BIA 656

Advance Data Analytics and Machine Learning

Assignment : Lab2

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Q1.a.

Is the expected log return zero? Are there any serial correlations in the log returns? Is there ARCH effect in the log returns?

We perform a t-test to check the expected log return.

```
> #Q1.a
> t.test(inta) #to check if there is significant difference

        One Sample t-test

data:  inta
t = 0.26515, df = 2534, p-value = 0.7909
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.0004633792  0.0006082874
sample estimates:
  mean of x
7.24541e-05
```

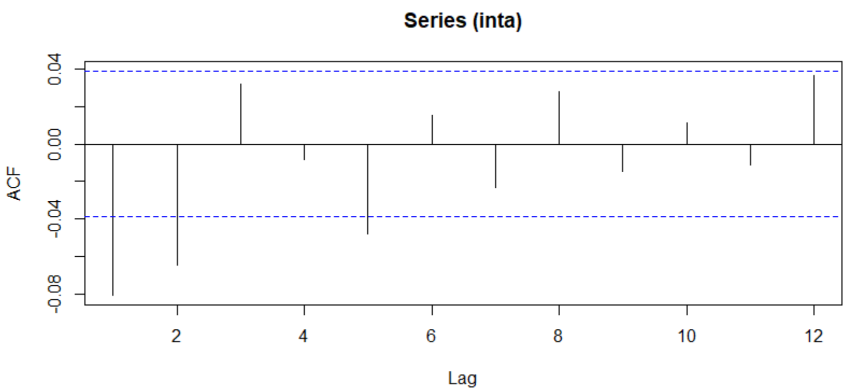
The results give a high p value. Therefore, the expected log-return is not zero.

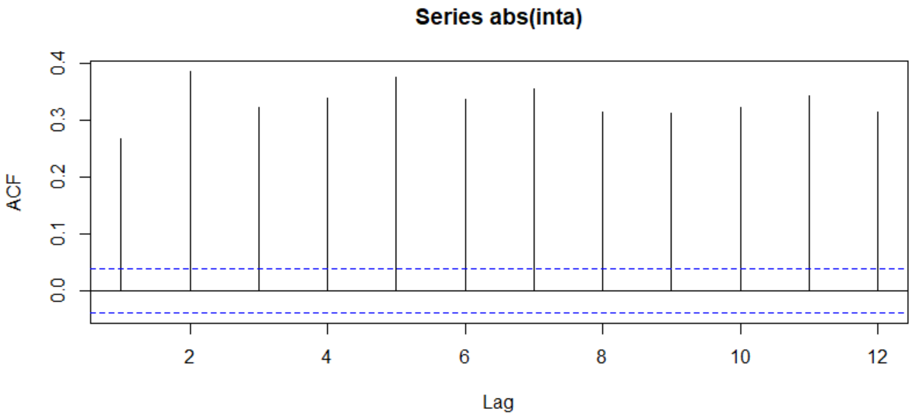
To find any serial correlations, we perform the Ljung box test.

```
> Box.test(inta, lag=12, type ='Ljung') #using 12 lags for monthly series

        Box-Ljung test

data:  inta
X-squared = 44.041, df = 12, p-value = 1.503e-05
```

The p value is low. Therefore, we can reject the null hypothesis and say that there is serial correlation in the log returns.

To check for ARCH effect in the log returns, we plot the ACF's





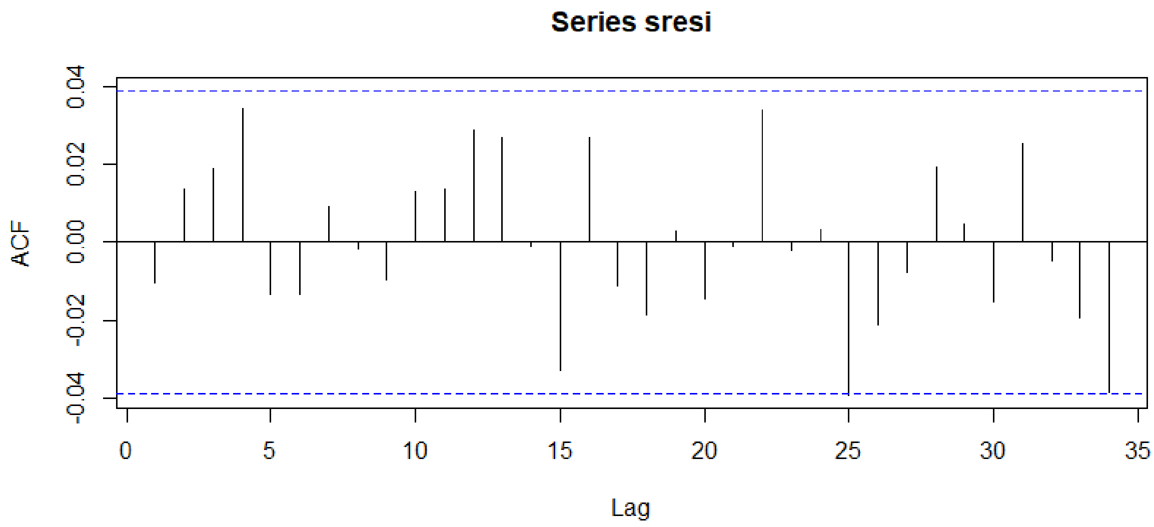
As we can see, the absolute value shows serial correlation for most of the lags. Then to confirm if ARCH effect is present or not, we perform Ljung box test.

```
> Box.test(inta,lag=12,type="Ljung")

        Box-Ljung test

data:  inta
X-squared = 44.041, df = 12, p-value = 1.503e-05

> Box.test(inta^2,lag=12,type="Ljung")

        Box-Ljung test

data:  inta^2
X-squared = 2373.6, df = 12, p-value < 2.2e-16
```

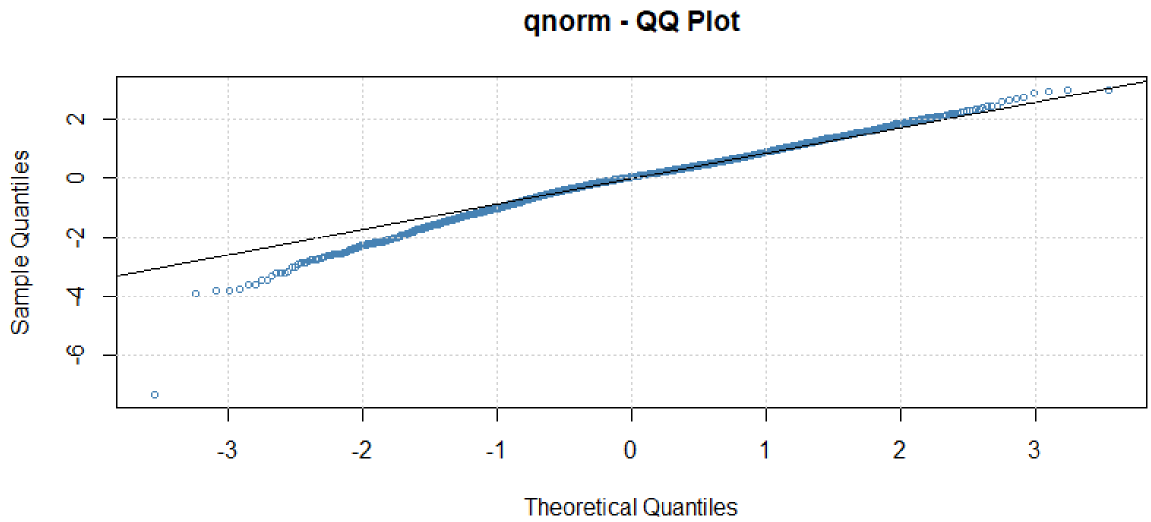
We can reject null hypothesis since the p value is low. This is an indication for ARCH effect.

Q1.b.

Fit a Gaussian ARMA-GARCH model for the log return series. Perform model checking, obtain the QQ-plot of the standardized residuals, and write down the fitted model. [Hint: Try GARCH(2,1).]



Performing Model Checking for the fitted model.



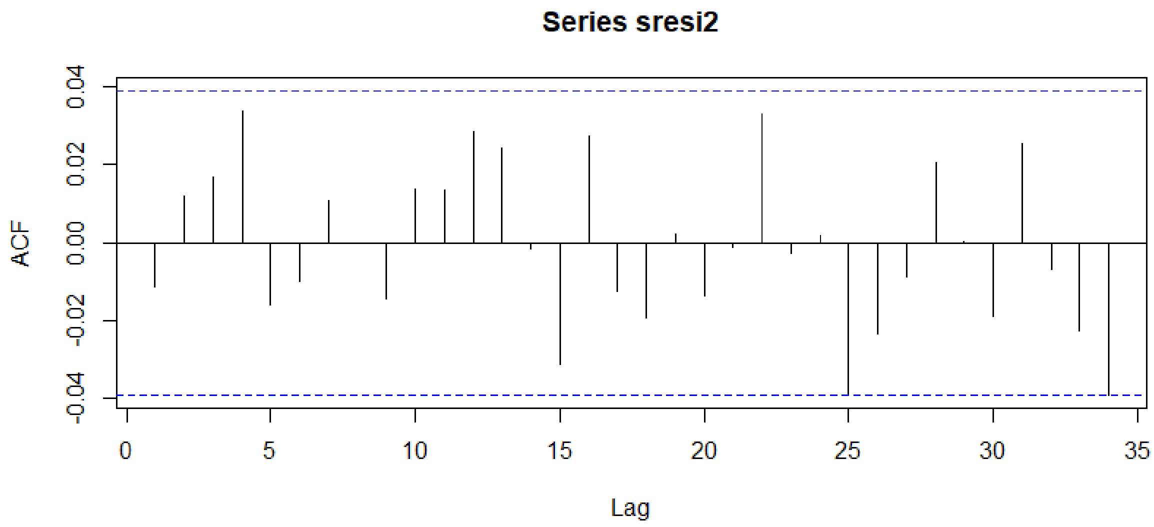
Obtaining QQ-plots for standardized residuals.

The model that we fitted was '~arma(1,1)+garch(2,1)'

We chose this model by performing trail and error method and checking lowest values for AIC and BIC.

Q1.c

Build an ARMA-GARCH model with Student-t innovations for the log return series. Perform model checking and write down the fitted model.



Performing model checking for the fitted model.

The model that we fit is ~arma(1,1) + garch(2,1)

Q1.d

Fit an ARMA-APARCH model with Student-t innovations to the data. Write down the fitted model and perform 1- to 5-step ahead predictions of the series and its volatility.

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model       : apARCH(1,1)
Mean Model        : ARFIMA(0,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error  t value Pr(>|t|)
mu      0.000190    0.000166  1.14184 0.253521
ma1    -0.066241    0.021482 -3.08359 0.002045
```

The fitted model for ARMA-APARCH model is ARMA(0,1)+APARCH(1,1).

```
> sigma(p1)
     1976-12-09 19:00:00
T+1           0.02115940
T+2           0.02105928
T+3           0.02095983
T+4           0.02086107
T+5           0.02076299
> 
```

The 1 to 5 steps ahead predictions are shown above.

The mean and volatility equations are:

r_t =

Q2.a

Is the expected monthly log return zero? Is there any serial correlction in the log returns? Is there any ARCH effect in the log returns?

We perform a t-test to check the expected log return.

```
> t.test(intb) #to check if there is significant difference

        One Sample t-test

data:  intb
t = 4.2198, df = 608, p-value = 2.819e-05
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 0.005655242 0.015501584
sample estimates:
 mean of x
0.01057841
```

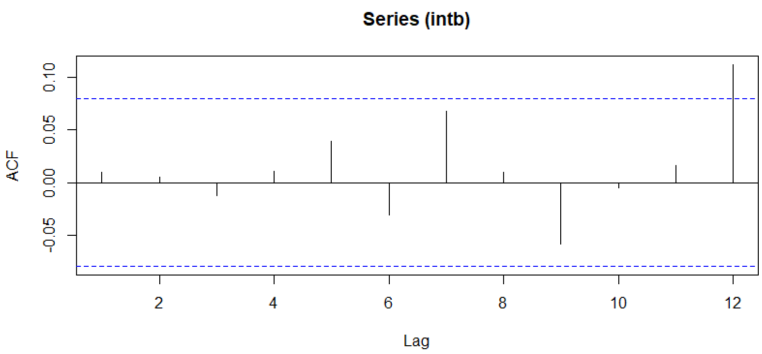
The results give a high p value. Therefore, the expected log-return is not zero.

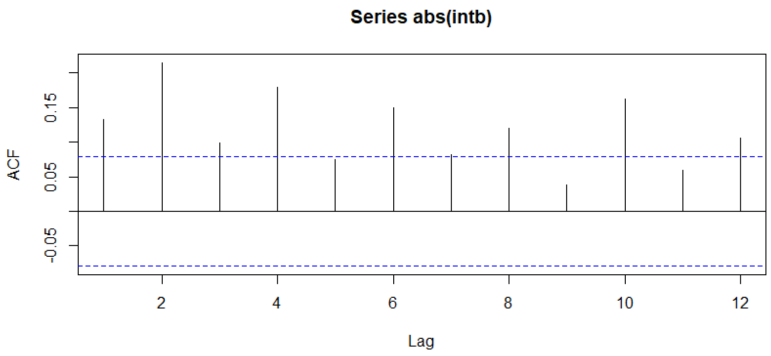
To find any serial correlations, we perform the Ljung box test.

```
> Box.test(intb, lag=12, type ='Ljung') #using 12 lags for monthly series

        Box-Ljung test

data:  intb
X-squared = 14.821, df = 12, p-value = 0.2514
```

The p value is low. Therefore, we can reject the null hypothesis and say that there is serial correlation in the log returns.

To check for ARCH effect in the log returns, we plot the ACF’s





As we can see, the absolute value shows serial correlation for most of the lags. Then to confirm if ARCH effect is present or not, we perform Ljung box test.

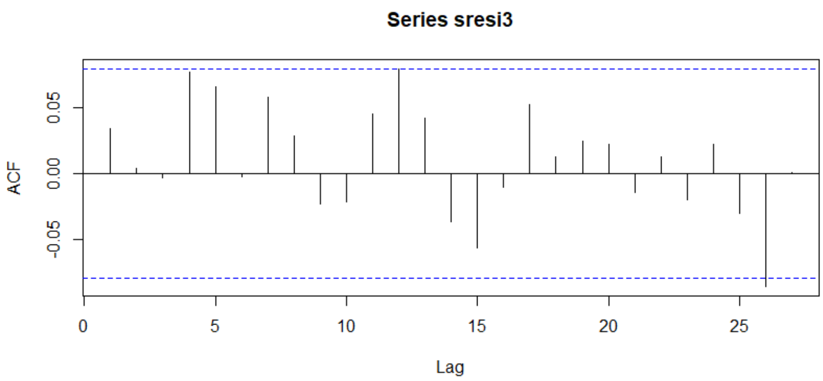
```
> Box.test(intb,lag=12,type="Ljung")

        Box-Ljung test

data:  intb
X-squared = 14.821, df = 12, p-value = 0.2514

> Box.test(intb^2,lag=12,type="Ljung")

        Box-Ljung test

data:  intb^2
X-squared = 171.8, df = 12, p-value < 2.2e-16
```

We can reject null hypothesis since the p value is low. This is an indication for ARCH effect.

Q2.b

Build a Gaussian GARCH model for the log returns. Perform model checking and write down the fitted model.

The fitted model is ‘garch(1,1)'



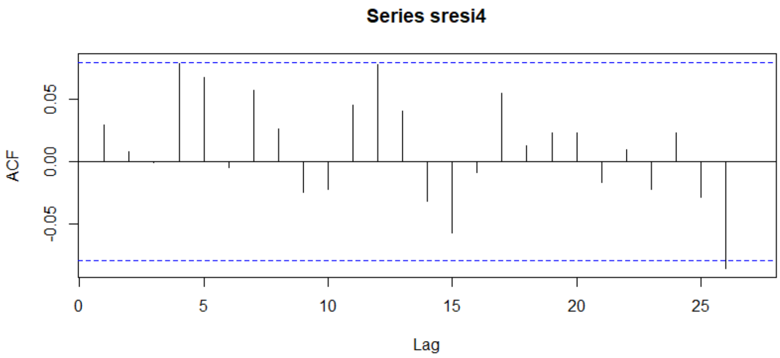
Performing model checking for the fitted model.

Q2.c

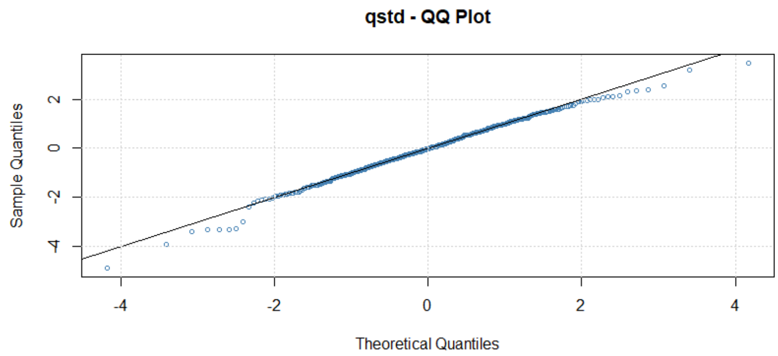
Build a GARCH model with Student-t innovations for the log returns. Perform model checking, obtain the QQ-plot of the standardized residuals, and write down the fitted model. Also, obtain 1- to 5-step ahead volatility predictions.

The fitted model is GARCH(1,1)

Performing Model checking for the fitted model.



Obtaining the QQ plot for standardized resiudals



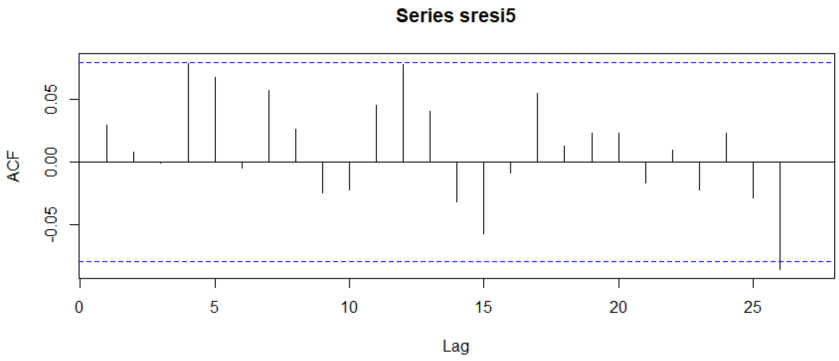
Obtaining 1 to 5 steps ahead volatility prediction

```
*------------------------------------*
*       GARCH Model Forecast         *
*------------------------------------*
Model: sGARCH
Horizon: 5
Roll Steps: 0
Out of Sample: 0

0-roll forecast [T0=1971-09-01 20:00:00]:
      Series   Sigma
T+1 0.01237 0.04590
T+2 0.01237 0.04707
T+3 0.01237 0.04813
T+4 0.01237 0.04909
T+5 0.01237 0.04997
```

Q3.a

Fit a TGARCH model to the series. Perform model checking and write down the fitted model. Is the leverage effect different from zero?

Performing model checking



The fitted model is garch(1,1)

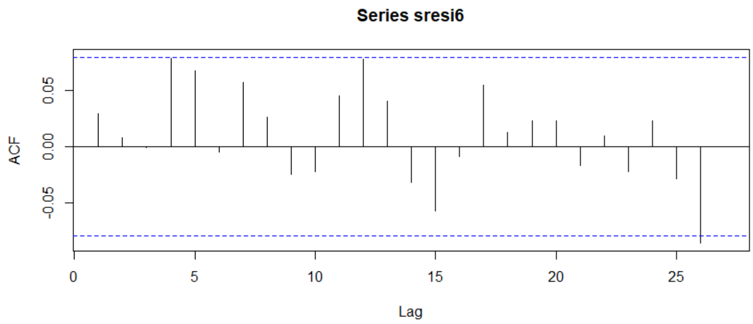
From the p-value of the gamma1 parameter, we can see that p value is high > 0.05. This means that the null hypothesis that it is not significant holds

This proves that the leverage effect is close to zero. The Weighted Ljung Box test for 12 lags give high p-values for Residuals and squared residuals. This shows that the model is good.

Q3.b

Fit a GARCH-M model to the series. Perform model checking and write down the fitted model. Is the risk premium significant? Why?

Performing Model checking



The fitted model is GARCH(1,1)

We can see that the archm value (ARCH volatility) in the summary has p value high. This proves the null hypothesis that the archm is statistically not significant

This means that the risk premium is not significant

The Weighted Ljung Box test for 12 lags give high pvalues for Residuals and squared residuals. This shows that the model is good