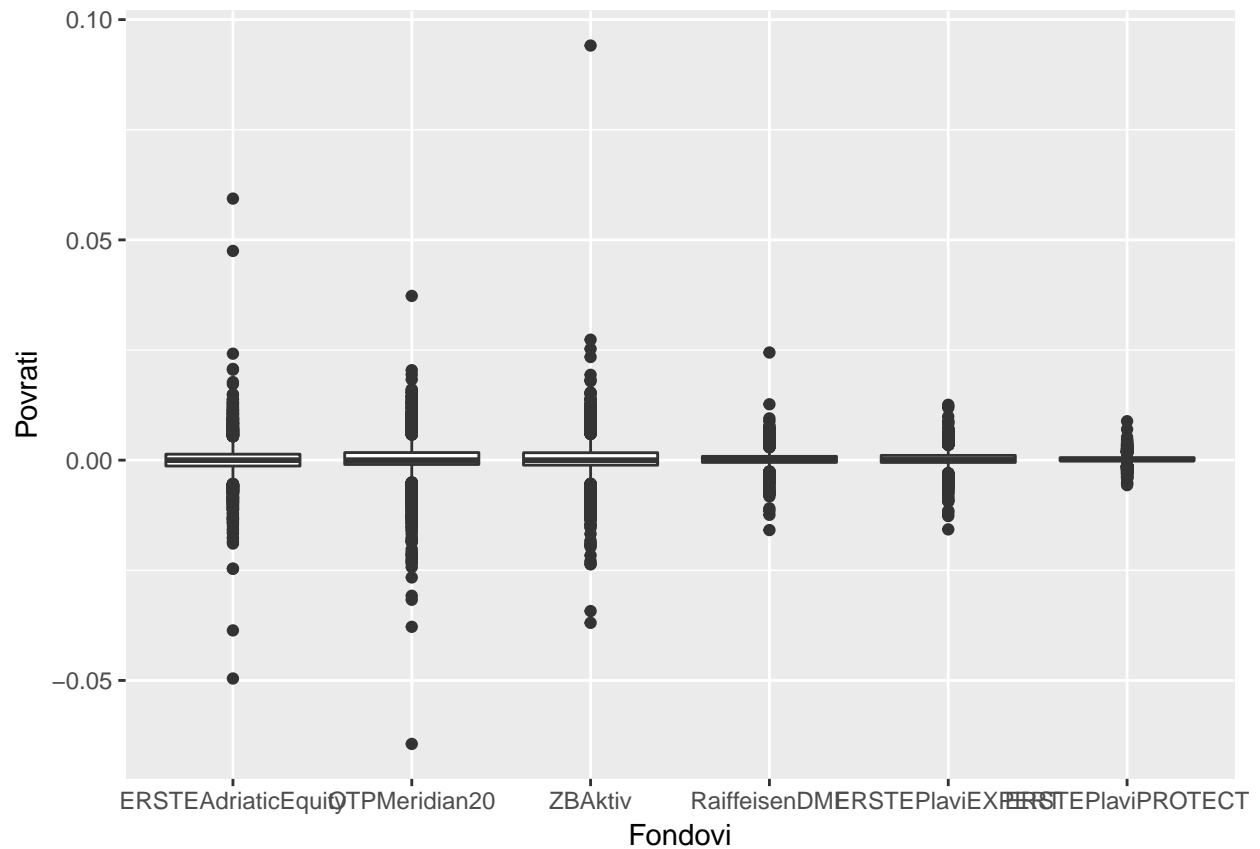
## Provjera normalnosti

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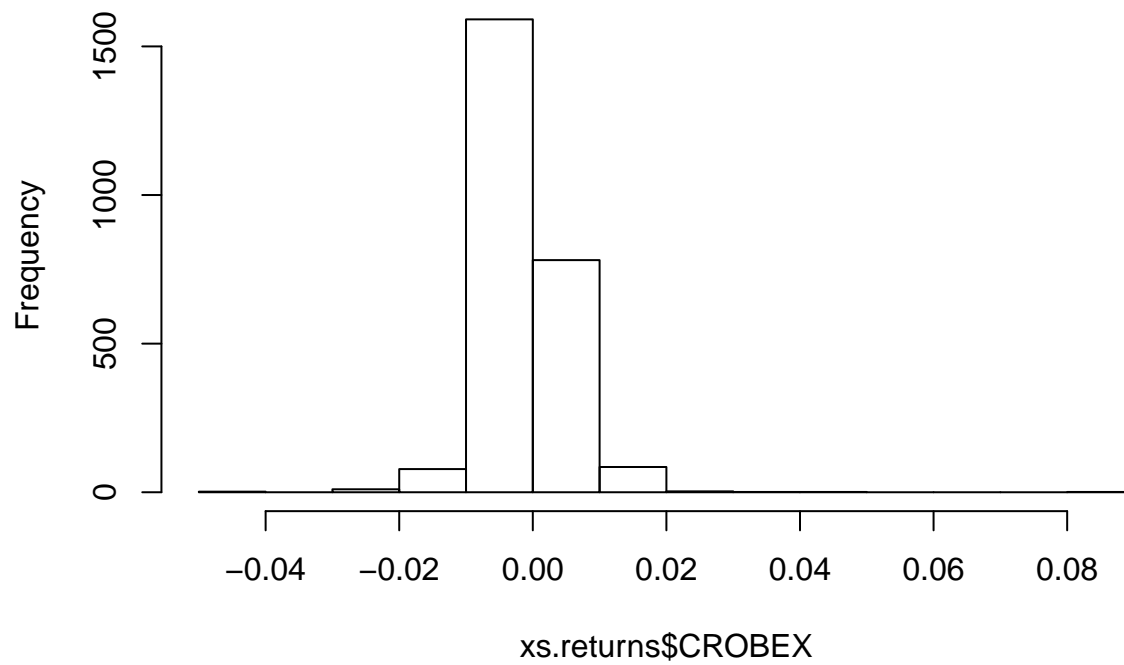
```
qqnorm(xs.returns$CROBEX)
qqline(xs.returns$CROBEX, col = "red")
```

## Normal Q–Q Plot
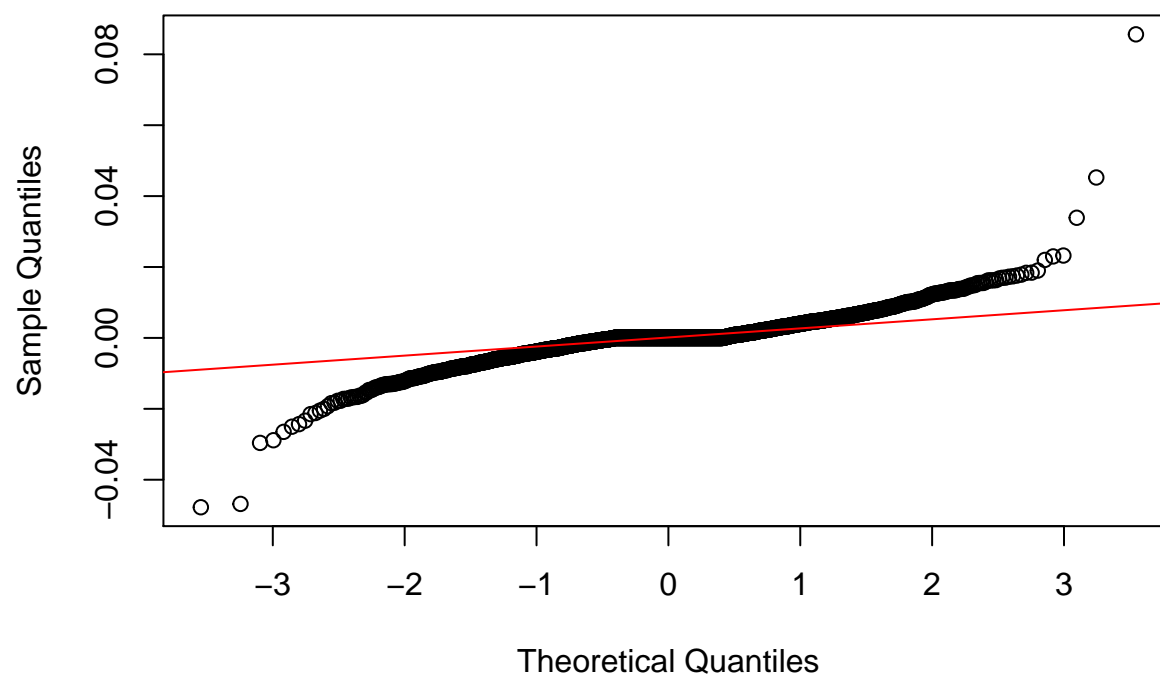


```
hist(xs.returns$CROBEX) #, breaks = seq(from = min(xs.returns$CROBEX) - 0.5, to = max(xs.returns$CROBEX,
```
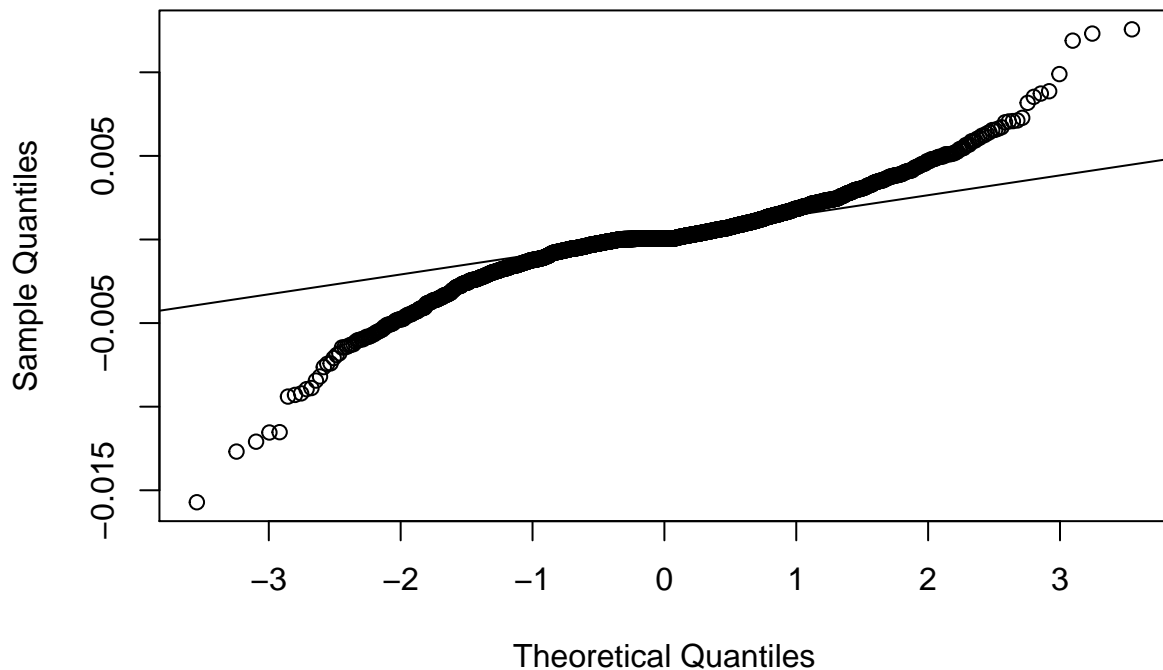
## Histogram of xs.returns$CROBEX



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

TODO: Kolmogorov-smirnov

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

## Normal Q–Q Plot



```
#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

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

```
## $ERSTEAdriaticEquity
##
##  Paired t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.45914, df = 2552, p-value = 0.6462
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.0002257286  0.0001400758
## sample estimates:
## mean of the differences
##           -4.282638e-05
##
##
## $OTPMeridian20
##
##  Paired t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.42867, df = 2552, p-value = 0.6682
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.0002440172  0.0001564677
## sample estimates:
## mean of the differences
##           -4.377476e-05
##
##
## $ZBAktiv
##
##  Paired t-test
##
## data:  xs.returns$CROBEX and r
## t = -0.8207, df = 2552, p-value = 0.4119
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.0003573138  0.0001464648
## sample estimates:
## mean of the differences
##           -0.0001054245
```

## Testovi povrata mirovinskih fondova u odnosu na CROBEX

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

```
## $RaiffeisenDMF
##
##  Paired t-test
##
## data:  xs.returns$CROBEX and r
## t = -1.7891, df = 2552, p-value = 0.07372
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -3.821299e-04  1.750544e-05
## sample estimates:
## mean of the differences
##            -0.0001823123
##
##
## $ERSTEPlaviEXPERT
##
##  Paired t-test
##
## data:  xs.returns$CROBEX and r
## t = -2.1255, df = 2552, p-value = 0.03364
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -3.940303e-04 -1.587034e-05
## sample estimates:
## mean of the differences
##            -0.0002049503
##
##
## $ERSTEPlaviPROTECT
##
##  Paired t-test
##
## data:  xs.returns$CROBEX and r
## t = -1.7115, df = 2552, p-value = 0.08711
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -4.063254e-04  2.759556e-05
## sample estimates:
## mean of the differences
##            -0.0001893649
```

## 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 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 = 2.202, df = 2552, p-value = 0.02776
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.403529e-05 2.423660e-04
## sample estimates:
## mean of the differences
##             0.0001282006
```

# 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
```

### 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)
```
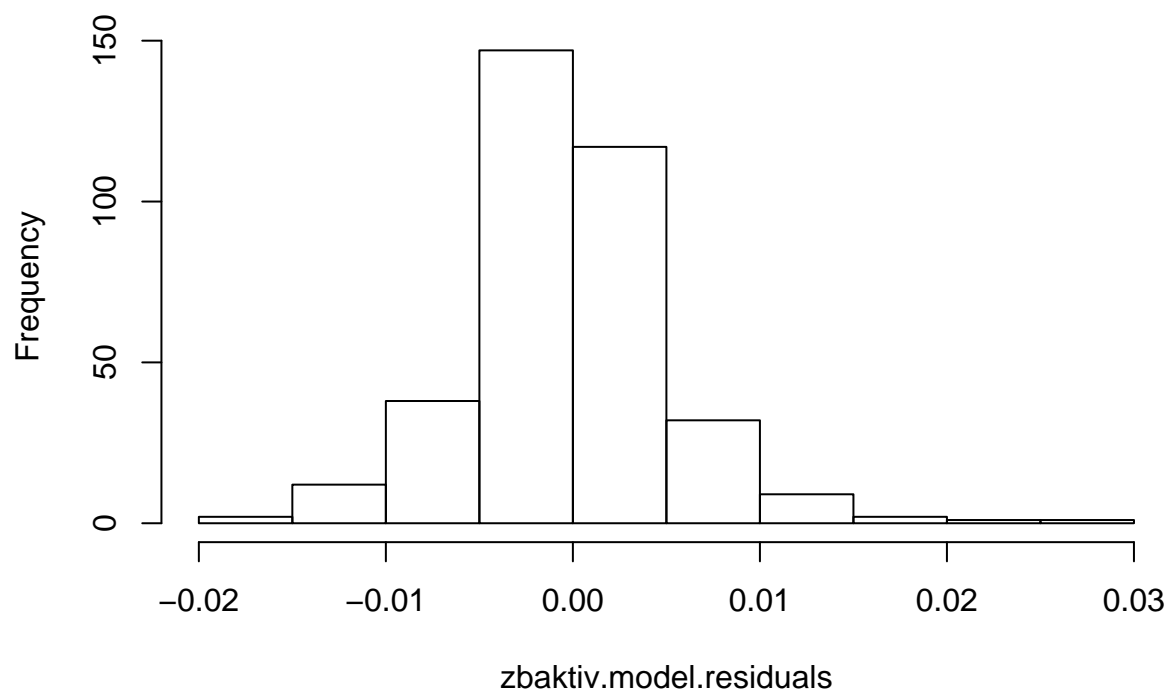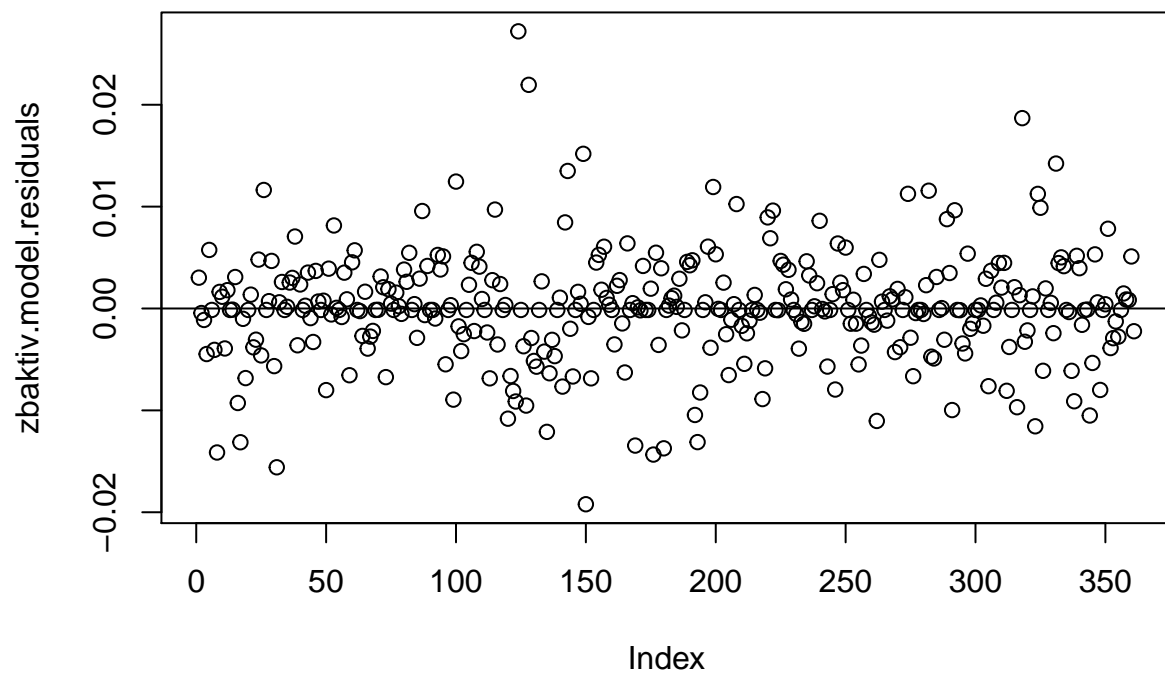
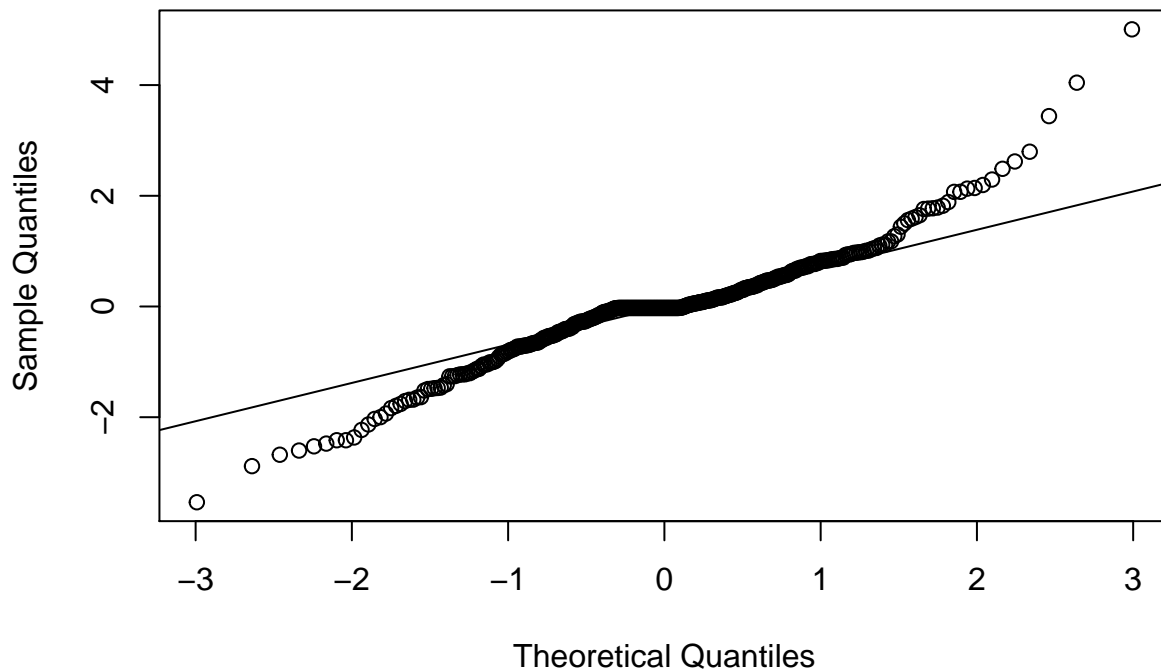## Histogram of zbaktiv.model.residuals



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

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

## Normal Q–Q Plot



```r
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

```r
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.
```

```r
require(PerformanceAnalytics)
```

```
## Loading required package: PerformanceAnalytics

##
## Attaching package: 'PerformanceAnalytics'

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

```r
library(xts)

get_capm_for_year <- function(df, fund, desired_year){
  xs.year = get_for_year(df, df$Date, desired_year)
  fund.year <- xs.year[c('Date', fund)]
  capm.market.year <- xs.year[c('Date', 'CROBEX')]
  capm.risk_free.year <- xs.year[c('Date', 'InterestRate.daily')]
  fund.ts <- xts(fund.year[, -1], order.by=fund.year$Date)


  capm.m.ts <-  xts(capm.market.year[, -1], order.by=capm.market.year$Date)
  capm.rf.year <- xts(capm.risk_free.year[, -1], order.by=capm.risk_free.year$Date)

  data.frame(sprintf('%s-%d', fund, desired_year), CAPM.alpha(fund.ts, capm.m.ts, capm.rf.year), CAPM.b
}

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("fond - godina", "alpha", "beta")
xs.capm
```

```
##              fond - godina          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  1.997474e-04 0.5976194634
## 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
```

```r
#PROVJERA REZIDUALA
zbaktiv.2010.res <- matrix(ncol = 1, nrow = 361)
zbaktiv.2010.alpha <- xs.capm[15, 2]
zbaktiv.2010.beta <- xs.capm[15, 3]
for (i in 1:length(zbaktiv.2010)) {
  zbaktiv.2010.res[i, 1] <- (zbaktiv.2010[i] - capm.risk_free.2010[i]) -
    (zbaktiv.2010.alpha + zbaktiv.2010.beta * (capm.market.2010[i] - capm.risk_free.2010[i]))
}
zbaktiv.2010.res
```

```
##                [,1]
##  [1,]  3.025737e-03
##  [2,] -4.470165e-04
##  [3,] -1.125709e-03
##  [4,] -4.469784e-03
##  [5,]  5.749055e-03
##  [6,] -1.422779e-04
##  [7,] -4.060959e-03
##  [8,] -1.413468e-02
##  [9,]  1.628328e-03
## [10,]  1.153703e-03
## [11,] -3.923409e-03
```

```
##  [12,]  1.799371e-03
##  [13,] -1.422779e-04
##  [14,] -1.148207e-04
##  [15,]  3.090839e-03
##  [16,] -9.275865e-03
##  [17,] -1.312774e-02
##  [18,] -1.015904e-03
##  [19,] -6.830567e-03
##  [20,] -1.422779e-04
##  [21,]  1.360527e-03
##  [22,] -3.813505e-03
##  [23,] -3.062942e-03
##  [24,]  4.800227e-03
##  [25,] -4.606474e-03
##  [26,]  1.163421e-02
##  [27,] -1.422779e-04
##  [28,]  7.209681e-04
##  [29,]  4.670183e-03
##  [30,] -5.655227e-03
##  [31,] -1.558577e-02
##  [32,]  6.086355e-04
##  [33,]  2.601787e-03
##  [34,] -1.422779e-04
##  [35,]  1.641154e-04
##  [36,]  2.547114e-03
##  [37,]  3.003235e-03
##  [38,]  7.063579e-03
##  [39,] -3.612323e-03
##  [40,]  2.360591e-03
##  [41,] -1.422779e-04
##  [42,]  2.683753e-04
##  [43,]  3.523494e-03
##  [44,] -9.437075e-04
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##  [47,]  6.840831e-04
##  [48,] -1.422779e-04
##  [49,]  7.620623e-04
##  [50,] -8.011311e-03
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##  [52,] -5.823963e-04
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##  [54,]  6.414179e-05
##  [55,] -1.422779e-04
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##  [58,]  9.003503e-04
##  [59,] -6.551485e-03
##  [60,]  4.532554e-03
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##  [63,] -2.551600e-04
##  [64,] -2.693673e-03
##  [65,]  1.644888e-03
```

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##   [66,] -3.936817e-03
##   [67,] -2.757829e-03
##   [68,] -2.199680e-03
##   [69,] -1.422779e-04
##   [70,] -1.311595e-04
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##   [72,]  2.084115e-03
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##   [74,]  1.892815e-03
##   [75,]  4.760239e-04
##   [76,] -1.422779e-04
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##   [78,]  2.222416e-04
##   [79,] -5.274909e-04
##   [80,]  3.821001e-03
##   [81,]  2.621817e-03
##   [82,]  5.466834e-03
##   [83,] -1.422779e-04
##   [84,]  4.284530e-04
##   [85,] -2.880095e-03
##   [86,]  2.930759e-03
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##   [88,] -6.452707e-04
##   [89,]  4.175215e-03
##   [90,] -1.422779e-04
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##   [92,] -9.864963e-04
##   [93,]  5.257048e-03
##   [94,]  3.830297e-03
##   [95,]  5.113058e-03
##   [96,] -5.477205e-03
##   [97,] -1.422779e-04
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## [112,] -2.355763e-03
## [113,] -6.856218e-03
## [114,]  2.781178e-03
## [115,]  9.708215e-03
## [116,] -3.532648e-03
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## [119,]  3.436363e-04
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## [124,]   2.720435e-02
## [125,]  -1.422779e-04
## [126,]  -3.705188e-03
## [127,]  -9.529607e-03
## [128,]   2.195334e-02
## [129,]  -2.896920e-03
## [130,]  -5.148515e-03
## [131,]  -5.711107e-03
## [132,]  -1.422779e-04
## [133,]   2.663304e-03
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## [137,]  -3.078393e-03
## [138,]  -4.673230e-03
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## [144,]  -1.992360e-03
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## [149,]   1.518149e-02
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## [159,]   3.683170e-04
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## [166,]   6.389691e-03
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## [168,]   5.236598e-04
## [169,]  -1.345533e-02
## [170,]   1.088195e-04
## [171,]  -1.804282e-04
## [172,]   4.177383e-03
## [173,]  -1.422779e-04
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## [176,] -1.433795e-02
## [177,]  5.475015e-03
## [178,] -3.573459e-03
## [179,]  3.947895e-03
## [180,] -1.372501e-02
## [181,] -1.422779e-04
## [182,]  2.827835e-04
## [183,]  1.012240e-03
## [184,]  1.256244e-03
## [185,]  1.602491e-04
## [186,]  2.919647e-03
## [187,] -2.147027e-03
## [188,] -1.422779e-04
## [189,]  4.575906e-03
## [190,]  4.245051e-03
## [191,]  4.731801e-03
## [192,] -1.045075e-02
## [193,] -1.311676e-02
## [194,] -8.247260e-03
## [195,] -1.422779e-04
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## [197,]  6.072006e-03
## [198,] -3.854281e-03
## [199,]  1.192621e-02
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## [201,] -3.726342e-05
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## [204,] -2.526232e-03
## [205,] -6.536442e-03
## [206,] -1.104574e-03
## [207,]  4.254821e-04
## [208,]  1.025097e-02
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## [213,] -1.194577e-03
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## [217,] -4.137103e-04
## [218,] -8.891545e-03
## [219,] -5.873309e-03
## [220,]  8.942820e-03
## [221,]  6.892917e-03
## [222,]  9.606738e-03
## [223,] -1.422779e-04
## [224,] -1.660525e-04
## [225,]  4.668321e-03
## [226,]  4.298550e-03
## [227,]  1.887936e-03
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## [229,]  8.813685e-04
## [230,] -1.422779e-04
## [231,] -5.437598e-04
## [232,] -3.940435e-03
## [233,] -1.326203e-03
## [234,] -1.502456e-03
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## [236,]  3.242167e-03
## [237,] -1.422779e-04
## [238,]  2.152822e-04
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## [243,] -5.700936e-03
## [244,] -1.422779e-04
## [245,]  1.408947e-03
## [246,] -7.952797e-03
## [247,]  6.378684e-03
## [248,]  2.539374e-03
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## [252,] -1.491068e-03
## [253,]  8.590525e-04
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## [255,] -5.489203e-03
## [256,] -3.639121e-03
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## [258,] -1.422779e-04
## [259,] -7.560073e-04
## [260,] -1.369226e-03
## [261,] -1.585540e-03
## [262,] -1.103781e-02
## [263,]  4.775733e-03
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## [265,] -1.422779e-04
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## [270,]  1.921430e-03
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## [272,] -1.422779e-04
## [273,]  1.103877e-03
## [274,]  1.125771e-02
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## [276,] -6.645688e-03
## [277,] -4.475437e-04
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## [279,] -1.422779e-04
## [280,] -5.374225e-04
## [281,]  2.288253e-03
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## [282,]  1.156389e-02
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## [286,] -1.422779e-04
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## [294,] -1.645404e-04
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## [300,] -1.422779e-04
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## [329,]  5.559793e-04
## [330,] -2.423560e-03
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## [332,]  4.458778e-03
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## [334,]  4.157123e-03
## [335,] -1.422779e-04
```

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## [336,] -3.464611e-04
## [337,] -6.119012e-03
## [338,] -9.105849e-03
## [339,]  5.169520e-03
## [340,]  3.956129e-03
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## [344,] -1.050462e-02
## [345,] -5.344082e-03
## [346,]  5.311828e-03
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## [356,] -1.422779e-04
## [357,]  1.475022e-03
## [358,]  8.852416e-04
## [359,]  8.396256e-04
## [360,]  5.108636e-03
## [361,] -2.232326e-03
```

```r
qqnorm(zbaktiv.2010.res)
qqline(zbaktiv.2010.res)
```

## Normal Q–Q Plot
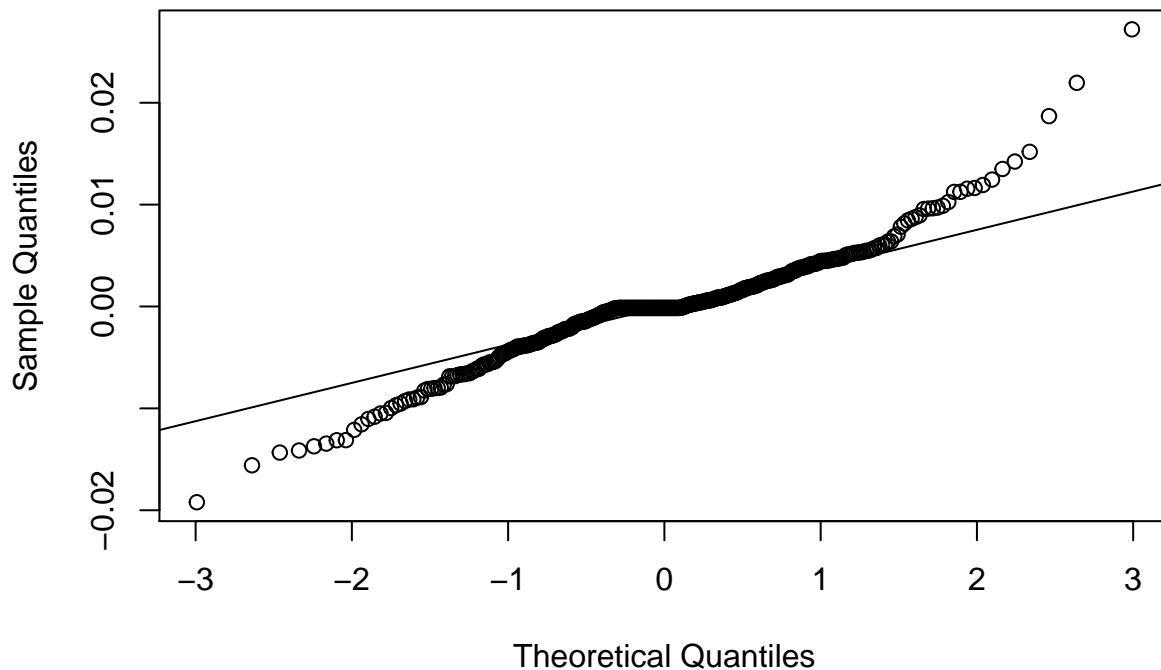


```
#zbaktiv.2010 <- xs.2010[c('Date', 'ZBAktiv')]
#capm.market.2010 <- xs.2010[c('Date', 'CROBEX')]
#capm.risk_free.2010 <- xs.2010[c('Date', 'InterestRate.daily')]

#zbaktiv.ts <- xts(zbaktiv.2010[, -1], order.by=zbaktiv.2010$Date)
#capm.m.ts <-  xts(capm.market.2010[, -1], order.by=capm.market.2010$Date)
#capm.rf.2010 <- xts(capm.risk_free.2010[, -1], order.by=capm.risk_free.2010$Date)

#CAPM.alpha(zbaktiv.ts, capm.m.ts, capm.rf.2010)
#CAPM.beta(zbaktiv.ts, capm.m.ts, capm.rf.2010)

anova(zbaktiv.model)
```

```
## Analysis of Variance Table
##
## Response: (zbaktiv.2010 - capm.risk_free.2010)
##                    Df    Sum Sq    Mean Sq F value    Pr(>F)
## capm.market.2010    1 0.0010622 0.00106222  35.877 5.107e-09 ***
## Residuals         359 0.0106290 0.00002961
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

TODO: ANOVA