```
install.packages("magrittr")
install.packages("tidyverse")
install.packages('dplyr')
install.packages('tseries')
install.packages("qqconf")
install.packages("powdist")
instal.packages("vars")
install.packages("tsDyn")
install.packages("dyn")
library(tsDyn)
library(powdist)
library(qqconf)
library(dplyr)
library(tsDyn)
library(dyn)
library(magrittr)
library(rlang)
library(tidyverse)
library(dynlm)
library(knitr)
library(orcutt)
library(nlWaldTest)
library(pdfetch)
library(lmtest)
library(broom)
library(PoEdata)
library(car)
library(sandwich)
library(forecast)
library(tseries)
library(vars)

my_packages <- library()$results[,1]
my_packages.list <- data.frame(my_list = unlist(my_packages))
write.table(my_packages.list, "my_packages.list.txt")

install.packages(c(my_packages.list.txt))

for (i in 1:nrow(my_packages_list)) {
  package_name <- my_packages_list[i, "my_list"]
  install.packages(package_name)
}

my_packages.list <- read.table("my_packages.list.txt", header = TRUE)

for (pkg in my_packages.list$my_list) {
  library(pkg, character.only = TRUE)
}

## ##

ch.sp500 <- sp500$`Change %`/100
ch.brentoil <- brent$`Change %`/100
ch.osebx <- osebx$`Change %`/100

fluct.df <- data.frame(ch.sp500, ch.brentoil, ch.osebx, by="Date")
is.ts(fluct.df)
fluct.ts <- ts(fluct.df, start=c(2000, 1), end=c(2022, 12), frequency=12)
is.ts(fluct.ts)

# 4.4 Deskriptiv statistikk
range(ch.osebx)
mean(ch.osebx)
sd(ch.osebx)

range(ch.brentoil)
mean(ch.brentoil)
sd(ch.brentoil)
```

```
range(ch.sp500)
mean(ch.sp500)
sd(ch.sp500)

# 4.5 Korrelasjonsanalyse
cor(ch.sp500, ch.brentoil, method = "pearson")
cor(ch.brentoil, ch.sp500, method = "pearson")

cor(ch.sp500, ch.osebx, method = "pearson")
cor(ch.brentoil, ch.osebx, method = "pearson")


# Visualization of time series

ts.plot(fluct.ts[,"ch.sp500"], fluct.ts[,"ch.brentoil"],
        type="l",
        lty=c(1,2), col=c(1,2))
legend("topleft", border=NULL, legend=c("SP500","BRENT"),
       lty=c(1,2), col=c(1,2))

ts.plot(fluct.ts[,"ch.osebx"], fluct.ts[,"ch.brentoil"],
        type="l",
        lty=c(1,2), col=c(1,2))
legend("topleft", border=NULL, legend=c("OSEBX","BRENT"),
       lty=c(1,2), col=c(1,2))

ts.plot(fluct.ts[,"ch.osebx"], fluct.ts[,"ch.sp500"],
        type="l",
        lty=c(1,2), col=c(1,2))
legend("topleft", border=NULL, legend=c("OSEBX","SP500"),
       lty=c(1,2), col=c(1,2))

fluct.dyn <- dynlm(ch.osebx ~ diff(ch.sp500) + diff(ch.brentoil),
                   data=fluct.ts)
summary(fluct.dyn)
ehat <- resid(fluct.dyn)
abline(h=0, lty=2)

corrgm <- acf(ehat)
plot(corrgm)

# kap. 4.5.2 ADF-test on stationarity. GJENNOMFØRT

ndiffs(ch.osebx)
ndiffs(ch.sp500)
ndiffs(ch.brentoil)


  Acf(ch.osebx)
    adf.test(ch.osebx)
    adf.test(diff(ch.osebx))
  Acf(ch.sp500)
    adf.test(ch.sp500)
    adf.test(diff(ch.sp500))
  Acf(ch.brentoil)
    adf.test(ch.brentoil)
    adf.test(diff(ch.brentoil))

# kap. 4.5.3
  # Velge antall lags: y = osebx, x_1 = sp500
  plot(fluct.ts[,"ch.osebx"])
  osebx.dyn0 <- dynlm(ch.osebx ~ L(ch.brentoil) + L(ch.sp500),
                      data=fluct.ts)
  osebx.dyn1 <- dynlm(ch.osebx ~ L(ch.brentoil, 0:0) + L(ch.sp500, 0:1),
                      data=fluct.ts)
  osebx.dyn2 <- dynlm(ch.osebx ~ L(ch.brentoil, 0:0) + L(ch.sp500, 0:2),
                      data=fluct.ts)
  osebx.dyn3 <- dynlm(ch.osebx ~ L(ch.brentoil, 0:0) + L(ch.sp500, 0:3),
                      data=fluct.ts)
```

```
  gl00 <- glance(osebx.dyn0)  [c("r.squared","statistic","AIC","BIC")]
  gl01 <- glance(osebx.dyn1)  [c("r.squared","statistic","AIC","BIC")] # 1 LAG
  gl02 <- glance(osebx.dyn2)  [c("r.squared","statistic","AIC","BIC")]
  gl03 <- glance(osebx.dyn3)  [c("r.squared","statistic","AIC","BIC")]

  osebx.tablGL <- rbind(gl00, gl01, gl02, gl03)
  kable(osebx.tablGL, caption="Goodness of fit statistics")

  # Velge antall lags: y = osebx, x_2 = brentoil
  plot(fluct.ts[,"ch.osebx"])
  osebx.br.dyn0 <- dynlm(ch.osebx ~ L(ch.brentoil) + L(ch.sp500),
                       data=fluct.ts)
  osebx.br.dyn1 <- dynlm(ch.osebx ~ L(ch.brentoil, 0:1) + L(ch.sp500, 0:0),
                       data=fluct.ts)
  osebx.br.dyn2 <- dynlm(ch.osebx ~ L(ch.brentoil, 0:2) + L(ch.sp500, 0:0),
                       data=fluct.ts)
  osebx.br.dyn3 <- dynlm(ch.osebx ~ L(ch.brentoil, 0:3) + L(ch.sp500, 0:0),
                       data=fluct.ts)

  glbr00 <- glance(osebx.br.dyn0)  [c("r.squared","statistic","AIC","BIC")]
  glbr01 <- glance(osebx.br.dyn1)  [c("r.squared","statistic","AIC","BIC")] # 1 LAG
  glbr02 <- glance(osebx.br.dyn2)  [c("r.squared","statistic","AIC","BIC")]
  glbr03 <- glance(osebx.br.dyn3)  [c("r.squared","statistic","AIC","BIC")]

  osebx.tablGLBrent <- rbind(glbr00, glbr01, glbr02, glbr03)
  kable(osebx.tablGLBrent, caption="Goodness of fit statistics")

  # Velge antall lags: y = osebx, y_t-1 = osebx

  # Homoskedastisitet for OSEBX
  osebx.dyn <- dynlm(ch.osebx ~ ch.brentoil + ch.sp500 + L(ch.brentoil, 0:1) +
(L(ch.sp500, 0:1)), data=fluct.ts,
                     start=c(2000,1), end=c(2022,12))
    ehat.osebx.dyn <- resid(osebx.dyn)

    help(plot)


  plot(osebx.dyn, ehat.osebx.dyn, which=1, main = "Scatterplot for OSEBX",
       id.n=NULL, sub="", col="blue")
       ## GJENNOMFØRT OG GODKJENT

  # Normalfordeling for OSEBX
   plot(osebx.dyn, ehat.osebx.dyn, which=2, main = "QQ plot for OSEBX",
        id.n=NULL, sub="", col="blue")
    ## GJENNOMFØRT, PASSERER IKKE TESTEN I STOR GRAD

# kap. 4.5.3 Velge antall lags: y = sp500, x = brentoil
plot(fluct.ts[,"ch.sp500"])
sp500.dyn0 <- dynlm(ch.sp500 ~ L(ch.brentoil),
                    data=fluct.ts)
sp500.dyn <- dynlm(ch.sp500 ~ L(ch.brentoil, 0:1),
                    data=fluct.ts)
sp500.dyn2 <- dynlm(ch.sp500 ~ L(ch.brentoil, 0:2),
                    data=fluct.ts)
sp500.dyn3 <- dynlm(ch.sp500 ~ L(ch.brentoil, 0:3),
                    data=fluct.ts)

spgl00 <- glance(sp500.dyn0)  [c("r.squared","statistic","AIC","BIC")]
spgl01 <- glance(sp500.dyn)  [c("r.squared","statistic","AIC","BIC")] # 1 LAG
spgl02 <- glance(sp500.dyn2)  [c("r.squared","statistic","AIC","BIC")]
spgl03 <- glance(sp500.dyn3)  [c("r.squared","statistic","AIC","BIC")]

osebx.tablGL <- rbind(spgl00, spgl01, spgl02, spgl03)
kable(osebx.tablGL, caption="Goodness of fit statistics")

  # Velge antall lags: y = sp500, y_t-1 = sp500
  osebx.sp500.lag <- fluct.df %>%
```

```
    mutate(opt.osebx.ny =        lag(fluct.df$ch.osebx,    n = 0),
           opt.sp500 =           lag(fluct.df$ch.sp500,    n = 0),
           opt.brentoil =        lag(fluct.df$ch.brentoil, n = 0),
           opt.lag.brentoil =    lag(fluct.df$ch.brentoil, n = 1),
           opt.lag.sp500 =       lag(fluct.df$ch.sp500,    n = 1),
           opt.lag.dep.osebx1 =  lag(fluct.df$ch.osebx,    n = 1),
           opt.lag.dep.osebx2 =  lag(fluct.df$ch.osebx,    n = 2),
           opt.lag.dep.osebx3 =  lag(fluct.df$ch.osebx,    n = 3),
           opt.lag.dep.sp500.1 = lag(fluct.df$ch.sp500,    n = 1),
           opt.lag.dep.sp500.2 = lag(fluct.df$ch.sp500,    n = 2),
           opt.lag.dep.sp500.3 = lag(fluct.df$ch.sp500,    n = 3)) %>%
    na.omit()

  lag.osebx0 <- dynlm(opt.osebx.ny ~ opt.sp500 + opt.brentoil + opt.lag.sp500 +
opt.lag.brentoil, data = osebx.sp500.lag)
  lag.osebx1 <- dynlm(opt.osebx.ny ~ opt.sp500 + opt.brentoil + opt.lag.sp500 +
opt.lag.brentoil + opt.lag.dep.osebx1, data = osebx.sp500.lag)
  lag.osebx2 <- dynlm(opt.osebx.ny ~ opt.sp500 + opt.brentoil + opt.lag.sp500 +
opt.lag.brentoil + opt.lag.dep.osebx2, data = osebx.sp500.lag)
  lag.osebx3 <- dynlm(opt.osebx.ny ~ opt.sp500 + opt.brentoil + opt.lag.sp500 +
opt.lag.brentoil + opt.lag.dep.osebx3, data = osebx.sp500.lag)

  gl.lagosebx0 <- glance(lag.osebx0)  [c("r.squared","statistic","AIC","BIC")]
  gl.lagosebx1 <- glance(lag.osebx1)  [c("r.squared","statistic","AIC","BIC")]
  gl.lagosebx2 <- glance(lag.osebx2)  [c("r.squared","statistic","AIC","BIC")]
  gl.lagosebx3 <- glance(lag.osebx3)  [c("r.squared","statistic","AIC","BIC")]

  lag.dep.osebx.tabl <- rbind(gl.lagosebx0, gl.lagosebx1, gl.lagosebx2, gl.lagosebx3)
  kable(lag.dep.osebx.tabl, caption="Goodness of fit statistics")

  lag.sp500.0 <- dynlm(opt.sp500 ~ opt.brentoil + opt.lag.brentoil, data =
osebx.sp500.lag) # OPTIMAL MODEL
  lag.sp500.1 <- dynlm(opt.sp500 ~ opt.brentoil + opt.lag.brentoil +
opt.lag.dep.sp500.1, data = osebx.sp500.lag)
  lag.sp500.2 <- dynlm(opt.sp500 ~ opt.brentoil + opt.lag.brentoil +
opt.lag.dep.sp500.2, data = osebx.sp500.lag)
  lag.sp500.3 <- dynlm(opt.sp500 ~ opt.brentoil + opt.lag.brentoil +
opt.lag.dep.sp500.3, data = osebx.sp500.lag)

  gl.lagsp500.0 <- glance(lag.sp500.0)  [c("r.squared","statistic","AIC","BIC")] #
OPTIMAL MODEL
  gl.lagsp500.1 <- glance(lag.sp500.1)  [c("r.squared","statistic","AIC","BIC")]
  gl.lagsp500.2 <- glance(lag.sp500.2)  [c("r.squared","statistic","AIC","BIC")]
  gl.lagsp500.3 <- glance(lag.sp500.3)  [c("r.squared","statistic","AIC","BIC")]

  lag.dep.sp500.tabl <- rbind(gl.lagsp500.0, gl.lagsp500.1, gl.lagsp500.2,
gl.lagsp500.3)
  kable(lag.dep.sp500.tabl, caption="Goodness of fit statistics")

  # Homoskedastisitet for SP500
  sp500.dyn2 <- dynlm(ch.sp500 ~ ch.brentoil + L(ch.brentoil, 0:1),
                      data=fluct.ts)

  ehat.sp500.dyn <- resid(sp500.dyn2)
  plot(sp500.dyn2, ehat.sp500.dyn, which=1, main = "Scatterplot for SP500",
       id.n=NULL, sub="", col="blue")
  ?title
  ## GJENNOMFØRT OG GODKJENT

  # Normalfordeling for SP500
  plot(sp500.dyn2, ehat.sp500.dyn, which=2, main = "QQ plot for SP500",
       id.n=NULL, sub="", col="blue")
  ## GJENNOMFØRT OG PASSERER IKKE TESTEN I STOR GRAD


# kap. 4.5.4 Test on cointegration; residuals

## aktuelle modeller:
  lag.osebx.ts <- ts(lag.osebx0)
```

```
  ehat.osebx <- resid(lag.osebx0)
    ch.osebx.ts <- ts(fluct.df$ch.osebx)
    ch.brentoil.ts <- ts(fluct.df$ch.brentoil)
  lag.sp500.ts <- lag.sp500.0
  ehat.sp500 <- resid(lag.sp500.0)
    ch.sp500.ts <- ts(fluct.df$ch.sp500)

   #OSEBX
   ehat.osebx
   adf.test(ehat.osebx)  # results: -6.8857 < -2.88 @ 5 % critical value.

   #SP500
   ehat.sp500
   adf.test(ehat.sp500)   # results: -5.3893 < -2.88 @ 5 % critical value.

# VEC-modellene
    as.data.frame()

   # VEC-merges
   ehat.osebx.ts <- ts(ehat.osebx)
   ehat.sp500.ts <- ts(ehat.sp500)

   VEC.all <- cbind(ch.osebx.ts, ch.sp500.ts, ch.brentoil.ts, ehat.osebx.ts,
ehat.sp500.ts)
    VEC.all.sub.I   <- VEC.all[1:48,]     # 48
    VEC.all.sub.II  <- VEC.all[49:108,]   # 60
    VEC.all.sub.III <- VEC.all[109:168,]  # 60
    VEC.all.sub.IV  <- VEC.all[169:228,]  # 60
    VEC.all.sub.V   <- VEC.all[229:276,]  # 48
   vec.df.osebx <- cbind(ch.osebx.ts, ch.sp500.ts, ch.brentoil.ts)
     vec.subset.osebx.I   <- vec.df.osebx[1:48,]     # 48
     vec.subset.osebx.II  <- vec.df.osebx[49:108,]   # 60
     vec.subset.osebx.III <- vec.df.osebx[109:168,]  # 60
     vec.subset.osebx.IV  <- vec.df.osebx[169:228,]  # 60
     vec.subset.osebx.V   <- vec.df.osebx[229:276,]  # 48
   vec.df.sp500 <- cbind(ch.sp500.ts, ch.brentoil.ts)
     vec.subset.sp500.I   <- vec.df.sp500[1:48,]     # 48
     vec.subset.sp500.II  <- vec.df.sp500[49:108,]   # 60
     vec.subset.sp500.III <- vec.df.sp500[109:168,]  # 60
     vec.subset.sp500.IV  <- vec.df.sp500[169:228,]  # 60
     vec.subset.sp500.V   <- vec.df.sp500[229:276,]  # 48

library(urca)

  # Running the VEC-model: OSEBX

    # 0. totale datasettet: 2000-2022
      coint.joh.osebx <- ca.jo(vec.df.osebx, type = "trace", ecdet = "const")
        summary(coint.joh.osebx) # Trace-test
      coint.eigen.osebx <- ca.jo(vec.df.osebx, type = "eigen" , ecdet = "const")
        summary(coint.eigen.osebx) # Maximum Eigenvalue-test

        ModelA <- VECM(vec.df.osebx, lag = 1, r = 2, estim=("ML"))
          summary(ModelA)

      coint.joh.sp500 <- ca.jo(vec.df.sp500, type = "trace", ecdet = "const")
        summary(coint.joh.sp500) # JOHANSEN-test
      coint.eigen.sp500 <- ca.jo(vec.df.sp500, type = "eigen" , ecdet = "const")
        summary(coint.eigen.sp500) # EIGENVALUE-test

        ModelB <- VECM(vec.df.sp500, lag = 1, r = 1, estim=("ML"))
          summary(ModelB)

  # 1. Interval I: 2000-2003
        coint.joh.osebx.I <- ca.jo(vec.subset.osebx.I, type = "trace", ecdet = "const")
        summary(coint.joh.osebx.I) # Trace-test
        coint.eigen.osebx.I <- ca.jo(vec.subset.osebx.I, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.osebx.I) # Maximum Eigenvalue-test
```

```
        ModelA <- VECM(vec.subset.osebx.I, lag = 1, r = 2, estim=("ML"))
        summary(ModelA)


        coint.joh.sp500.I <- ca.jo(vec.subset.sp500.I, type = "trace", ecdet = "const")
        summary(coint.joh.sp500.I) # JOHANSEN-test
        coint.eigen.sp500.I <- ca.jo(vec.subset.sp500.I, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.sp500.I) # EIGENVALUE-test

        ModelB <- VECM(vec.subset.sp500.I, lag = 1, r = 1, estim=("ML"))
        summary(ModelB)

  # 2. Interval II: 2004-2008
        coint.joh.osebx.II <- ca.jo(vec.subset.osebx.II, type = "trace", ecdet =
"const")
        summary(coint.joh.osebx.II) # Trace-test
        coint.eigen.osebx.II <- ca.jo(vec.subset.osebx.II, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.osebx.II) # Maximum Eigenvalue-test

        ModelA <- VECM(vec.subset.osebx.II, lag = 1, r = 2, estim=("ML"))
        summary(ModelA)

        coint.joh.sp500.II <- ca.jo(vec.subset.sp500.II, type = "trace", ecdet =
"const")
        summary(coint.joh.sp500.II) # JOHANSEN-test
        coint.eigen.sp500.II <- ca.jo(vec.subset.sp500.II, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.sp500.II) # EIGENVALUE-test

        ModelB <- VECM(vec.subset.sp500.II, lag = 1, r = 1, estim=("ML"))
        summary(ModelB)

  # 3. Interval III: 2009-2013
        coint.joh.osebx.III <- ca.jo(vec.subset.osebx.III, type = "trace", ecdet =
"const")
        summary(coint.joh.osebx.III) # Trace-test
        coint.eigen.osebx.III <- ca.jo(vec.subset.osebx.III, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.osebx.III) # Maximum Eigenvalue-test

        ModelA <- VECM(vec.subset.osebx.III, lag = 1, r = 2, estim=("ML"))
        summary(ModelA)

        coint.joh.sp500.III <- ca.jo(vec.subset.sp500.III, type = "trace", ecdet =
"const")
        summary(coint.joh.sp500.I) # JOHANSEN-test
        coint.eigen.sp500.III <- ca.jo(vec.subset.sp500.III, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.sp500.III) # EIGENVALUE-test

        ModelB <- VECM(vec.subset.sp500.III, lag = 1, r = 1, estim=("ML"))
        summary(ModelB)

 # 4. Interval IV: 2014-2018
        coint.joh.osebx.IV <- ca.jo(vec.subset.osebx.IV, type = "trace", ecdet =
"const")
        summary(coint.joh.osebx.IV) # Trace-test
        coint.eigen.osebx.IV <- ca.jo(vec.subset.osebx.IV, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.osebx.IV) # Maximum Eigenvalue-test

        ModelA <- VECM(vec.subset.osebx.IV, lag = 1, r = 2, estim=("ML"))
        summary(ModelA)

        coint.joh.sp500.IV <- ca.jo(vec.subset.sp500.IV, type = "trace", ecdet =
"const")
```

```
        summary(coint.joh.sp500.IV) # JOHANSEN-test
        coint.eigen.sp500.IV <- ca.jo(vec.subset.sp500.IV, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.sp500.IV) # EIGENVALUE-test

        ModelB <- VECM(vec.subset.sp500.IV , lag = 1, r = 1, estim=("ML"))
        summary(ModelB)

 # 5. Interval V: 2019-2022
        coint.joh.osebx.V <- ca.jo(vec.subset.osebx.V, type = "trace", ecdet = "const")
        summary(coint.joh.osebx.V) # Trace-test
        coint.eigen.osebx.V <- ca.jo(vec.subset.osebx.V, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.osebx.V) # Maximum Eigenvalue-test

        ModelA <- VECM(vec.subset.osebx.V, lag = 1, r = 2, estim=("ML"))
        summary(ModelA)

        coint.joh.sp500.V <- ca.jo(vec.subset.sp500.V, type = "trace", ecdet = "const")
        summary(coint.joh.sp500.I) # JOHANSEN-test
        coint.eigen.sp500.V <- ca.jo(vec.subset.sp500.V, type = "eigen" , ecdet =
"const")
        summary(coint.eigen.sp500.V) # EIGENVALUE-test

        ModelB <- VECM(vec.subset.sp500.V, lag = 1, r = 1, estim=("ML"))
        summary(ModelB)
```