Homework 5

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Due Thursday, November 30 at 3:00 PM

Please do not submit photos of your homework. Scanners are available for your use.

Question 1

```
options("getSymbols.yahoo.warning"=FALSE)
options("getSymbols.warning4.0"=FALSE)
source("http://www.stat.cmu.edu/~cschafer/MSCF/ModelSelectionExample.txt")
library(fGarch)
```

```
## Warning: package 'fGarch' was built under R version 3.4.2
## Loading required package: timeDate
## Warning: package 'timeDate' was built under R version 3.4.2
## Warning in as.POSIXlt.POSIXct(Sys.time()): unknown timezone 'default/
## America/Detroit'
## Loading required package: timeSeries
## Warning: package 'timeSeries' was built under R version 3.4.2
##
## Attaching package: 'timeSeries'
## The following object is masked from 'package:zoo':
##
##     time<-
## Loading required package: fBasics
## Warning: package 'fBasics' was built under R version 3.4.2
##
## Attaching package: 'fBasics'
## The following object is masked from 'package:TTR':
##
##     volatility
```

```
library(ggplot2)
library(ggfortify)
```

```
## Warning: namespace 'DBI' is not available and has been replaced
## by .GlobalEnv when processing object 'call.'
## Warning: namespace 'DBI' is not available and has been replaced
## by .GlobalEnv when processing object 'call.'
```

```
Kellogg = getSymbols("K", from="2010-1-1", to="2016-12-31", auto.assign=F)
lwrk = data.frame(weeklyReturn(Ad(Kellogg), type="log"))

# Generalized Error Distribution
print("Generalized Error Distribution trial")
```

```
## [1] "Generalized Error Distribution trial"
```

```
ged_out = FitGED(lwrk$weekly.returns)
print(ged_out$mle)
```

```
##          mu       sigma          nu
## 0.002425106 0.019569354 1.308185257
```

```
# Non-standard T-distribution
print("Non-standard T-distribution trial")
```

```
## [1] "Non-standard T-distribution trial"
```

```
nstd_out = FitNonStdT(lwrk$weekly.returns)
print(nstd_out$mle)
```

```
##          mu       sigma          nu
## 0.002408331 0.019835619 5.240941438
```

```
# Skewed T-distribution (no shift)
print("Skewed T-distribution (shifted, optimized) trial")
```

```
## [1] "Skewed T-distribution (shifted, optimized) trial"
```

```
skt_out = FitSkewT(lwrk$weekly.returns)
print(skt_out$mle)
```

```
##            k            n       lambda       sigma2
## 2.1941746738 4.8452173405 0.0385915399 0.0003983916
```

```
# Skewed T-distribution (shifted, optimized)
print("Skewed T-distribution (shifted, optimized) trial")
```

```
## [1] "Skewed T-distribution (shifted, optimized) trial"
```

```
sktShiftOpt_out = FitSkewT(lwrk$weekly.returns, allowshift=T, control=list(maxit=1000))
print(round(sktShiftOpt_out$mle,6))
```

```
##         k         n    lambda    sigma2        mu
##  1.907886  5.890992 -0.172947  0.000393  0.006519
```

```
# Normal Distribution
print("Normal Distribution trial")
```

```
## [1] "Normal Distribution trial"
```

```r
n = length(lwrk$weekly.returns)
norm_out = c(mean(lwrk$weekly.returns), sqrt(var(lwrk$weekly.returns)*(n-1)/n))
print(norm_out)
```

```
## [1] 0.001490615 0.019670283
```

```r
### For each trial, compute LLH

# Generalized Error Distribution
print("Generalized Error Distribution plot/llh")
```

```
## [1] "Generalized Error Distribution plot/llh"
```

```r
print(sum(dged(lwrk$weekly.returns, ged_out$mle[1], ged_out$mle[2], ged_out$mle[3], log=
```

```
## [1] 926.4382
```

```r
# Non-standard T-distribution
print("Non-standard T-distribution llh")
```

```
## [1] "Non-standard T-distribution llh"
```

```r
print(sum(dstd(lwrk$weekly.returns, nstd_out$mle[1], nstd_out$mle[2], nstd_out$mle[3], l
```

```
## [1] 928.1839
```

```r
# Skewed T-distribution (no shift)
print("Skewed T-distribution (no shift) llh")
```

```
## [1] "Skewed T-distribution (no shift) llh"
```

```r
print(sum(dSkewT(lwrk$weekly.returns, skt_out$mle[1], skt_out$mle[2], skt_out$mle[3], sk
```

```
## [1] 925.7129
```

```r
# Skewed T-distribution (shifted, optimized)
print("Skewed T-distribution (shifted, optimized) llh")
```

```
## [1] "Skewed T-distribution (shifted, optimized) llh"
```

```r
print(sum(dSkewT(lwrk$weekly.returns, sktShiftOpt_out$mle[1], sktShiftOpt_out$mle[2], sk
```

```
## [1] 930.9148
```

```r
# Normal Distribution
print("Normal Distribution llh")
```

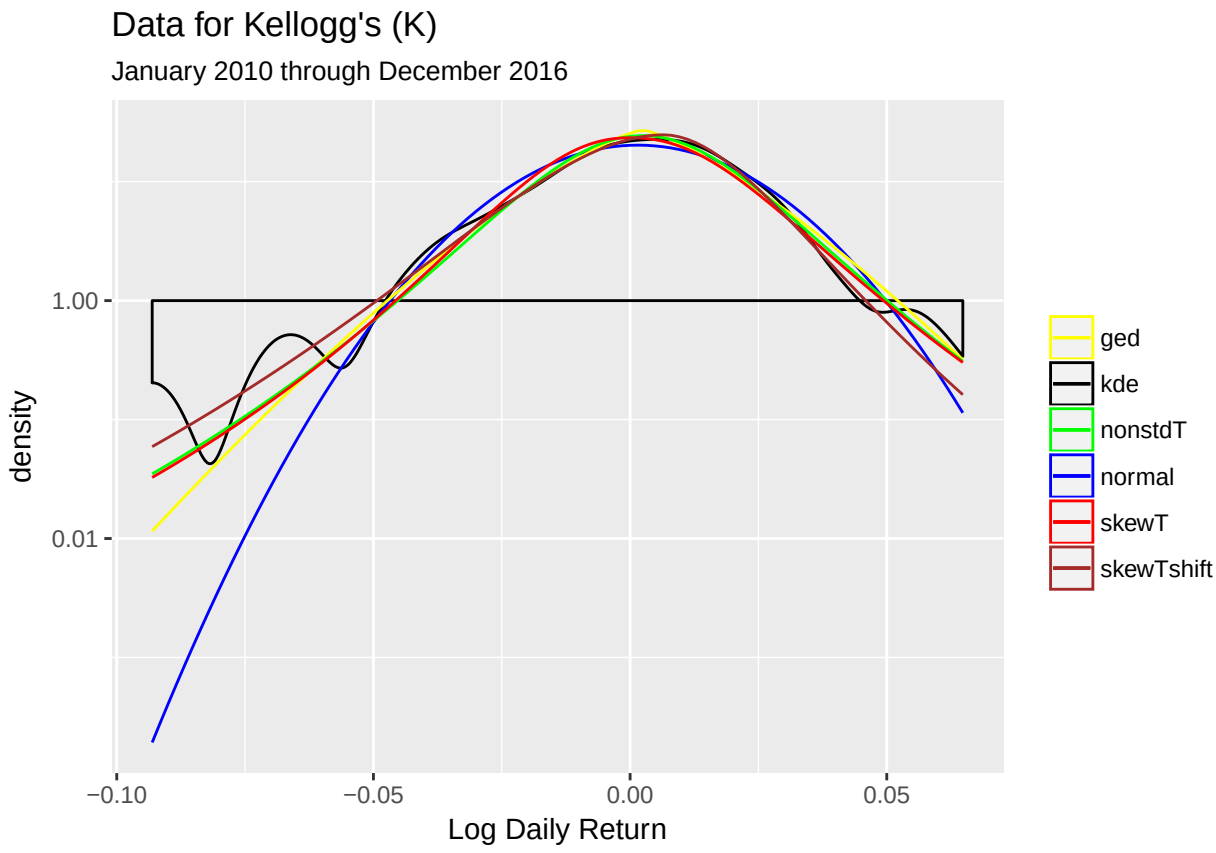
```
## [1] "Normal Distribution llh"
```

```r
print(sum(dnorm(lwrk$weekly.returns, norm_out[1], norm_out[2], log=TRUE)))
```

```
## [1] 916.0433
```

```r
### Constructing plots, code taken from Model_Selection.txt from Canvas
ggplot(lwrk,aes(x=weekly.returns)) +
```

```
  geom_density(bw="SJ",aes(color="kde")) +
  stat_function(fun=dnorm, aes(color="normal"),
                args=list(mean=norm_out[1],sd=norm_out[2])) +
  stat_function(fun=dged, aes(color="ged"),
                args=list(mean=ged_out$mle[1],sd=ged_out$mle[2],nu=ged_out$mle[3])) +
  stat_function(fun=dstd, aes(color="nonstdT"),
                args=list(mean=nstd_out$mle[1],sd=nstd_out$mle[2],nu=nstd_out$mle[3])) +
  stat_function(fun=dSkewT, aes(color="skewT"),
                args=list(k=skt_out$mle[1],n=skt_out$mle[2],lambda=skt_out$mle[3],sigma2
  stat_function(fun=dSkewT, aes(color="skewTshift"),
                args=list(k=sktShiftOpt_out$mle[1],n=sktShiftOpt_out$mle[2],lambda=sktSh
  scale_color_manual(name="",
                     values=c("kde"="black","normal"="blue",
                              "ged"="yellow","nonstdT"="green",
                              "skewT"="red","skewTshift"="brown")) +
  labs(x="Log Daily Return",title="Data for Kellogg's (K)",subtitle="January 2010 throug
  scale_y_log10()
```




```
## It seems that the Non-Standard T-Distribution has the maximal LLH... doesn't necessar

### Determine Minimal AIC

print("Finding minimal AIC")
```

```
## [1] "Finding minimal AIC"
```

```
# Parameter Vector
p_vec = c(3,3,4,5,2)

# LLH Vector for each
ged_llh = sum(dged(lwrk$weekly.returns, ged_out$mle[1], ged_out$mle[2], ged_out$mle[3],
nstd_llh = sum(dstd(lwrk$weekly.returns, nstd_out$mle[1], nstd_out$mle[2], nstd_out$mle[
skwt_llh = sum(dSkewT(lwrk$weekly.returns, skt_out$mle[1], skt_out$mle[2], skt_out$mle[3
skwtShiftOpt_llh = sum(dSkewT(lwrk$weekly.returns, sktShiftOpt_out$mle[1], sktShiftOpt_o
norm_llh = sum(dnorm(lwrk$weekly.returns, norm_out[1], norm_out[2], log=TRUE))

llh_vec = c(ged_llh, nstd_llh, skwt_llh, skwtShiftOpt_llh, norm_llh)

aic_func = function(p,llh) {

  return ( -2*llh + 2*p )

}

aic_vec = c()
for ( j in 1:length(p_vec) ) {
  aic_vec[j] = aic_func(p_vec[j], llh_vec[j])
}

print("aic_vec:")
```

```
## [1] "aic_vec:"
```

```
print(aic_vec)
```

```
## [1] -1846.876 -1850.368 -1843.426 -1800.944 -1828.087
```

```
print("Min of aic_vec:")
```

```
## [1] "Min of aic_vec:"
```

```
print(min(aic_vec))
```

```
## [1] -1850.368
```

```
print("Max of llh_vec:")
```

```
## [1] "Max of llh_vec:"
```

```
print(max(llh_vec))
```

```
## [1] 928.1839
```

By AIC, the model selected is the Non-Standard T-distribution since it is the minimal AIC out of the models compared. It has an AIC value of -1850.368. Additionally, the model that yielded the maximal loglikelihood was the Non-Standard T-distribution as well. Therefore,

it seems that the Non-Standard T-distribution would be the best model for modelling log returns, perhaps the usage of the Normal Distribution is just because of its ease.

Question 2

Scanned in jgiebas_HW5.pdf

Question 3

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