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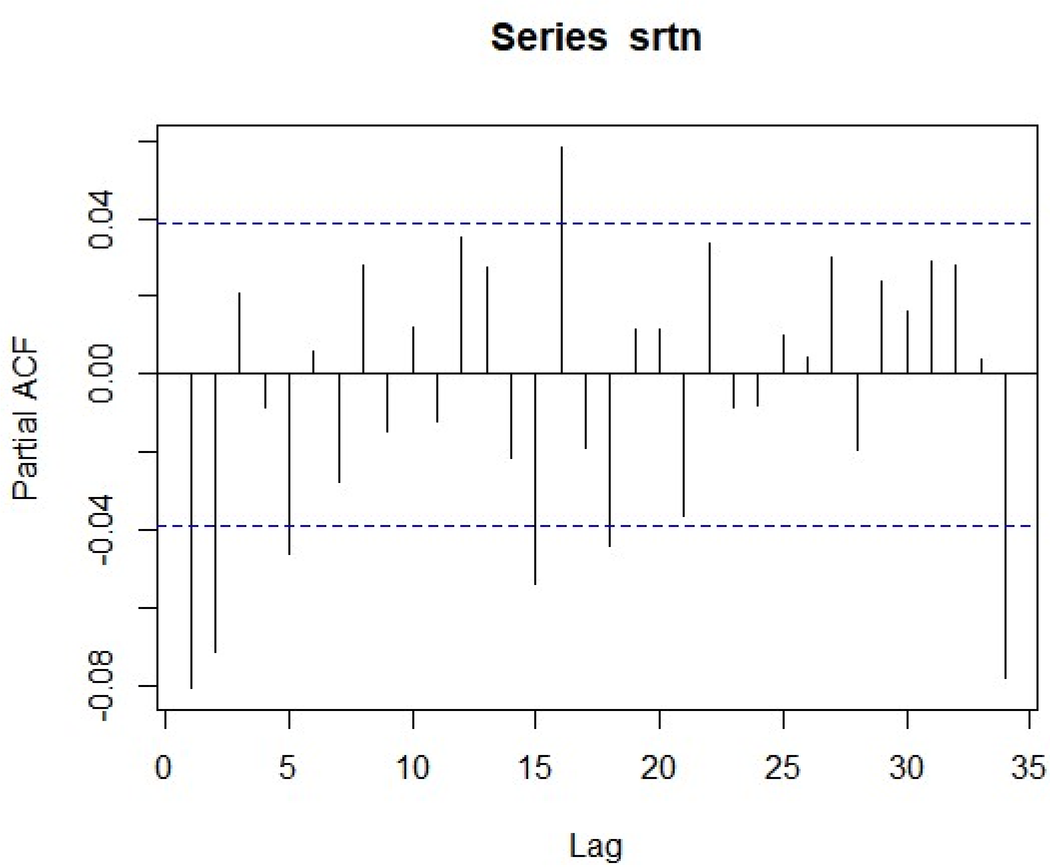
BIA-656 Advanced Data Analytics and Machine Learning

Assignment – 2

1(a)

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

Ans: The expected log return is not zero. Yes, there are serial correlation in the log returns as the image below tells about it.



After conducting the ARCH-LM Test we have following conclusions (Significance level = 0.05):

```
        ARCH LM-test; Null hypothesis: no ARCH effects
```

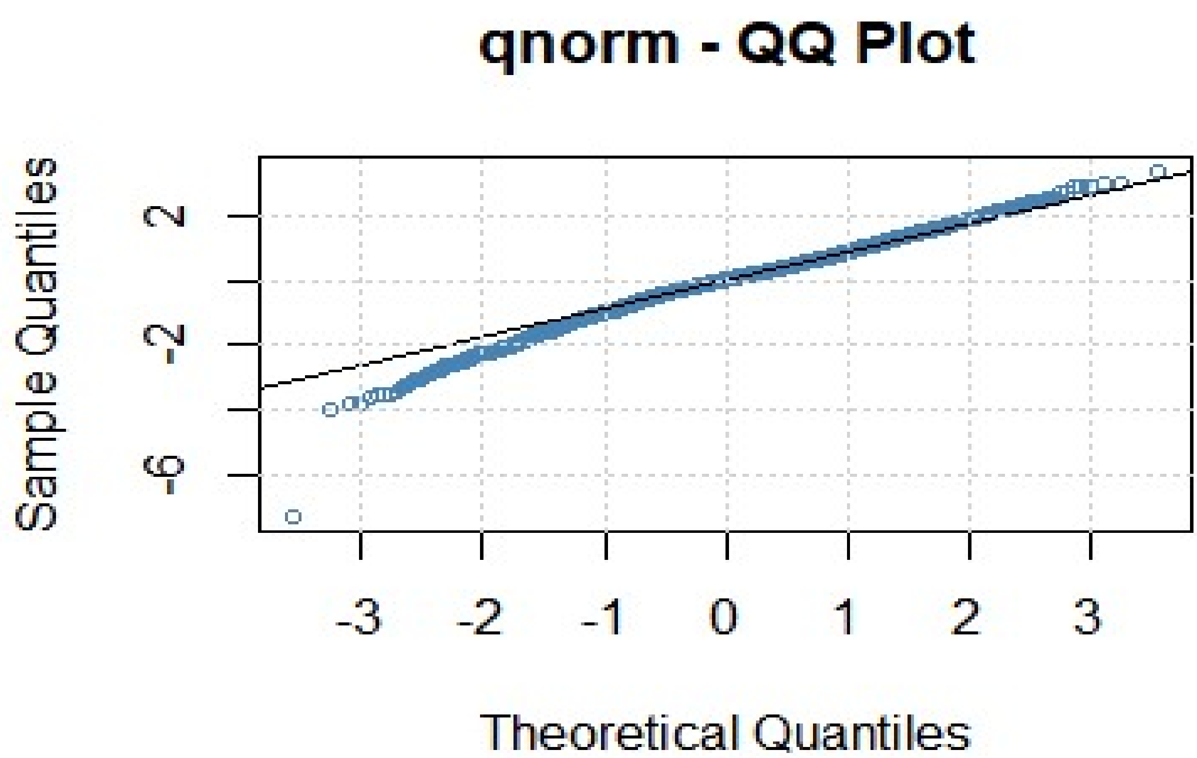
```
data:  srtn
Chi-squared = 784.76, df = 12, p-value < 2.2e-16
```

Since the p-value is lower than 0.05 the Null Hypothesis is rejected which tells us that, there is an ARCH-effect on the log returns.

1 (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).]

Ans: The fitted model was ARMA (1,1) + GARCH (2,1) and the QQ-plot of Standardized Residuals is as follows:



1 (c)

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

Ans: The fitted model was ARMA (1,1) + GARCH (2,1)

The model testing was done using the Ljung-box test

```
        Box-Ljung test

data:  sresidual
X-squared = 9.7969, df = 12, p-value = 0.6338
```

```
        Box-Ljung test

data:  sresidual^2
X-squared = 5.9847, df = 12, p-value = 0.9169
```

1 (d)

(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.

Ans: The fitted model is ARMA (1,1) + APARCH (1,1) with student-t innovations to the data

Prediction from 1 step to 5 steps ahead:

```
0-roll forecast [T0=1976-12-09 19:00:00]:
       Series    Sigma
T+1 0.0017632 0.02195
T+2 0.0011712 0.02178
T+3 0.0008559 0.02161
T+4 0.0006880 0.02144
T+5 0.0005986 0.02127
```

The volatility prediction of the model:

```
> sigma(p1) ### volatility prediction
    1976-12-09 19:00:00
T+1          0.02195131
T+2          0.02177878
T+3          0.02160853
T+4          0.02144051
T+5          0.02127471
```

2 (a)

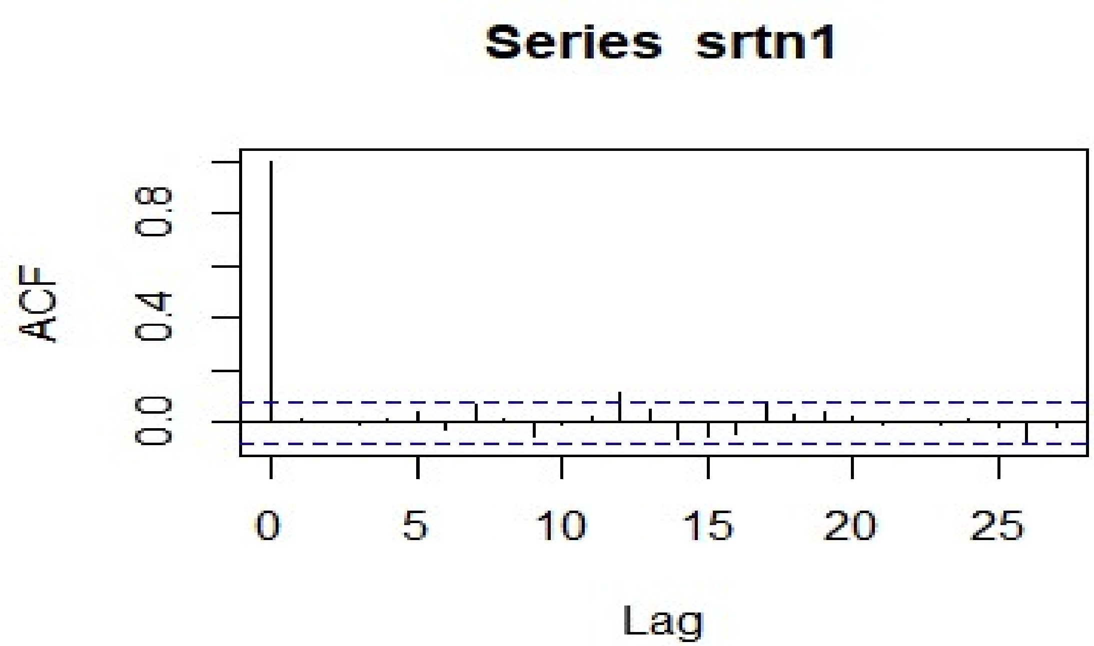
(a) Is the expected monthly log return zero? Is there any serial correlction in the log returns? Is there any ARCH effect in the log returns?

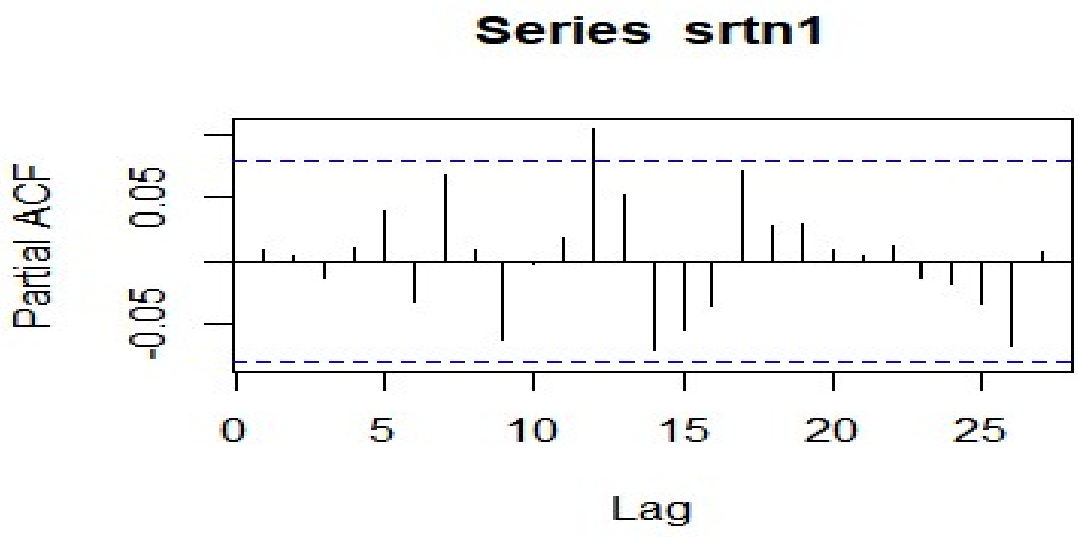
Ans:

```
        One Sample t-test
```

```
data:  srtn1
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 expected log return is not zero as we do the t-test. Yes, there are serial correlation in the log returns as the acf and pacf plots below tells about it.





The start of the series does not show any significant correlation but later there is a value greater than the significance line on lag 12 as seen above in both the graphs.

After conducting the ARCH-LM Test we have following conclusions (Significance level = 0.05):

```
	ARCH LM-test; Null hypothesis: no ARCH effects

data:  srtn1
Chi-squared = 94.125, df = 12, p-value = 7.812e-15
```

Since the p-value is lower than 0.05 the Null Hypothesis is rejected which tells us that, there is an ARCH-effect.

2 (b)

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

Ans: The fitted model is GARCH (1,1) and the result below are for the model-fit. High p-values results in a good model.

```
	Box-Ljung test

data:  standardresi
X-squared = 14.91, df = 12, p-value = 0.2464
```

```
        Box-Ljung test

data:  standardresi^2
X-squared = 12.834, df = 12, p-value = 0.3813
```

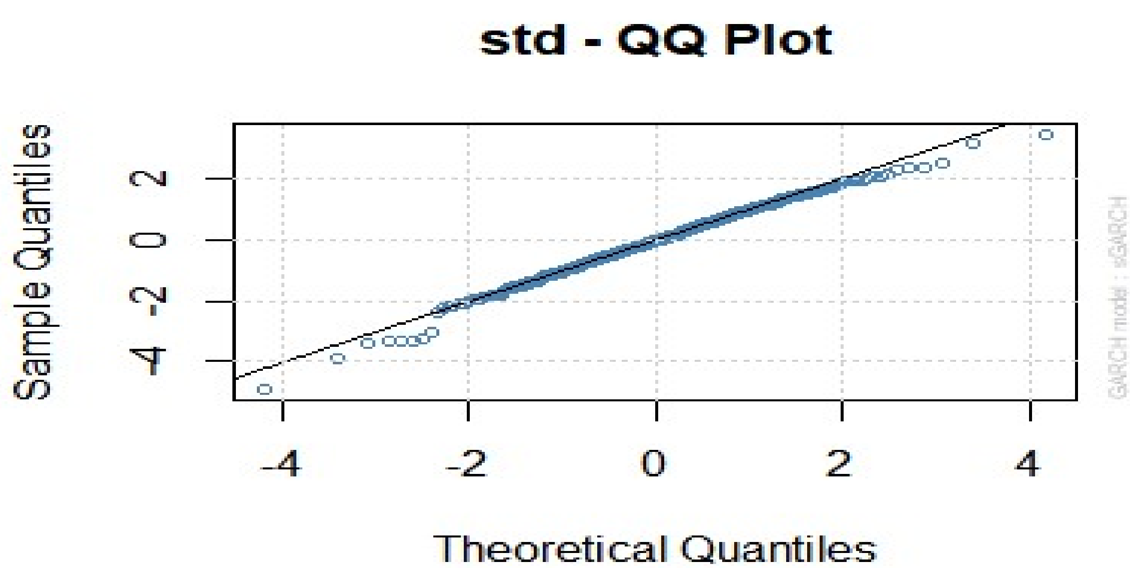
2 (c)

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.

Ans: The model fitted is GARCH (1,1) the output below gives us the volatility predictions of step-1 to step-5

```
sigma(predict1) ### volatility prediction
    1971-09-01 20:00:00
T+1          0.04481666
T+2          0.04594494
T+3          0.04698098
T+4          0.04793459
T+5          0.04881413
```

The QQ-Plot of the Standardized Residuals is given below:



3 (a)

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

Ans:

Since the Weighted Ljung-Box test for 12 lags gives high p-values for Standardized Residuals and Squared Residuals. This shows the model is good.

The results of model testing are shown below.

```
Ans:    Box-Ljung test

data:  sresiduals
X-squared = 14.91, df = 12, p-value = 0.2464
```

```
        Box-Ljung test

data:  sresiduals^2
X-squared = 12.834, df = 12, p-value = 0.3813
Joint Statistic:  0.9051
Individual Statistics:
mu     0.18686
omega  0.15567
alpha1 0.15927
beta1  0.16566
gamma1 0.05508
```

The leverage effect is shown by gamma(γ): It shows that the null hypothesis is not rejected as the value of the gamma1 is higher > 0.05 and the Null Hypotheses is accepted meaning that the leverage effect is very close to zero

3 (b)

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

Ans:

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error  t value Pr(>|t|)
mu      1.157266    0.228350   5.0680 0.000000
omega   3.031673    1.050280   2.8865 0.003895
alpha1  0.048810    0.030121   1.6205 0.105132
beta1   0.823399    0.037896  21.7278 0.000000
gamma1  0.080484    0.044828   1.7954 0.072589
```

After the running the model we get Beta value as 0.8233 which is significant. The beta is the measure of how risky an asset is compared to the overall market. The premium is adjusted for the risk of the asset.

An asset with zero risk and, therefore, zero beta, for example, would have the market risk premium canceled out. On the other hand, a highly risky asset, with a beta of 0.8, would take on almost the full premium.