GARCH Model EUR And CAD

Jane

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Forcasting Exchange Rate Using GARCH Model for EUR And CAD

Reading EUR and CAD Currency into r

```r
library(readr)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
EURCADGARCH<-  read.csv ("EURCAD_Candlestick_1_D_BID_01.01.2000-31.12.2020.csv")%>%
  select('GMT.TIME', CLOSE)%>%
  rename(Date = ('GMT.TIME'), RateEURCAD = ("CLOSE"))


tail(EURCADGARCH)
```

```
##            Date RateEURCAD
## 6323 2020-12-25    1.56688
## 6324 2020-12-27    1.56702
## 6325 2020-12-28    1.56931
## 6326 2020-12-29    1.57065
## 6327 2020-12-30    1.56820
## 6328 2020-12-31    1.55384
```

Conversion of Gmt time to date format

```r
library(dplyr)
library(lubridate)
```

```
##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```r
EURCADGARCH$Date <- lubridate::ymd(EURCADGARCH$Date)
head(EURCADGARCH)
```

```
##         Date RateEURCAD
## 1 2000-01-03     1.4817
## 2 2000-01-04     1.4969
## 3 2000-01-05     1.4963
## 4 2000-01-06     1.5064
## 5 2000-01-07     1.4992
## 6 2000-01-10     1.4928
```

##Checking for obvious errors or missingg value

```r
#Checking for obvious errors
which(is.na(EURCADGARCH))
```

```
## integer(0)
```

##Converting the data set into time series object

```r
#Converting the data set into time series object
EURCADGARCHTS<- ts(as.vector(EURCADGARCH$Rate),  frequency = 317, start= c(2000,01,03))
plot.ts(EURCADGARCHTS)
title("Time Series plot of EURCADTimeseries ", sub = "(2000-2020)",
      cex.main = 1.5,   font.main= 4, col.main= "blue",
      cex.sub = 0.75, font.sub = 3, col.sub = "red")
```
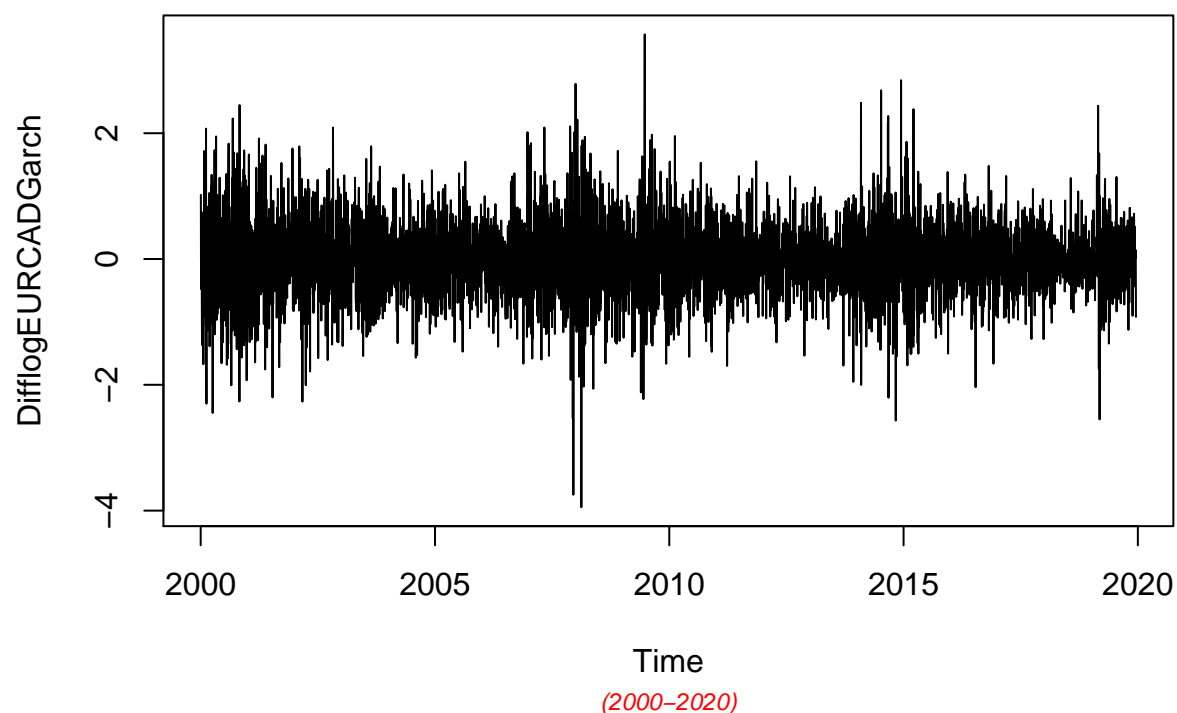
Time Series plot of EURCADTimeseries

Time
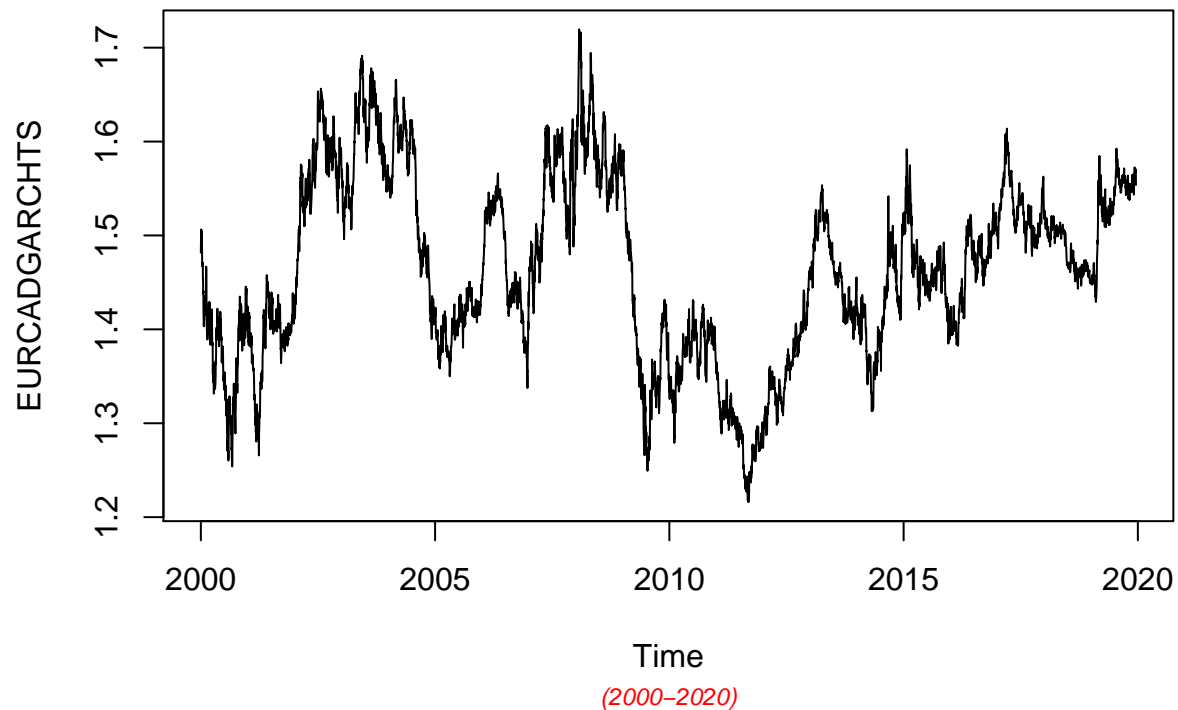
(2000–2020)

##Dealing with Conditional Heteroscedaticity:

```r
DifflogEURCADGarch= diff(log(EURCADGARCHTS))*100
plot(DifflogEURCADGarch)
title("Plot of returns of EURCAD", sub = "(2000-2020)",
      cex.main = 1.5,   font.main= 4, col.main= "blue",
      cex.sub = 0.75, font.sub = 3, col.sub = "red")
```

Plot of returns of EURCAD

(2000–2020)

##nature as almost at all lags the p-values fall below the significance levels.

```r
library(TSA)
```

```
## Warning: package 'TSA' was built under R version 4.0.5
```

```
##
## Attaching package: 'TSA'
```

```
## The following object is masked from 'package:readr':
##
##     spec
```

```
## The following objects are masked from 'package:stats':
##
##     acf, arima
```
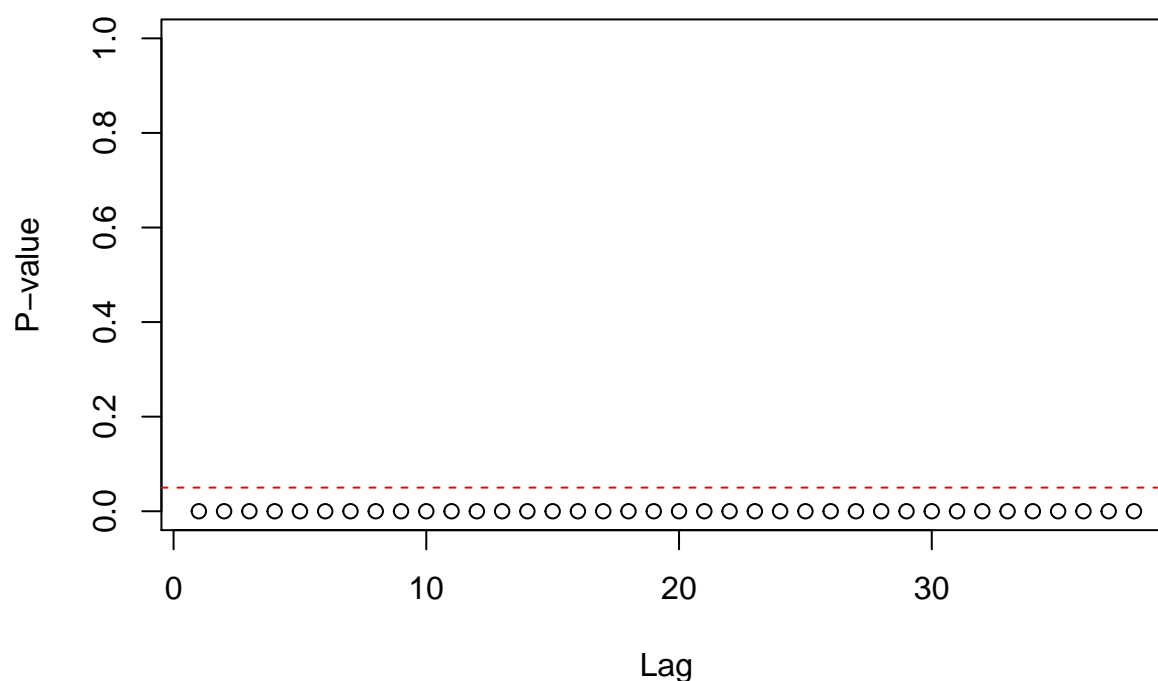
```
## The following object is masked from 'package:utils':
##
##     tar
```

```r
McLeod.Li.test(y= DifflogEURCADGarch,main="McLeod-Li test statistics for Daily return series")
```

## McLeod–Li test statistics for Daily return series

In order to get an order of GARCH , we further transform the return series into absolute values and squared return values.

```
abs = abs(DifflogEURCADGarch)
sqr = DifflogEURCADGarch^2
```

GARCH Model specification:

```
par(mfrow=c(1,2))
acf(abs, ci.type="ma",main=" ACF for abs. returns")
pacf(abs, main=" PACF plot for abs.returns")
```

**ACF for abs. returns**　　　　　　**PACF plot for abs.returns**
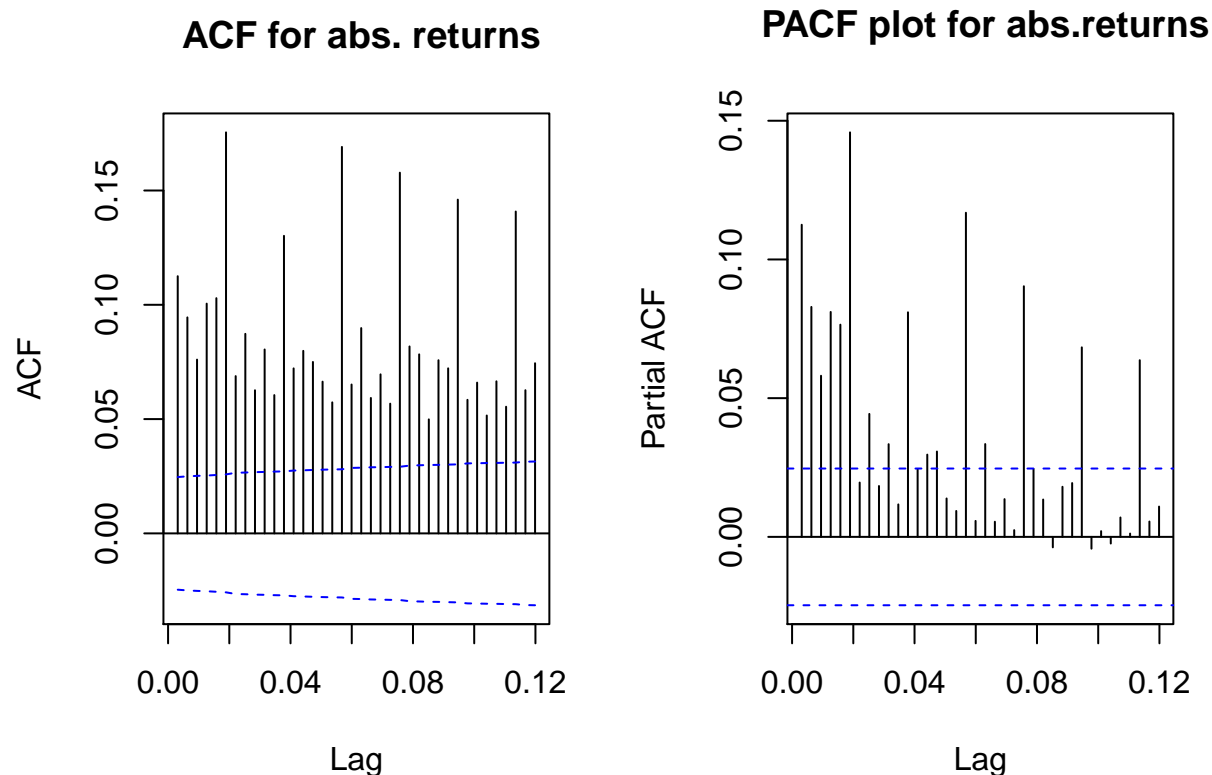
##From ACF and PACF we see many lags are significant. Hence, we plot EACF to get the candidate models

```
eacf(abs)
```

```
## AR/MA
##   0 1 2 3 4 5 6 7 8 9 10 11 12 13
## 0 x x x x x x x x x x x  x  x  x
## 1 x o o o o x x x o o o  x  x  o
## 2 x x x o o x x x o o o  x  x  o
## 3 x x x o o x x x o o o  x  o  o
## 4 x x x x o x x x o o o  x  o  o
## 5 x x x x x x x o x o x o  x  o  o
## 6 x x x x x x x o o o o  x  o  o
## 7 x x x x o x x o o o o  x  o  o
```

##From the squared returns ACF and PACF plot, it is not that clear to derive the order of p and q. Hence, I approach EACF and the order of ARMA are ARMA (2,3), ARMA (3,3), ARMA (2,4). Thus, GARCH candidate models would be GARCH (3,2) GARCH (3,3) GARCH (4,2)

```
par(mfrow=c(1,2))
acf(sqr, ci.type="ma",main="ACF  for sqr. return")
pacf(sqr, main="PACF for sqr. return")
```

ACF for sqr. return

PACF for sqr. return
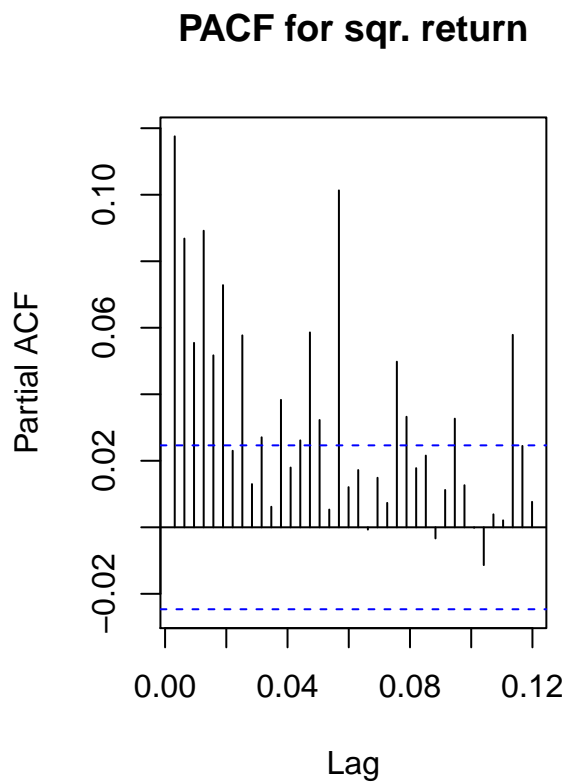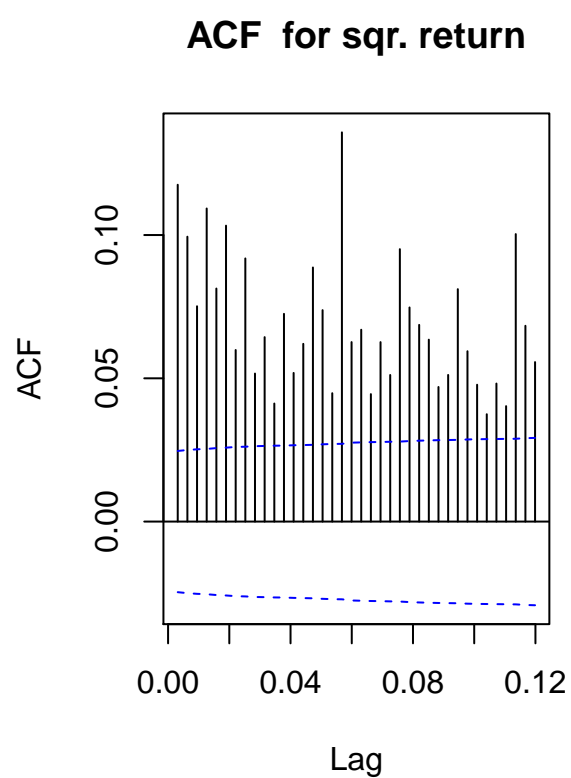

```
eacf(sqr)
```

```
## AR/MA
##    0 1 2 3 4 5 6 7 8 9 10 11 12 13
## 0 x x x x x x x x x x x  x  x  x
## 1 x o o x o x x x x o o  x  o  o
## 2 x x x o o o o o o o o  o  o  o
## 3 x x x o o o o o o o o  o  o  o
## 4 x x x x o o o o o o o  o  o  o
## 5 x x x x x o o o o o o  o  o  o
## 6 x x x x x o o o o o o  o  o  o
## 7 x x x x x x x o o o o  o  o  o
```

With reference to the Dickey-Fuller Test, p-value is less than the 0.02 and we can reject the null hypothesis stating the non-stationarity. Hence , we can proceed further for model selection .

#MODEL ESTIMATION: ##GARCH (2,1): for GBP and USD Curruency Pair

```
# GARCH(2,1)
library(tseries)
```

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```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
EURCADGARCHFit.21 = garch(DifflogEURCADGarch,order=c(2,1),trace =FALSE)
summary(EURCADGARCHFit.21)
```

```
##
## Call:
## garch(x = DifflogEURCADGarch, order = c(2, 1), trace = FALSE)
##
## Model:
## GARCH(2,1)
##
## Residuals:
##      Min      1Q   Median       3Q      Max
## -4.97662 -0.57416  0.01536  0.55113  5.46322
##
## Coefficient(s):
##     Estimate  Std. Error  t value Pr(>|t|)
## a0 0.0023600   0.0004289    5.502 3.74e-08 ***
## a1 0.0475672   0.0054530    8.723  < 2e-16 ***
## b1 0.4829249   0.1611500    2.997  0.00273 **
## b2 0.4621471   0.1559044    2.964  0.00303 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Diagnostic Tests:
##  Jarque Bera Test
##
## data:  Residuals
## X-squared = 570.24, df = 2, p-value < 2.2e-16
##
##
##  Box-Ljung test
##
## data:  Squared.Residuals
## X-squared = 2.0369, df = 1, p-value = 0.1535
```

GARCH (2,2):

##This model can be interpreted as an overfit model of GARCH(2,1) and p values from residual tests confirms that residuals are highly correlated. Thus this model is not consider to be a good fit.

```
EURCADGARCHFit.22 = garch(DifflogEURCADGarch, order =c(2,2),trace =FALSE)
```

```
## Warning in garch(DifflogEURCADGarch, order = c(2, 2), trace = FALSE): singular
## information
```

```
summary(EURCADGARCHFit.22)
```

```
## 
## Call:
## garch(x = DifflogEURCADGarch, order = c(2, 2), trace = FALSE)
## 
## Model:
## GARCH(2,2)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.9379 -0.5738  0.0154  0.5512  5.4316
## 
## Coefficient(s):
##      Estimate  Std. Error  t value Pr(>|t|)
## a0 1.631e-03          NA       NA       NA
## a1 3.418e-02          NA       NA       NA
## a2 2.248e-15          NA       NA       NA
## b1 9.489e-01          NA       NA       NA
## b2 1.203e-02          NA       NA       NA
## 
## Diagnostic Tests:
##  Jarque Bera Test
## 
## data:  Residuals
## X-squared = 579.46, df = 2, p-value < 2.2e-16
## 
## 
##  Box-Ljung test
## 
## data:  Squared.Residuals
## X-squared = 5.3913, df = 1, p-value = 0.02024
```

##GARCH (3,1): ##This model can be interpreted as an overfit model of GARCH(2,1) and GARCH (2,2). This model may not be consider to be a good fit.

```
EURCADGARCHFit.31 = garch(DifflogEURCADGarch,order=c(3,1),trace =FALSE)
summary(EURCADGARCHFit.31)
```

```
## 
## Call:
## garch(x = DifflogEURCADGarch, order = c(3, 1), trace = FALSE)
## 
## Model:
## GARCH(3,1)
## 
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.99054 -0.57284  0.01518  0.54605  5.38866
## 
## Coefficient(s):
##      Estimate  Std. Error  t value Pr(>|t|)
## a0 0.0030661   0.0005502    5.573 2.51e-08 ***
## a1 0.0618519   0.0071282    8.677  < 2e-16 ***
## b1 0.3219028   0.1280592    2.514   0.0119 *
```

```
## b2 0.2877271   0.1552235    1.854   0.0638 .
## b3 0.3189208   0.1437480    2.219   0.0265 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Diagnostic Tests:
##  Jarque Bera Test
##
## data:  Residuals
## X-squared = 556.14, df = 2, p-value < 2.2e-16
##
##
##  Box-Ljung test
##
## data:  Squared.Residuals
## X-squared = 0.34049, df = 1, p-value = 0.5595
```

##GARCH (3,2): ##This model can be interpreted as an overfitting model and p values from residual tests confirms that residuals are highly correlated. Thus this model is not consider to be a good fit.

GARCH(3,2)

```
EURCADGARCHFit.32 = garch(DifflogEURCADGarch,order=c(3,2),trace =FALSE)
summary(EURCADGARCHFit.32)
```

```
##
## Call:
## garch(x = DifflogEURCADGarch, order = c(3, 2), trace = FALSE)
##
## Model:
## GARCH(3,2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.01481 -0.57328  0.01523  0.54579  5.41575
##
## Coefficient(s):
##      Estimate  Std. Error  t value Pr(>|t|)
## a0 3.123e-03   1.139e-03    2.742   0.0061 **
## a1 6.320e-02   8.625e-03    7.327 2.35e-13 ***
## a2 5.579e-07   2.538e-02    0.000   1.0000
## b1 2.614e-01   4.010e-01    0.652   0.5145
## b2 3.477e-01   2.109e-01    1.649   0.0992 .
## b3 3.180e-01   2.464e-01    1.290   0.1969
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Diagnostic Tests:
##  Jarque Bera Test
##
## data:  Residuals
```

```
## X-squared = 559.45, df = 2, p-value < 2.2e-16
##
##
##  Box-Ljung test
##
## data:  Squared.Residuals
## X-squared = 0.26127, df = 1, p-value = 0.6092
```

GARCH (3,3):

This model can be interpreted as an overfitting model and p values from residual tests confirms that residuals are highly correlated. Thus, this model is not consider to be a good fit.

GARCH(3,3)

```
EURCADGARCHFit.33 = garch(DifflogEURCADGarch,order=c(3,3),trace =FALSE)
summary(EURCADGARCHFit.33)
```

```
##
## Call:
## garch(x = DifflogEURCADGarch, order = c(3, 3), trace = FALSE)
##
## Model:
## GARCH(3,3)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.07302 -0.56549  0.01616  0.53947  6.35562
##
## Coefficient(s):
##      Estimate  Std. Error  t value Pr(>|t|)
## a0 1.066e-02   1.955e-03    5.453 4.95e-08 ***
## a1 1.262e-01   1.307e-02    9.656  < 2e-16 ***
## a2 2.911e-02   3.109e-02    0.936  0.34922
## a3 5.021e-16   2.295e-02    0.000  1.00000
## b1 1.210e-01   2.104e-01    0.575  0.56539
## b2 2.558e-01   2.049e-01    1.249  0.21180
## b3 4.436e-01   1.218e-01    3.642  0.00027 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Diagnostic Tests:
##  Jarque Bera Test
##
## data:  Residuals
## X-squared = 611.7, df = 2, p-value < 2.2e-16
##
##
##  Box-Ljung test
##
```

```
## data:  Squared.Residuals
## X-squared = 4.1306, df = 1, p-value = 0.04211
```

##GARCH (4,2): ##This model can be interpreted as an overfitting model and p values from residual tests confirms that residuals are highly correlated. Thus, this model is not considered to be a good fit.

```
EURCADGARCHFit.42 = garch(DifflogEURCADGarch,order=c(4,2),trace =FALSE)
summary(EURCADGARCHFit.42)
```

```
##
## Call:
## garch(x = DifflogEURCADGarch, order = c(4, 2), trace = FALSE)
##
## Model:
## GARCH(4,2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -4.95834 -0.57058   0.01532   0.54579   5.29551
##
## Coefficient(s):
##      Estimate  Std. Error  t value Pr(>|t|)
## a0 3.724e-03   1.583e-03    2.353   0.0186 *
## a1 7.411e-02   9.563e-03    7.750  9.1e-15 ***
## a2 5.170e-05   3.519e-02    0.001   0.9988
## b1 3.704e-01   4.682e-01    0.791   0.4289
## b2 1.467e-14   2.454e-01    0.000   1.0000
## b3 2.776e-01   1.255e-01    2.212   0.0270 *
## b4 2.662e-01   2.512e-01    1.060   0.2893
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Diagnostic Tests:
##   Jarque Bera Test
##
## data:  Residuals
## X-squared = 549.19, df = 2, p-value < 2.2e-16
##
##
##   Box-Ljung test
##
## data:  Squared.Residuals
## X-squared = 0.0091194, df = 1, p-value = 0.9239
```

```
##
```

```
EURCADGARCHFit.41 = garch(DifflogEURCADGarch,order=c(4,1),trace =FALSE)
summary(EURCADGARCHFit.41)
```

```
##
## Call:
## garch(x = DifflogEURCADGarch, order = c(4, 1), trace = FALSE)
```

```
## 
## Model:
## GARCH(4,1)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.9638 -0.5705  0.0153  0.5461  5.3224
## 
## Coefficient(s):
##     Estimate  Std. Error  t value Pr(>|t|)
## a0 3.755e-03   6.444e-04    5.827 5.64e-09 ***
## a1 7.471e-02   7.177e-03   10.409  < 2e-16 ***
## b1 3.711e-01   1.187e-01    3.126  0.00177 **
## b2 3.297e-06   1.273e-01    0.000  0.99998
## b3 2.466e-01   1.201e-01    2.054  0.04001 *
## b4 2.958e-01   9.554e-02    3.097  0.00196 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Diagnostic Tests:
##   Jarque Bera Test
## 
## data:  Residuals
## X-squared = 552.36, df = 2, p-value < 2.2e-16
## 
## 
##   Box-Ljung test
## 
## data:  Squared.Residuals
## X-squared = 0.014786, df = 1, p-value = 0.9032
```

Model Selection:

##Best possible model is selected by AIC scores of the models. From the below sort function, GARCH(3,1) would be the best model for the return series. From the p-value, 3.1 also has the lowest correlation

```
library(dLagM)
```

```
## Warning: package 'dLagM' was built under R version 4.0.5
```

```
## Loading required package: nardl
```

```
## Warning: package 'nardl' was built under R version 4.0.5
```

```
## Loading required package: dynlm
```

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

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

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric

GARCHModelSelectionEURCAD = AIC(EURCADGARCHFit.21,EURCADGARCHFit.22 ,EURCADGARCHFit.31,EURCADGARCHFit.3
sortScore(GARCHModelSelectionEURCAD, score ="aic")


##                 df       AIC
## EURCADGARCHFit.41  6   9933.954
## EURCADGARCHFit.42  7   9936.089
## EURCADGARCHFit.31  5   9937.328
## EURCADGARCHFit.32  6   9939.461
## EURCADGARCHFit.21  4   9942.407
## EURCADGARCHFit.22  5   9950.468
## EURCADGARCHFit.33  7  10008.500
```

Model Fitting:

```
library(rugarch)


## Warning: package 'rugarch' was built under R version 4.0.5


## Loading required package: parallel


##
## Attaching package: 'rugarch'


## The following object is masked from 'package:stats':
##
##     sigma

EURCADmodel3.3<-ugarchspec(variance.model = list(model = "sGARCH", garchOrder = c(3,3)),
                mean.model = list(armaOrder = c(1, 1), include.mean = TRUE),
                distribution.model = "norm")

EURCADgarchMODEL3.3<-ugarchfit(spec=EURCADmodel3.3,data=DifflogEURCADGarch, out.sample = 100)
plot(EURCADgarchMODEL3.3,which="all")


##
## please wait...calculating quantiles...
```

Series with 2 Conditional SD Superimposed

Series with with 1% VaR Limits

Conditional SD (vs |returns|)

ACF of Observations

ACF of Squared Observations

ACF of Absolute Observations

Cross–Correlations of
Squared vs Actual Observations

Empirical Density of Standardized Resid

norm – QQ Plot

ACF of Standardized Residuals

ACF of Squared Standardized Residu

News Impact Curve

Model Diagnostics

EURCADgarchMODEL3.3

```
## 
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
## 
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(3,3)
## Mean Model   : ARFIMA(1,0,1)
## Distribution : norm
## 
## Optimal Parameters
## -----------------------------------
##          Estimate  Std. Error   t value Pr(>|t|)
## mu      -0.002184    0.006326 -0.345175 0.729963
## ar1     -0.029553    0.652955 -0.045260 0.963900
## ma1      0.033057    0.652768  0.050641 0.959611
## omega    0.003114    0.000791  3.934430 0.000083
## alpha1   0.060800    0.012144  5.006555 0.000001
## alpha2   0.000000    0.011352  0.000007 0.999995
## alpha3   0.000000    0.011210  0.000002 0.999998
## beta1    0.377842    0.010056 37.575243 0.000000
```

```
## beta2    0.220744    0.049173  4.489166 0.000007
## beta3    0.331015    0.011378 29.092892 0.000000
##
## Robust Standard Errors:
##          Estimate  Std. Error    t value Pr(>|t|)
## mu     -0.002184    0.006157  -0.354669 0.722838
## ar1    -0.029553    0.114852  -0.257312 0.796938
## ma1     0.033057    0.115942   0.285117 0.775554
## omega   0.003114    0.001392   2.236739 0.025303
## alpha1  0.060800    0.017756   3.424265 0.000616
## alpha2  0.000000    0.016680   0.000005 0.999996
## alpha3  0.000000    0.015412   0.000002 0.999999
## beta1   0.377842    0.004775  79.135713 0.000000
## beta2   0.220744    0.015052  14.665037 0.000000
## beta3   0.331015    0.003225 102.639502 0.000000
##
## LogLikelihood : -4927.917
##
## Information Criteria
## ---------------------------------
##
## Akaike        1.5860
## Bayes         1.5968
## Shibata       1.5860
## Hannan-Quinn  1.5897
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                            statistic   p-value
## Lag[1]                        0.3553 5.511e-01
## Lag[2*(p+q)+(p+q)-1][5]       9.6296 2.338e-12
## Lag[4*(p+q)+(p+q)-1][9]      13.2046 3.060e-04
## d.o.f=2
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                            statistic  p-value
## Lag[1]                        0.4056 0.524202
## Lag[2*(p+q)+(p+q)-1][17]     13.8842 0.093069
## Lag[4*(p+q)+(p+q)-1][29]     28.7761 0.005799
## d.o.f=6
##
## Weighted ARCH LM Tests
## ---------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[7]     0.1198 0.500 2.000  0.7293
## ARCH Lag[9]     2.2395 1.485 1.796  0.4708
## ARCH Lag[11]    6.1882 2.440 1.677  0.1836
##
## Nyblom stability test
## ---------------------------------
## Joint Statistic:  2.8533
## Individual Statistics:
```

```
## mu      0.0257
## ar1     0.3381
## ma1     0.3389
## omega   0.4470
## alpha1 0.3268
## alpha2 0.3280
## alpha3 0.4169
## beta1   0.4907
## beta2   0.4988
## beta3   0.4957
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:         2.29 2.54 3.05
## Individual Statistic:    0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value    prob sig
## Sign Bias            0.4205 0.6741
## Negative Sign Bias  0.3615 0.7177
## Positive Sign Bias  0.9484 0.3430
## Joint Effect        3.4883 0.3223
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ---------------------------------
##   group statistic p-value(g-1)
## 1    20     250.2    2.867e-42
## 2    30     278.6    1.364e-42
## 3    40     296.4    2.597e-41
## 4    50     314.4    2.086e-40
##
##
## Elapsed time : 0.7085669
```

Forecasting

```
forcgarchEURCAD= ugarchforecast(EURCADgarchMODEL3.3, data = DifflogEURCADGarch, n.ahead = 100, n.roll =
print(forcgarchEURCAD)
```

```
##
## *---------------------------------------*
## *         GARCH Model Forecast          *
## *---------------------------------------*
## Model: sGARCH
## Horizon: 100
## Roll Steps: 10
## Out of Sample: 100
##
## 0-roll forecast [T0=1987-01-19 02:00:00]:
##          Series  Sigma
## T+1   -0.001808 0.4243
```

```
## T+2    -0.002195 0.4332
## T+3    -0.002183 0.4347
## T+4    -0.002184 0.4325
## T+5    -0.002184 0.4347
## T+6    -0.002184 0.4357
## T+7    -0.002184 0.4359
## T+8    -0.002184 0.4370
## T+9    -0.002184 0.4378
## T+10   -0.002184 0.4384
## T+11   -0.002184 0.4393
## T+12   -0.002184 0.4400
## T+13   -0.002184 0.4408
## T+14   -0.002184 0.4415
## T+15   -0.002184 0.4423
## T+16   -0.002184 0.4430
## T+17   -0.002184 0.4437
## T+18   -0.002184 0.4445
## T+19   -0.002184 0.4452
## T+20   -0.002184 0.4459
## T+21   -0.002184 0.4466
## T+22   -0.002184 0.4473
## T+23   -0.002184 0.4480
## T+24   -0.002184 0.4487
## T+25   -0.002184 0.4494
## T+26   -0.002184 0.4501
## T+27   -0.002184 0.4508
## T+28   -0.002184 0.4515
## T+29   -0.002184 0.4522
## T+30   -0.002184 0.4528
## T+31   -0.002184 0.4535
## T+32   -0.002184 0.4542
## T+33   -0.002184 0.4548
## T+34   -0.002184 0.4555
## T+35   -0.002184 0.4562
## T+36   -0.002184 0.4568
## T+37   -0.002184 0.4574
## T+38   -0.002184 0.4581
## T+39   -0.002184 0.4587
## T+40   -0.002184 0.4593
## T+41   -0.002184 0.4600
## T+42   -0.002184 0.4606
## T+43   -0.002184 0.4612
## T+44   -0.002184 0.4618
## T+45   -0.002184 0.4624
## T+46   -0.002184 0.4630
## T+47   -0.002184 0.4636
## T+48   -0.002184 0.4642
## T+49   -0.002184 0.4648
## T+50   -0.002184 0.4654
## T+51   -0.002184 0.4660
## T+52   -0.002184 0.4666
## T+53   -0.002184 0.4672
## T+54   -0.002184 0.4678
## T+55   -0.002184 0.4683
```

```
## T+56   -0.002184 0.4689
## T+57   -0.002184 0.4695
## T+58   -0.002184 0.4700
## T+59   -0.002184 0.4706
## T+60   -0.002184 0.4711
## T+61   -0.002184 0.4717
## T+62   -0.002184 0.4722
## T+63   -0.002184 0.4728
## T+64   -0.002184 0.4733
## T+65   -0.002184 0.4739
## T+66   -0.002184 0.4744
## T+67   -0.002184 0.4749
## T+68   -0.002184 0.4755
## T+69   -0.002184 0.4760
## T+70   -0.002184 0.4765
## T+71   -0.002184 0.4770
## T+72   -0.002184 0.4775
## T+73   -0.002184 0.4781
## T+74   -0.002184 0.4786
## T+75   -0.002184 0.4791
## T+76   -0.002184 0.4796
## T+77   -0.002184 0.4801
## T+78   -0.002184 0.4806
## T+79   -0.002184 0.4811
## T+80   -0.002184 0.4816
## T+81   -0.002184 0.4820
## T+82   -0.002184 0.4825
## T+83   -0.002184 0.4830
## T+84   -0.002184 0.4835
## T+85   -0.002184 0.4840
## T+86   -0.002184 0.4844
## T+87   -0.002184 0.4849
## T+88   -0.002184 0.4854
## T+89   -0.002184 0.4858
## T+90   -0.002184 0.4863
## T+91   -0.002184 0.4868
## T+92   -0.002184 0.4872
## T+93   -0.002184 0.4877
## T+94   -0.002184 0.4881
## T+95   -0.002184 0.4886
## T+96   -0.002184 0.4890
## T+97   -0.002184 0.4895
## T+98   -0.002184 0.4899
## T+99   -0.002184 0.4903
## T+100 -0.002184 0.4908
```

plotting

```
plot(forcgarchEURCAD, which= "all")
```

Forecast Series w/th unconditional 1–Sigma bands

Rolling Forecast vs Actual Series w/th conditional 2–Sigma bands

Forecast Unconditional Sigma (n.roll = 0)

Forecast Rolling Sigma vs |Series|

Forecasting the rate

```
p.t_1 = 1.55384
  R_t <- c( -0.001808, -0.002195, -0.002183, -0.002184, -0.002184,  -0.002184, -0.002184, -0.002184, -0


)
  p_t= 0
  for (i in 1:100){
    p_t =  p.t_1  *((2.71828)^(R_t[i]/100))
   print(p_t)
    p.t_1=p_t
  }
```

```
## [1] 1.553812
## [1] 1.553778
## [1] 1.553744
## [1] 1.55371
## [1] 1.553676
## [1] 1.553642
## [1] 1.553608
## [1] 1.553574
```

```
## [1] 1.55354
## [1] 1.553506
## [1] 1.553472
## [1] 1.553439
## [1] 1.553405
## [1] 1.553371
## [1] 1.553337
## [1] 1.553303
## [1] 1.553269
## [1] 1.553235
## [1] 1.553201
## [1] 1.553167
## [1] 1.553133
## [1] 1.553099
## [1] 1.553065
## [1] 1.553031
## [1] 1.552998
## [1] 1.552964
## [1] 1.55293
## [1] 1.552896
## [1] 1.552862
## [1] 1.552828
## [1] 1.552794
## [1] 1.55276
## [1] 1.552726
## [1] 1.552692
## [1] 1.552658
## [1] 1.552624
## [1] 1.552591
## [1] 1.552557
## [1] 1.552523
## [1] 1.552489
## [1] 1.552455
## [1] 1.552421
## [1] 1.552387
## [1] 1.552353
## [1] 1.552319
## [1] 1.552285
## [1] 1.552252
## [1] 1.552218
## [1] 1.552184
## [1] 1.55215
## [1] 1.552116
## [1] 1.552082
## [1] 1.552048
## [1] 1.552014
## [1] 1.55198
## [1] 1.551946
## [1] 1.551913
## [1] 1.551879
## [1] 1.551845
## [1] 1.551811
## [1] 1.551777
## [1] 1.551743
```

```
## [1] 1.551709
## [1] 1.551675
## [1] 1.551641
## [1] 1.551608
## [1] 1.551574
## [1] 1.55154
## [1] 1.551506
## [1] 1.551472
## [1] 1.551438
## [1] 1.551404
## [1] 1.55137
## [1] 1.551336
## [1] 1.551303
## [1] 1.551269
## [1] 1.551235
## [1] 1.551201
## [1] 1.551167
## [1] 1.551133
## [1] 1.551099
## [1] 1.551065
## [1] 1.551032
## [1] 1.550998
## [1] 1.550964
## [1] 1.55093
## [1] 1.550896
## [1] 1.550862
## [1] 1.550828
## [1] 1.550794
## [1] 1.550761
## [1] 1.550727
## [1] 1.550693
## [1] 1.550659
## [1] 1.550625
## [1] 1.550591
## [1] 1.550557
## [1] 1.550524
## [1] 1.55049
## [1] 1.550456
```