

```
#detecting structural breaks in the volatility of carbon prices (R code)
#julien chevallier

#set directory
setwd("/home/joypadeux/Bureau/PhD/strucchange/Excel/")

#declaring libraries
library("strucchange")

#importing and naming data
data = read.csv(file="dataset_garch_iv_rv_bis.csv",head=TRUE,sep=",")

#dates=data[,1]
#date=as.Date(dates,format="%d/%m/%Y")

garch<-data[,1]

iv<-data[,2]

rv<-data[,3]

#model
garch.model <- garch~1
iv.model <- iv~1
rv.model <- rv~1

#empirical fluctuation processes
garch.cusum <- efp(garch.model, type = "OLS-CUSUM")
plot(garch.cusum)

iv.cusum <- efp(iv.model, type = "OLS-CUSUM")
plot(iv.cusum)

rv.cusum <- efp(rv.model, type = "OLS-CUSUM")
plot(rv.cusum)

postscript(file="garch.cusum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(garch.cusum)
dev.off()

postscript(file="iv.cusum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(iv.cusum)
dev.off()

postscript(file="rv.cusum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(rv.cusum)
dev.off()

garch.recusum <- efp(garch.model, type = "Rec-CUSUM")
plot(garch.recusum)

iv.recusum <- efp(iv.model, type = "Rec-CUSUM")
```

```
plot(iv.recusum)
```

```
rv.recusum <- efp(rv.model, type = "Rec-CUSUM")  
plot(rv.recusum)
```

```
postscript(file="garch.recusum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")  
plot(garch.recusum)  
dev.off()
```

```
postscript(file="iv.recusum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")  
plot(iv.recusum)  
dev.off()
```

```
postscript(file="rv.recusum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")  
plot(rv.recusum)  
dev.off()
```

```
garch.mosum <- efp(garch.model, type = "OLS-MOSUM")  
plot(garch.mosum)
```

```
iv.mosum <- efp(iv.model, type = "OLS-MOSUM")  
plot(iv.mosum)
```

```
rv.mosum <- efp(rv.model, type = "OLS-MOSUM")  
plot(rv.mosum)
```

```
postscript(file="garch.mosum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")  
plot(garch.mosum)  
dev.off()
```

```
postscript(file="iv.mosum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")  
plot(iv.mosum)  
dev.off()
```

```
postscript(file="rv.mosum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")  
plot(rv.mosum)  
dev.off()
```

```
garch.recmosum <- efp(garch.model, type = "Rec-MOSUM",h=0.2)  
plot(garch.recmosum)
```

```
iv.recmosum <- efp(iv.model, type = "Rec-MOSUM",h=0.2)  
plot(iv.recmosum)
```

```
rv.recmosum <- efp(rv.model, type = "Rec-MOSUM",h=0.2)  
plot(rv.recmosum)
```

```
postscript(file="garch.recmosum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter"  
)  
plot(garch.recmosum)  
dev.off()
```

```
postscript(file="iv.recmosum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(iv.recmosum)
dev.off()
```

```
postscript(file="rv.recmosum.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(rv.recmosum)
dev.off()
```

```
garch.me <- efp(garch.model, type = "ME", h=0.2)
plot(garch.me)
```

```
iv.me <- efp(iv.model, type = "ME", h=0.2)
plot(iv.me)
```

```
rv.me <- efp(rv.model, type = "ME", h=0.2)
plot(rv.me)
```

```
postscript(file="garch.me.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(garch.me)
dev.off()
```

```
postscript(file="iv.me.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(iv.me)
dev.off()
```

```
postscript(file="rv.me.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(rv.me)
dev.off()
```

```
garch.recme <- efp(garch.model, type = "fluctuation",h=0.2)
plot(garch.recme)
```

```
iv.recme <- efp(iv.model, type = "fluctuation",h=0.2)
plot(iv.recme)
```

```
rv.recme <- efp(rv.model, type = "fluctuation",h=0.2)
plot(rv.recme)
```

```
postscript(file="garch.recme.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(garch.recme)
dev.off()
```

```
postscript(file="iv.recme.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(iv.recme)
dev.off()
```

```
postscript(file="rv.recme.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(rv.recme)
dev.off()
```

```

#bound.cusum <- boundary(cusum, alpha = 0.05)
#plot(cusum, boundary = FALSE)
#lines(bound.cusum, col = 4)
#lines(-bound.cusum, col = 4)

#F statistics
fs.garch.sup <- Fstats(garch.model)
plot(fs.garch.sup)

postscript(file="fs.garch.ave.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(fs.garch.sup,aveF=TRUE)
dev.off()

postscript(file="fs.garch.sup.pval.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter"
)
plot(fs.garch.sup,pval=TRUE)
dev.off()

fs.iv.sup <- Fstats(iv.model,from=0.15,to=0.85)
plot(fs.iv.sup)

postscript(file="fs.iv.ave.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(fs.iv.sup,aveF=TRUE)
dev.off()

postscript(file="fs.iv.sup.pval.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(fs.iv.sup,pval=TRUE)
dev.off()

fs.rv.sup <- Fstats(rv.model,from=0.15,to=0.85)
plot(fs.rv.sup)

postscript(file="fs.rv.ave.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(fs.rv.sup,aveF=TRUE)
dev.off()

postscript(file="fs.rv.sup.pval.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(fs.rv.sup,pval=TRUE)
dev.off()

#structural change test
#sctest(cusum)
#sctest(fs, type = "supF")
#sctest(fs, type = "aveF")
#sctest(fs, type = "expF")

#breakpoints
bp.garch <- breakpoints(garch.model)
bp.garch

bp.iv <- breakpoints(iv.model)
bp.iv

```

```
bp.rv <- breakpoints(rv.model)
bp.rv
```

```
#monitoring with the generalized fluctuation test
```

```
#2006 EGARCH
```

```
serie<-ts(data, start=c(1,1),frequency=7)
```

```
serie<-ts(data, start=c(1,1),end=c(24,1),frequency=7)
```

```
garch.mefp.april2006 <- mefp(garch.model, type = "ME", data = serie, alpha = 0.05)
```

```
garch.mefp.april2006.fe <- mefp(garch.model, type = "fluctuation", data = serie, alpha = 0.05)
```

```
serie<-ts(data, start=c(1,1),end=c(63,1),frequency=7)
```

```
garch.mefp.april2006 <- monitor(garch.mefp.april2006)
```

```
garch.mefp.april2006.fe <- monitor(garch.mefp.april2006.fe)
```

```
plot(garch.mefp.april2006)
```

```
plot(garch.mefp.april2006.fe)
```

```
postscript(file="garch.mefp.april2006.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
```

```
plot(garch.mefp.april2006)
```

```
dev.off()
```

```
postscript(file="garch.mefp.april2006.fe.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
```

```
plot(garch.mefp.april2006.fe)
```

```
dev.off()
```

```
#2007 EGARCH
```

```
serie<-ts(data, start=c(1,1),frequency=7)
```

```
serie<-ts(data, start=c(1,1),end=c(63,1),frequency=7)
```

```
garch.mefp.2007 <- mefp(garch.model, type = "ME", data = serie, alpha = 0.05)
```

```
garch.mefp.2007.fe <- mefp(garch.model, type = "fluctuation", data = serie, alpha = 0.05)
```

```
serie<-ts(data, start=c(1,1),end=c(101,1),frequency=7)
```

```
garch.mefp.2007 <- monitor(garch.mefp.2007)
```

```
garch.mefp.2007.fe <- monitor(garch.mefp.2007.fe)
```

```
plot(garch.mefp.2007)
```

```
plot(garch.mefp.2007.fe)
```

```
postscript(file="garch.mefp.2007.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
```

```
plot(garch.mefp.2007)
```

```
dev.off()
```

```
postscript(file="garch.mefp.2007.fe.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(garch.mefp.2007.fe)
dev.off()
```

```
#2008 EGARCH
```

```
serie<-ts(data, start=c(1,1),frequency=7)
```

```
serie<-ts(data, start=c(1,1),end=c(101,1),frequency=7)
```

```
garch.mefp.2008 <- mefp(garch.model, type = "ME", data = serie, alpha = 0.05)
```

```
garch.mefp.2008.fe <- mefp(garch.model, type = "fluctuation", data = serie, alpha = 0.05)
```

```
serie<-ts(data, start=c(1,1),end=c(135,1),frequency=7)
```

```
garch.mefp.2008 <- monitor(garch.mefp.2008)
```

```
garch.mefp.2008.fe <- monitor(garch.mefp.2008.fe)
```

```
plot(garch.mefp.2008)
```

```
plot(garch.mefp.2008.fe)
```

```
postscript(file="garch.mefp.2008.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter"
)
```

```
plot(garch.mefp.2008)
```

```
dev.off()
```

```
postscript(file="garch.mefp.2008.fe.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
```

```
plot(garch.mefp.2008.fe)
```

```
dev.off()
```

```
#2008 IV
```

```
serie<-ts(data, start=c(1,1),frequency=7)
```

```
serie<-ts(data, start=c(1,1),end=c(102,1),frequency=7)
```

```
iv.mefp.2008 <- mefp(iv.model, type = "ME", data = serie, alpha = 0.05)
```

```
iv.mefp.2008.fe <- mefp(iv.model, type = "fluctuation", data = serie, alpha = 0.05)
```

```
serie<-ts(data, start=c(1,1),end=c(135,1),frequency=7)
```

```
iv.mefp.2008 <- monitor(iv.mefp.2008)
```

```
iv.mefp.2008.fe <- monitor(iv.mefp.2008.fe)
```

```
plot(iv.mefp.2008)
```

```
plot(iv.mefp.2008.fe)
```

```
postscript(file="iv.mefp.2008.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
```

```
plot(iv.mefp.2008)
```

```
dev.off()
```

```
postscript(file="iv.mefp.2008.fe.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
plot(iv.mefp.2008.fe)
dev.off()
```

```
#2008 RV
```

```
serie<-ts(data, start=c(1,1),frequency=7)
```

```
serie<-ts(data, start=c(1,1),end=c(101,1),frequency=7)
```

```
rv.mefp.2008 <- mefp(rv.model, type = "ME", data = serie, alpha = 0.05)
```

```
rv.mefp.2008.fe <- mefp(rv.model, type = "fluctuation", data = serie, alpha = 0.05)
```

```
serie<-ts(data, start=c(1,1),end=c(135,1),frequency=7)
```

```
rv.mefp.2008 <- monitor(rv.mefp.2008)
```

```
rv.mefp.2008.fe <- monitor(rv.mefp.2008.fe)
```

```
plot(rv.mefp.2008)
```

```
plot(rv.mefp.2008.fe)
```

```
postscript(file="rv.mefp.2008.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
```

```
plot(rv.mefp.2008)
```

```
dev.off()
```

```
postscript(file="rv.mefp.2008.fe.eps",horiz=FALSE,onefile=FALSE,width=11,height=8.5,paper="letter")
```

```
plot(rv.mefp.2008.fe)
```

```
dev.off()
```