FA542 - Homework #1

I pledge my honor that I have abided by the Stevens Honor System.

Sid Bhatia

2023-09-16

Problem #1

Import Libraries

```
# Load libraries for skewness, kurtosis, and plotting.
library(moments)
library(fBasics)
```

```
##
## Attaching package: 'fBasics'

## The following objects are masked from 'package:moments':
##
##     kurtosis, skewness
```

Data Retrieval

```
# Establish the directory for data.
data_directory <- "C:/Users/sbhatia2/My Drive/University/Academics/Semester V/FA542 - Time Series with

# Load in each dataset.
data_problem_1 <- read.table(paste(data_directory, 'HW1_1.txt', sep=""), header = T)
data_problem_2 <- read.table(paste(data_directory, 'HW1_2.txt', sep=""), header = T)
data_problem_3 <- read.table(paste(data_directory, 'HW1_3.txt', sep=""), header = T)
```

```

df_1 <- as.data.frame(data_problem_1)

# Create function that calculates the sample mean, standard deviation, skewness, kurtosis, minimum, and
compute_statistics <- function(returns)
{
  mean_val <- mean(returns)
  sd_val <- sd(returns)
  skewness_val <- skewness(returns)
  kurtosis_val <- kurtosis(returns)
  min_val <- min(returns)
  max_val <- max(returns)

  # Create a list to hold each sample statistic.
  result <- list(
    mean = mean_val,
```

```r
    standard_deviation = sd_val,
    skewness = skewness_val,
    kurtosis = kurtosis_val,
    minimum = min_val,
    maximum = max_val
  )

  return(result)
}

# Compute statistics for each simple return series.
CAT_statistics <- compute_statistics(df_1$RET)
VW_statistics <- compute_statistics(df_1$vwretd)
EW_statistics <- compute_statistics(df_1$ewretd)
SP_statistics <- compute_statistics(df_1$sprtrn)

CAT_statistics
```

1a)

```
## $mean
## [1] 0.0004945544
##
## $standard_deviation
## [1] 0.02092881
##
## $skewness
## [1] 0.2304287
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 5.029022
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.11434
##
## $maximum
## [1] 0.147229
```

```r
VW_statistics
```

```
## $mean
## [1] 0.0003372415
##
## $standard_deviation
## [1] 0.01320677
##
## $skewness
## [1] -0.1879131
## attr(,"method")
## [1] "moment"
##
```

```
## $kurtosis
## [1] 9.14096
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.089771
##
## $maximum
## [1] 0.114887
```

```
EW_statistics
```

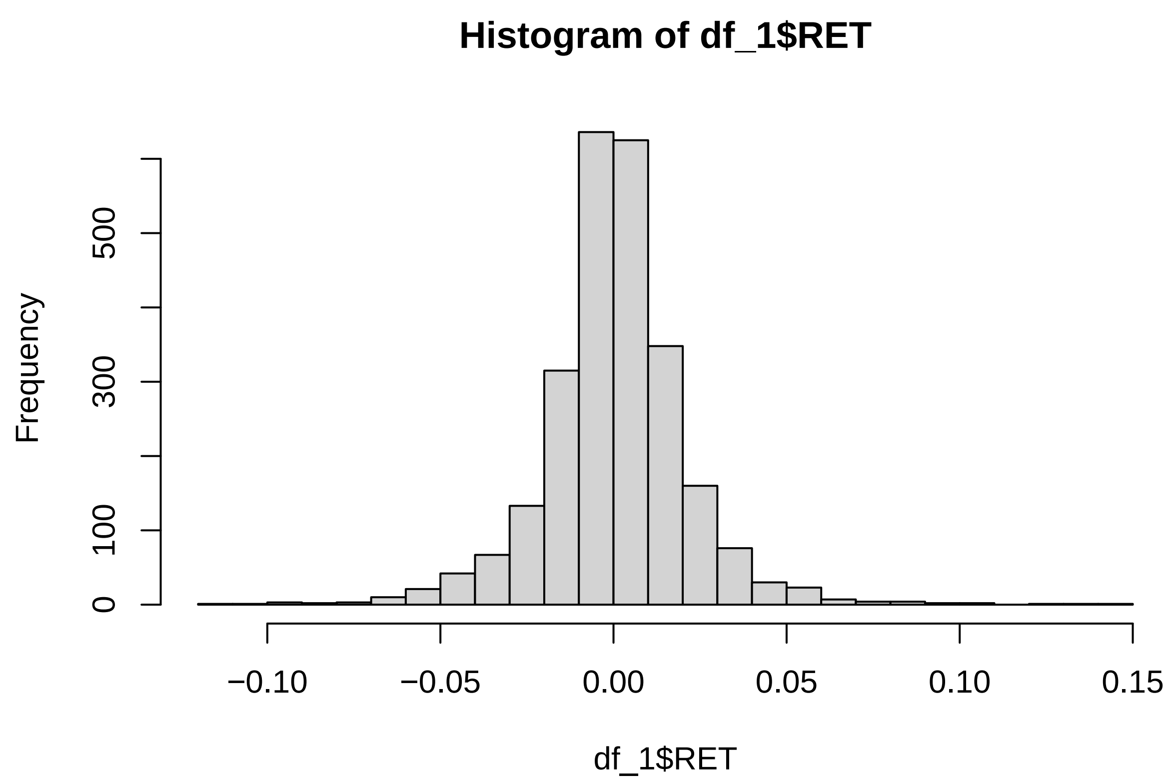
```
## $mean
## [1] 0.0004484198
##
## $standard_deviation
## [1] 0.01220235
##
## $skewness
## [1] -0.2246611
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 7.847616
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.07824
##
## $maximum
## [1] 0.107422
```

```
SP_statistics
```

```
## $mean
## [1] 0.0002682593
##
## $standard_deviation
## [1] 0.01317902
##
## $skewness
## [1] -0.08946497
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 10.14406
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.09035
##
```

```
## $maximum
## [1] 0.1158
```

```
# Display the empirical density distribution of simple returns for CAT.
hist(df_1$RET, nclass=30)
```



1b)

```
CAT_density_estimate <- density(df_1$RET)

# Obtain density estimate of simple returns for CAT.
CAT_density_estimate
```

```
##
## Call:
##  density.default(x = df_1$RET)
##
## Data: df_1$RET (2518 obs.);  Bandwidth 'bw' = 0.002757
##
##        x                   y
##  Min.   :-0.12261   Min.   : 0.00068
##  1st Qu.:-0.05308   1st Qu.: 0.06048
##  Median : 0.01644   Median : 0.22439
##  Mean   : 0.01644   Mean   : 3.59220
##  3rd Qu.: 0.08597   3rd Qu.: 2.89997
##  Max.   : 0.15550   Max.   :27.50193
```

```r
# Perform a Jarque-Bera test for normality of simple returns.
normalTest(df_1$RET, method = 'jb')
```

```
##
## Title:
##  Jarque - Bera Normalality Test
##
## Test Results:
##   STATISTIC:
##     X-squared: 2682.5018
##   P VALUE:
##     Asymptotic p Value: < 2.2e-16
```

At $\alpha = 0.05$ or at the 5% significance level, we reject the null hypothesis:

$$H_0 : \text{The simple returns of CAT are normally distributed}$$

since the p-value is less than 0.05.

1c) Log returns in relation to simple returns are defined as the following:

$$r_t = \ln(1 + R_t)$$

where r_t are log returns and R_t are simple returns.

```r
# Create function that transforms simple returns to log returns. log(...) is base e.
simple_to_log <- function(returns) {
  return(log(1 + returns))
}

# Convert simple returns to log using function.
CAT_log_returns <- simple_to_log(df_1$RET)
VW_log_returns <- simple_to_log(df_1$vwretd)
EW_log_returns <- simple_to_log(df_1$ewretd)
SP_log_returns <- simple_to_log(df_1$sprtrn)

# Use `compute_statistics()` function to calculate all relevant statistics.
CAT_log_statistics <- compute_statistics(CAT_log_returns)
VW_log_statistics <- compute_statistics(VW_log_returns)
EW_log_statistics <- compute_statistics(EW_log_returns)
SP_log_statistics <- compute_statistics(SP_log_returns)

CAT_log_statistics
```

```
## $mean
## [1] 0.0002760543
##
## $standard_deviation
## [1] 0.02089984
##
## $skewness
## [1] 0.01646851
## attr(,"method")
## [1] "moment"
##
```

```
## $kurtosis
## [1] 4.739097
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.1214221
##
## $maximum
## [1] 0.1373495
```

```
VW_log_statistics
```

```
## $mean
## [1] 0.0002498325
##
## $standard_deviation
## [1] 0.01323116
##
## $skewness
## [1] -0.4052208
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 9.027875
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.09405906
##
## $maximum
## [1] 0.1087531
```

```
EW_log_statistics
```

```
## $mean
## [1] 0.0003737711
##
## $standard_deviation
## [1] 0.01222235
##
## $skewness
## [1] -0.4018266
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 7.747635
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.08147039
##
```

```
## $maximum
## [1] 0.1020348
```

```r
SP_log_statistics
```

```
## $mean
## [1] 0.0001812947
##
## $standard_deviation
## [1] 0.01319662
##
## $skewness
## [1] -0.3254499
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 9.905808
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.09469537
##
## $maximum
## [1] 0.1095716
```

1d) To test the following the null hypothesis that the mean log returns are zero, we need to conduct a t-test:

$$H_0 : \text{Mean log returns are zero.}$$

$$H_0 : \text{Mean log returns do not equal zero.}$$

```r
t.test(x = CAT_log_returns, alternative = c('two.sided'), mu = 0)
```

```
##
##  One Sample t-test
##
## data:  CAT_log_returns
## t = 0.6628, df = 2517, p-value = 0.5075
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.0005406637  0.0010927723
## sample estimates:
##    mean of x
## 0.0002760543
```

```r
t.test(x = SP_log_returns, alternative = c('two.sided'), mu = 0)
```

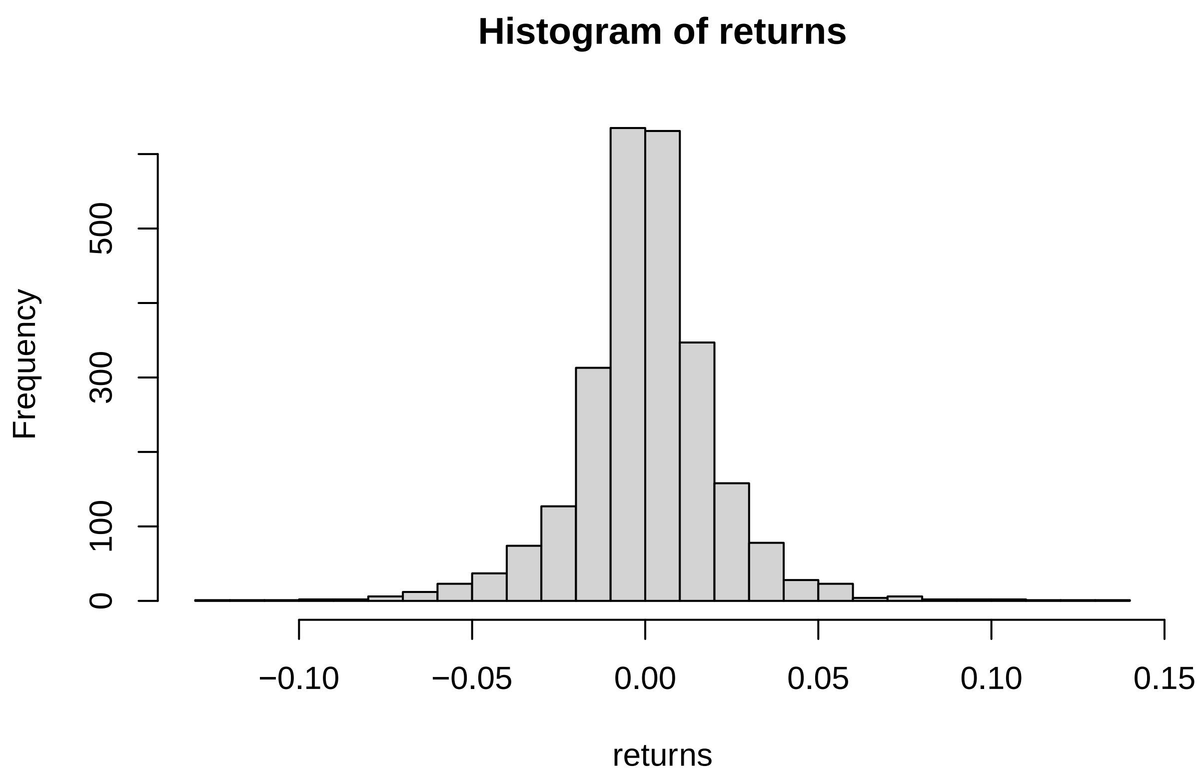
```
##
##  One Sample t-test
##
## data:  SP_log_returns
```

```
## t = 0.68937, df = 2517, p-value = 0.4907
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.0003343990  0.0006969884
## sample estimates:
##    mean of x
## 0.0001812947
```

As seen above, at the $\alpha = 0.05$ or the 5% significance level, we fail to reject the null hypothesis that the mean log returns for both CAT and S&P are zero since the p-values are well above 0.05.

```r
# Create function to retrieve empirical density distribution function and plot it.
density_plot <- function(returns)
{
  hist(returns, nclass=30)
  return(density(returns))
}

density_plot(CAT_log_returns)
```

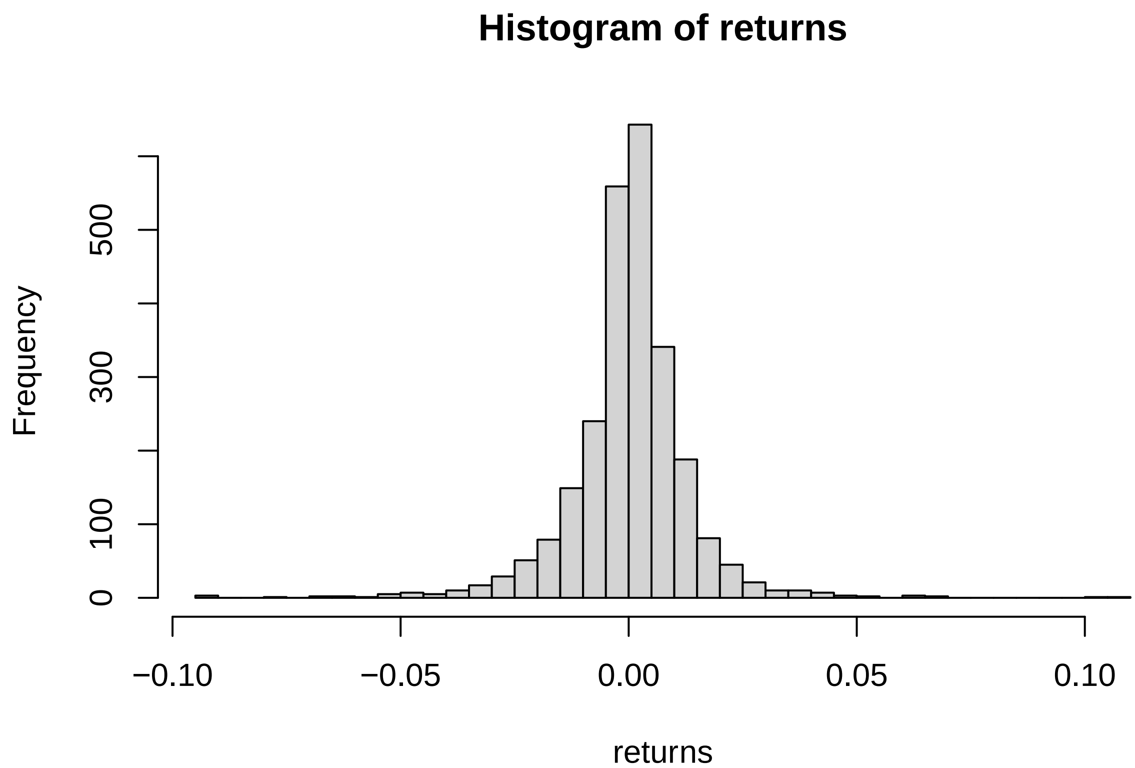


1e)

```
##
## Call:
##  density.default(x = returns)
##
## Data: returns (2518 obs.);   Bandwidth 'bw' = 0.002755
##
```

```
##        x                   y
##  Min.   :-0.129687   Min.   : 0.000663
##  1st Qu.:-0.060862   1st Qu.: 0.058853
##  Median : 0.007964   Median : 0.255782
##  Mean   : 0.007964   Mean   : 3.628847
##  3rd Qu.: 0.076789   3rd Qu.: 2.927840
##  Max.   : 0.145615   Max.   :27.510088
```

```
density_plot(SP_log_returns)
```




```
##
## Call:
##  density.default(x = returns)
##
## Data: returns (2518 obs.);   Bandwidth 'bw' = 0.001465
##
##        x                   y
##  Min.   :-0.099090   Min.   : 0.00000
##  1st Qu.:-0.045826   1st Qu.: 0.03419
##  Median : 0.007438   Median : 0.22369
##  Mean   : 0.007438   Mean   : 4.68935
##  3rd Qu.: 0.060702   3rd Qu.: 2.07732
##  Max.   : 0.113966   Max.   :55.73129
```

Problem #2

```
df_2 <- as.data.frame(data_problem_2)

compute_statistics(df_2$RET)
```

1a)

```
## $mean
## [1] 0.01034235
##
## $standard_deviation
## [1] 0.05538326
##
## $skewness
## [1] -0.2969337
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 3.220276
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.357041
##
## $maximum
## [1] 0.250931
```

```
compute_statistics(df_2$vwretd)
```

```
## $mean
## [1] 0.00887971
##
## $standard_deviation
## [1] 0.04403532
##
## $skewness
## [1] -0.522434
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 1.984566
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.225363
##
## $maximum
## [1] 0.165585
```

```
compute_statistics(df_2$ewretd)
```

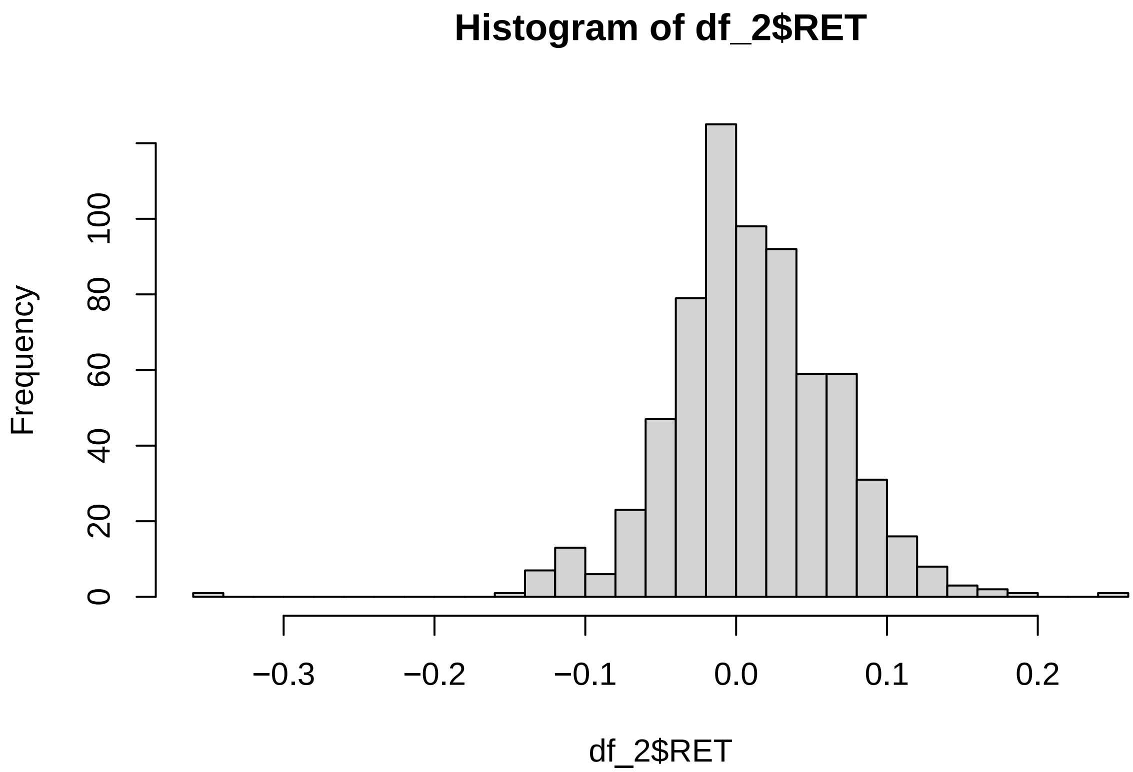
```
## $mean
```

```
## [1] 0.01136855
##
## $standard_deviation
## [1] 0.05554414
##
## $skewness
## [1] -0.1806713
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 2.919352
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.272248
##
## $maximum
## [1] 0.29926
```

```r
compute_statistics(df_2$sprtrn)
```

```
## $mean
## [1] 0.006359545
##
## $standard_deviation
## [1] 0.04251519
##
## $skewness
## [1] -0.4228902
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 1.813676
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.21763
##
## $maximum
## [1] 0.163047
```

```r
# Display the empirical density distribution of simple returns for PG.
hist(df_2$RET, nclass=30)
```



2b)

```r
PG_density_estimate <- density(df_2$RET)

# Obtain density estimate of simple returns for CAT.
PG_density_estimate
```

```
##
## Call:
##  density.default(x = df_2$RET)
##
## Data: df_2$RET (672 obs.);   Bandwidth 'bw' = 0.01197
##
##        x                  y
##  Min.   :-0.39296   Min.   :0.000000
##  1st Qu.:-0.22301   1st Qu.:0.004268
##  Median :-0.05305   Median :0.079307
##  Mean   :-0.05305   Mean   :1.469559
##  3rd Qu.: 0.11690   3rd Qu.:1.647373
##  Max.   : 0.28685   Max.   :8.486108
```

```r
# Perform a Jarque-Bera test for normality of simple returns.
normalTest(df_2$RET, method = 'jb')
```

```
##
## Title:
##  Jarque - Bera Normalality Test
##
## Test Results:
```

```
##   STATISTIC:
##     X-squared: 303.6398
##   P VALUE:
##     Asymptotic p Value: < 2.2e-16
```

At $\alpha = 0.05$ or at the 5% significance level, we reject the null hypothesis:

$$H_0 : \text{The simple returns of PG are normally distributed}$$

since the p-value is less than 0.05.

```r
compute_statistics(simple_to_log(df_2$RET))
```

2c)

```
## $mean
## [1] 0.008756106
##
## $standard_deviation
## [1] 0.05580647
##
## $skewness
## [1] -0.8330476
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 6.351822
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.4416743
##
## $maximum
## [1] 0.2238881
```

```r
compute_statistics(simple_to_log(df_2$vwretd))
```

```
## $mean
## [1] 0.007869959
##
## $standard_deviation
## [1] 0.04434013
##
## $skewness
## [1] -0.7880992
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 2.859168
## attr(,"method")
## [1] "excess"
##
## $minimum
```

```
## [1] -0.2553607
##
## $maximum
## [1] 0.1532231
```

```r
compute_statistics(simple_to_log(df_2$ewretd))
```

```
## $mean
## [1] 0.009774514
##
## $standard_deviation
## [1] 0.05564156
##
## $skewness
## [1] -0.5980258
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 3.53031
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.3177949
##
## $maximum
## [1] 0.2617949
```

```r
compute_statistics(simple_to_log(df_2$sprtrn))
```

```
## $mean
## [1] 0.005433599
##
## $standard_deviation
## [1] 0.0427925
##
## $skewness
## [1] -0.6717913
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 2.538153
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.2454275
##
## $maximum
## [1] 0.1510433
```

2d) To test the following the null hypothesis that the mean log returns are zero, we need to conduct a t-test:

$$H_0 : \text{Mean log returns are zero.}$$

$$H_0 : \text{Mean log returns do not equal zero.}$$

```r
t.test(x = simple_to_log(df_2$RET), alternative = c('two.sided'), mu = 0)
```

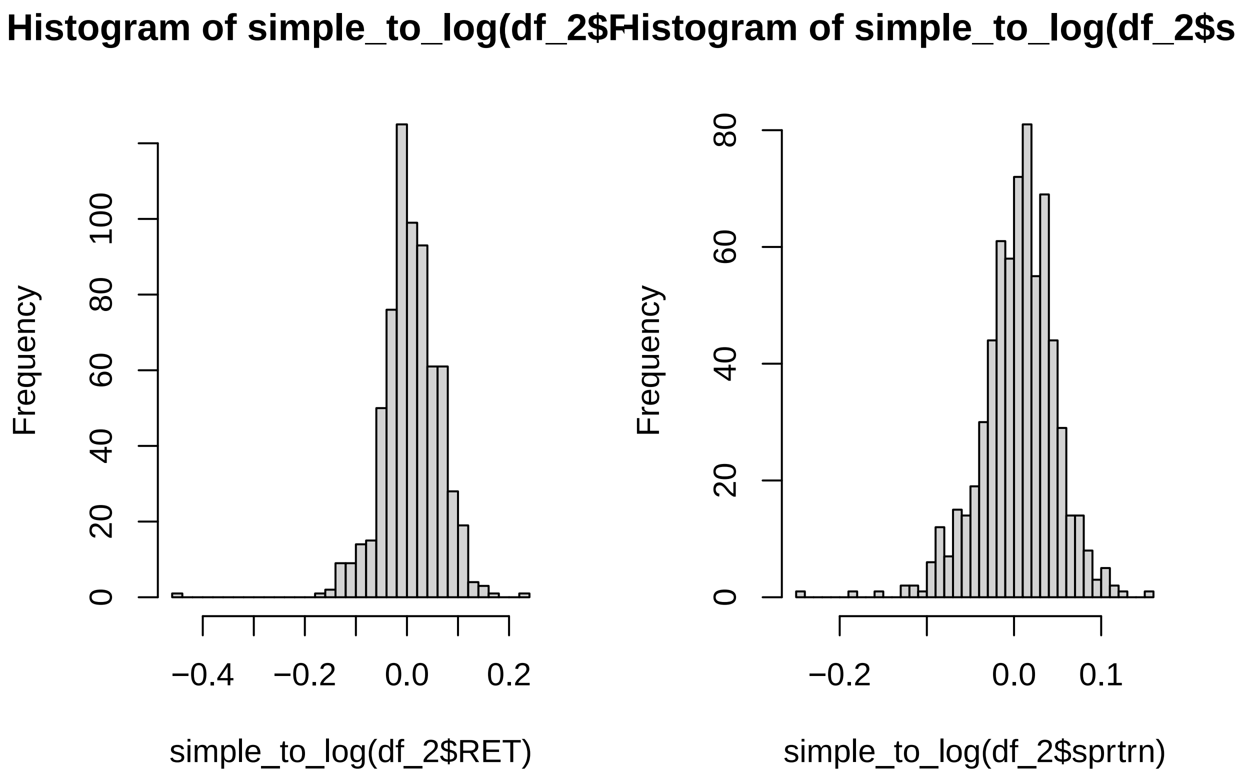
```
##
##  One Sample t-test
##
## data:  simple_to_log(df_2$RET)
## t = 4.0673, df = 671, p-value = 5.32e-05
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  0.004529107 0.012983105
## sample estimates:
##   mean of x
## 0.008756106
```

```r
t.test(x = simple_to_log(df_2$sprtrn), alternative = c('two.sided'), mu = 0)
```

```
##
##  One Sample t-test
##
## data:  simple_to_log(df_2$sprtrn)
## t = 3.2916, df = 671, p-value = 0.001048
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  0.002192330 0.008674869
## sample estimates:
##   mean of x
## 0.005433599
```

As seen above, at the $\alpha = 0.05$ or the 5% significance level, we reject the null hypothesis that the mean log returns for both CAT and S&P are zero since the p-values below 0.05.

```r
par(mfrow = c(1, 2))
hist(simple_to_log(df_2$RET), nclass=30)
hist(simple_to_log(df_2$sprtrn), nclass=30)
```



2e)

```
density(simple_to_log(df_2$RET))
```

```
##
## Call:
##  density.default(x = simple_to_log(df_2$RET))
##
## Data: simple_to_log(df_2$RET) (672 obs.);    Bandwidth 'bw' = 0.01184
##
##        x                 y
##  Min.   :-0.47720   Min.   :0.000000
##  1st Qu.:-0.29305   1st Qu.:0.000035
##  Median :-0.10889   Median :0.049018
##  Mean   :-0.10889   Mean   :1.356242
##  3rd Qu.: 0.07526   3rd Qu.:1.360786
##  Max.   : 0.25941   Max.   :8.473655
```

```
density(simple_to_log(df_2$sprtrn))
```

```
##
## Call:
##  density.default(x = simple_to_log(df_2$sprtrn))
##
## Data: simple_to_log(df_2$sprtrn) (672 obs.); Bandwidth 'bw' = 0.009471
##
##        x                 y
##  Min.   :-0.27384   Min.   : 0.000711
##  1st Qu.:-0.16052   1st Qu.: 0.050301
```

```
##  Median :-0.04719   Median : 0.352586
##  Mean   :-0.04719   Mean   : 2.203906
##  3rd Qu.: 0.06613   3rd Qu.: 2.879510
##  Max.   : 0.17946   Max.   :10.731430
```

Problem 3

```r
# Create function to calculate the confidence interval for a t-test.
t_confidence_interval <- function(alpha, n, mean, sd)
{
  # Define degrees of freedom as n - 1.
  df <- n - 1
  t_score <- qt(p = alpha/2, df)

  lower_bound <- mean - abs(t_score) * (sd / sqrt(n))
  upper_bound <- mean + abs(t_score) * (sd / sqrt(n))

  return(c(lower_bound, upper_bound))
}

# Define significance level alpha = 0.05 or 95% CI.
alpha <- 0.05

n <- length(CAT_log_returns)
CAT_mean <- CAT_log_statistics$mean
CAT_sd <- CAT_log_statistics$standard_deviation

t_confidence_interval(alpha, n, CAT_mean, CAT_sd)
```

3a)

```
## [1] -0.0005406637  0.0010927723
```

```r
t.test(CAT_log_returns)$conf.int
```

```
## [1] -0.0005406637  0.0010927723
## attr(,"conf.level")
## [1] 0.95
```

3b) We are testing the following:

$$H_0 : S(r) = 0$$

$$H_a : S(r) \neq 0$$

Where $S(r)$ is the skewness of the log returns.

The t-statistic for sample skewness is the following:

$$t = \frac{\hat{S}(r)}{\sqrt{6/n}}$$

```r
# Construct function to test whether the population skewness of returns is equal to 0 or not.
skewness_test <- function(returns)
{
  t_skewness <- skewness(returns) / sqrt(6 / length(returns))

  p_skewness <- 2 * (1 - pnorm(abs(t_skewness)))

  return(p_skewness)
}

skewness_test(CAT_log_returns)
```

```
## [1] 0.7358379
## attr(,"method")
## [1] "moment"
```

Since the p-value is greater than 0.05, we fail to reject the null hypothesis at the 5% significance level.

3c) We are testing the following:

$$H_0 : K = 3$$
$$H_a : K \neq 3$$

where K denotes the kurtosis of the returns (excess kurtosis = 0).

The t-statistic for kurtosis of the log returns is the following:

$$t = \frac{\hat{K}(r) - 3}{\sqrt{24/n}}$$

```r
# Construct function to test whether the population kurtosis of returns is equal to 3 or not (excess ku
kurtosis_test <- function(returns)
{
  # Since the kurtosis function already computes excess log returns, we do not have to subtract by thre
  t_kurtosis <- (kurtosis(returns)) / sqrt(24 / length(returns))

  p_kurtosis <- 2 * (1 - pnorm(abs(t_kurtosis)))

  return(p_kurtosis)
}

kurtosis_test(CAT_log_returns)
```

```
## [1] 0
## attr(,"method")
## [1] "excess"
```

Since the p-value is less than 0.05, we reject the null hypothesis at the 5% significance level.

Problem 4

4a) We are testing the following:

$$H_0 : S(r) = 0$$

$$H_a : S(r) \neq 0$$

Where $S(r)$ is the skewness of the daily log returns for S&P from 01/03/2007 to 12/31/2016.

```
skewness_test(SP_log_returns)
```

```
## [1] 2.609224e-11
## attr(,"method")
## [1] "moment"
```

Since the p-value is less than 0.05, we reject the null hypothesis at the 5% significance level that the log returns are symmetric with respect to its mean.

4b) We are testing the following:

$$H_0 : K = 3$$

$$H_a : K \neq 3$$

where K denotes the kurtosis of the returns (excess kurtosis = 0).

```
kurtosis_test(SP_log_returns)
```

```
## [1] 0
## attr(,"method")
## [1] "excess"
```

Since the p-value is less than 0.05, we reject the null hypothesis at the 5% significance level that the excess kurtosis of the log returns is zero.

4c) We are constructing a 95% CI for the expected daily log return (mean of log return) of the S&P.

We will use our previously coded function:

```
t_confidence_interval(0.05, length(SP_log_returns), mean(SP_log_returns), sd(SP_log_returns))
```

```
## [1] -0.0003343990  0.0006969884
```

```
t.test(SP_log_returns)$conf.int
```

```
## [1] -0.0003343990  0.0006969884
## attr(,"conf.level")
## [1] 0.95
```

Problem 5

5a) Log returns are defined as the following:

$$r_t = \ln\left(\frac{S_t}{S_{t-1}}\right) = \ln(S_t) - \ln(S_{t-1})$$

```
head(data_problem_3)
```

```
##   year mon day   euro
## 1 2005   1   3 1.3476
## 2 2005   1   4 1.3295
## 3 2005   1   5 1.3292
```

```
## 4 2005   1   6 1.3187
## 5 2005   1   7 1.3062
## 6 2005   1  10 1.3109
```

```
# Compute log returns of the Dollar-Euro exchange rate.
euro_log_returns <- diff(log(data_problem_3$euro))

head(euro_log_returns)
```

```
## [1] -0.0135223008 -0.0002256742 -0.0079308547 -0.0095242443  0.0035917657
## [6]  0.0039588936
```

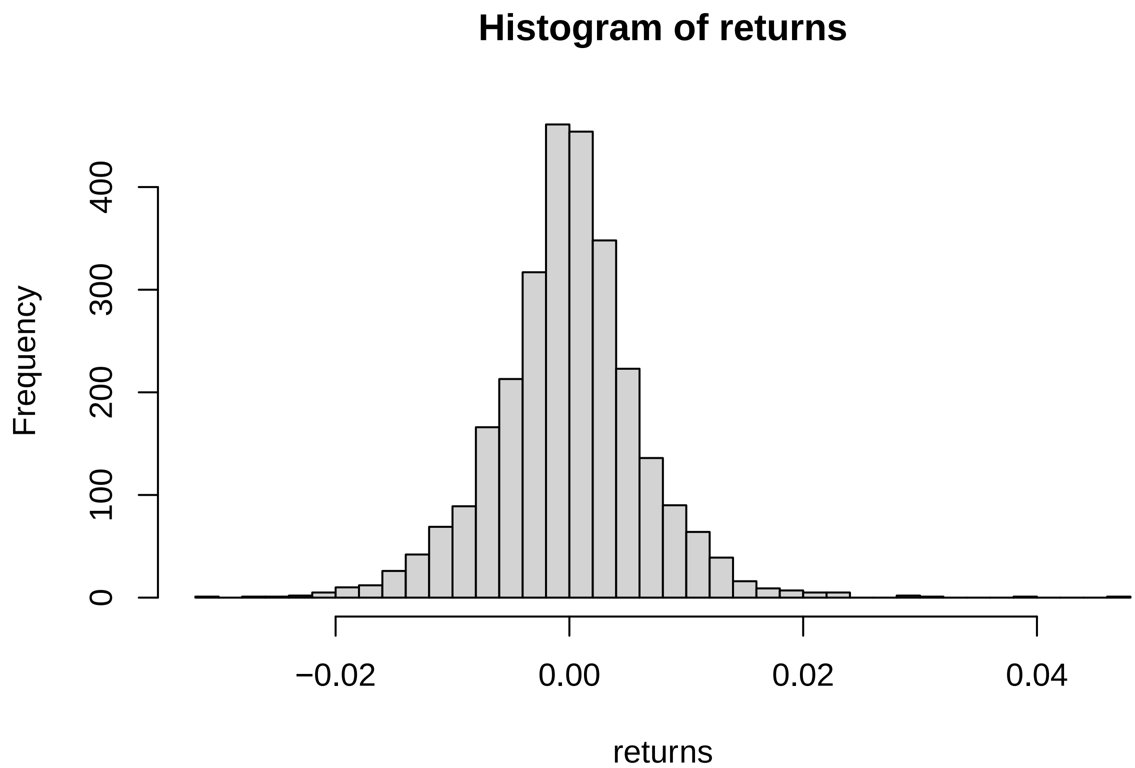
5b) We will compute the sample mean, standard deviation, skewness, excess kurtosis, minimum, and maximum of the log returns of the exchange rate using the previously coded function `density_plot`.

```
compute_statistics(euro_log_returns)
```

```
## $mean
## [1] -6.278971e-05
##
## $standard_deviation
## [1] 0.006362766
##
## $skewness
## [1] 0.2061161
## attr(,"method")
## [1] "moment"
##
## $kurtosis
## [1] 2.890412
## attr(,"method")
## [1] "excess"
##
## $minimum
## [1] -0.03003101
##
## $maximum
## [1] 0.04620792
```

5c) We will obtain the density plot using the previously coded function, `density_plot`.

```
density_plot(euro_log_returns)
```




```
##
## Call:
##  density.default(x = returns)
##
## Data: returns (2816 obs.);   Bandwidth 'bw' = 0.0009258
##
##        x                   y
##  Min.   :-0.032808   Min.   : 0.00002
##  1st Qu.:-0.012360   1st Qu.: 0.11177
##  Median : 0.008088   Median : 1.12271
##  Mean   : 0.008088   Mean   :12.21392
##  3rd Qu.: 0.028537   3rd Qu.:12.52048
##  Max.   : 0.048985   Max.   :85.42477
```

5d) We will test the following:

$$H_0 : \mu = 0$$

$$H_a : \mu \neq 0$$

Where μ is the mean of the daily log return of the Dollar-Euro exchange rate.

```
t.test(euro_log_returns)$p.value
```

```
## [1] 0.6005483
```

Since the p-value is greater than 0.05, we fail to reject the null hypothesis that the mean of the daily log return of the Dollar-Euro exchange rate is zero at the 5% significance level.

5e) We will perform the Jarque-Bera test for normality which states the following:

$$H_0 : S(r) = 0 = K(r)$$

Where $S(r)$ denotes the skewness of the distribution and $K(r)$ denotes the excess kurtosis.

```
normalTest(euro_log_returns, method = 'jb')
```

```
##
## Title:
##  Jarque - Bera Normalality Test
##
## Test Results:
##   STATISTIC:
##     X-squared: 1003.0606
##   P VALUE:
##     Asymptotic p Value: < 2.2e-16
```

Since the p-value is less than 0.05, we reject the null hypothesis that the skewness and excess kurtosis are zero at the 5% significance level. As such, the log returns are most likely not normally distributed since samples from a normal distribution have an expected skewness of 0 and an expected excess kurtosis of 0.