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QUESTION 1

#1a. IMPORT DATA INTO R#

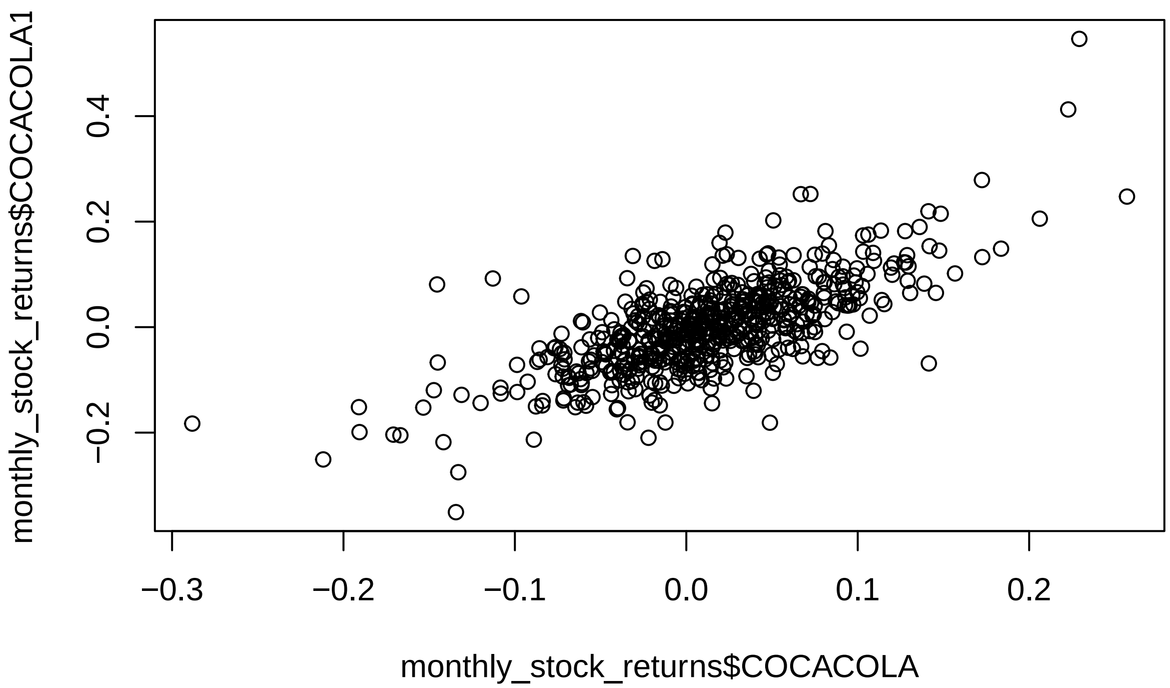
```
library(readxl)
monthly_stock_returns <- read_excel("Documents/4328 - Applied Financial Econometrics/Assignment/Assignme
```

#1b. TRANSFORM THE SIMPLE RETURNS INTO LOG RETURNS#

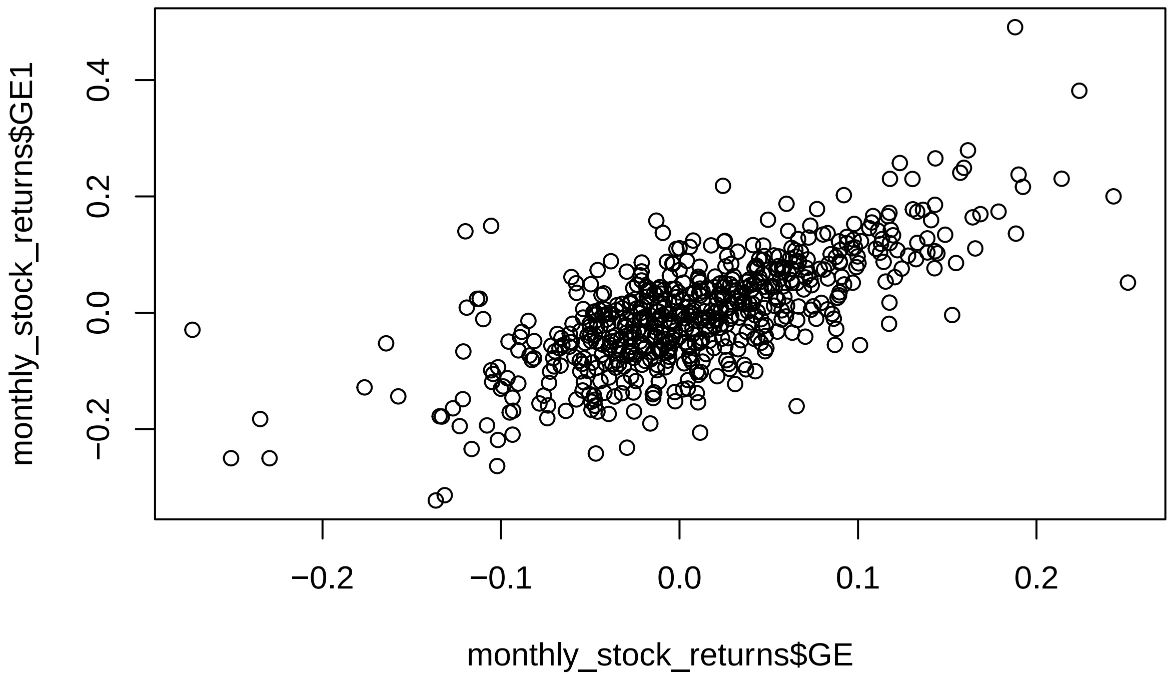
```
monthly_stock_returns$COCACOLA1 <- c(0, diff(log(1+monthly_stock_returns$COCACOLA), lag = 1))
monthly_stock_returns$GE1 <- c(0, diff(log(1+monthly_stock_returns$GE), lag = 1))
monthly_stock_returns$IBM1 <- c(0, diff(log(1+monthly_stock_returns$IBM), lag = 1))
monthly_stock_returns$VWRET1 <- c(0, diff(log(1+monthly_stock_returns$VWRET), lag = 1))
monthly_stock_returns$EWRET1 <- c(0, diff(log(1+monthly_stock_returns$EWRET), lag = 1))
```

#1c. PLOT THE SIMPLE AND LOG RETURNS FOR ALL THE SERIES#

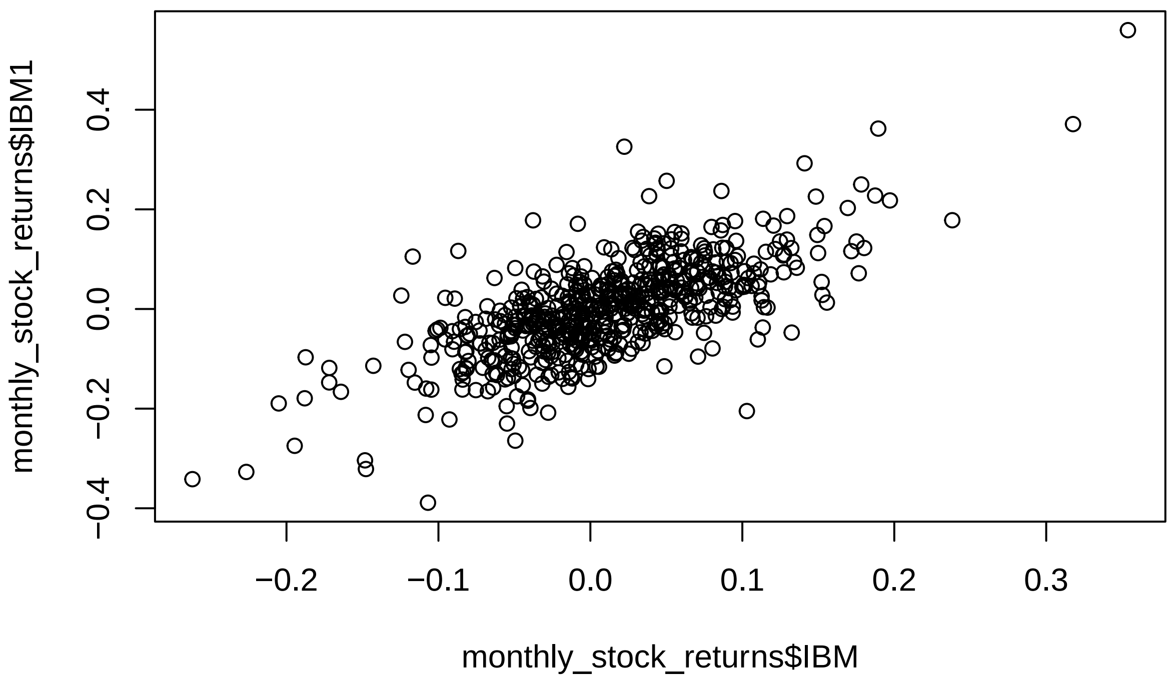
```
plot(monthly_stock_returns$COCACOLA, monthly_stock_returns$COCACOLA1)
```




```
plot(monthly_stock_returns$GE, monthly_stock_returns$GE1)
```

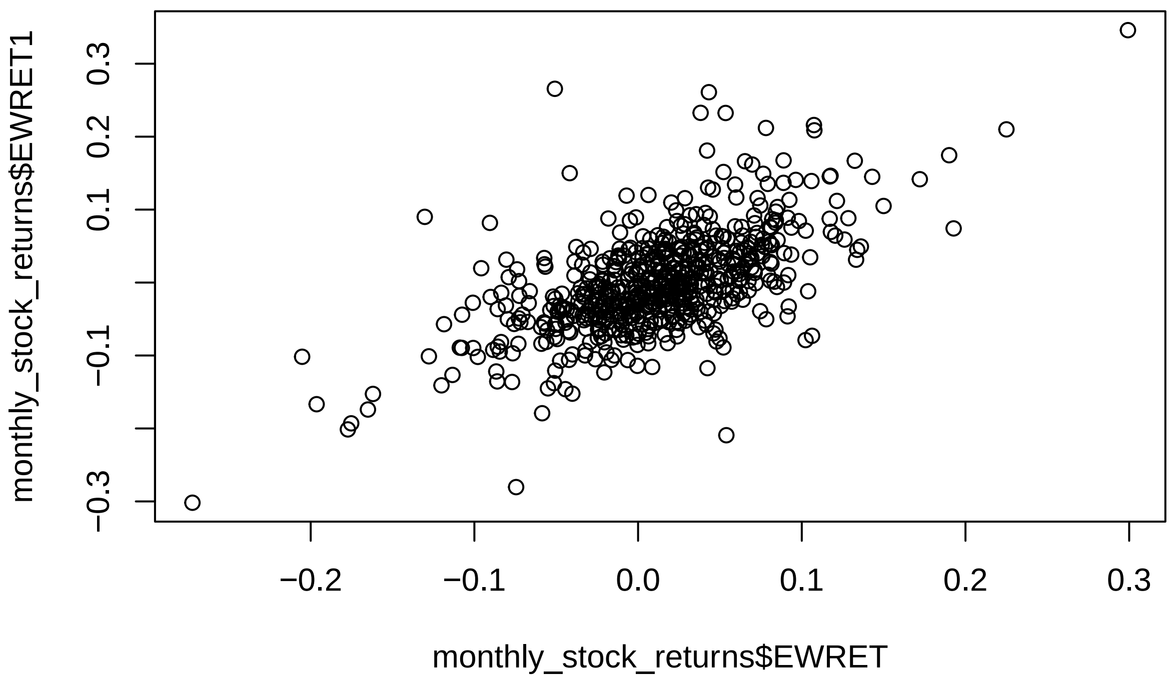



```
plot(monthly_stock_returns$IBM, monthly_stock_returns$IBM1)
```



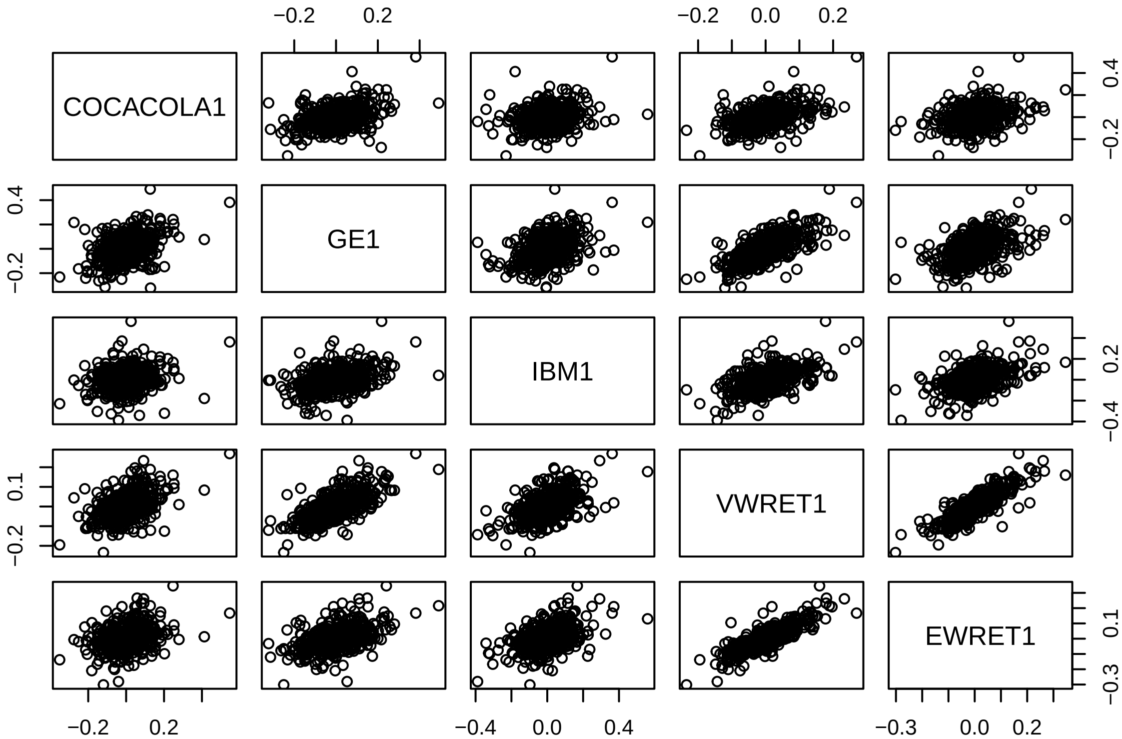

```
plot(monthly_stock_returns$VWRET, monthly_stock_returns$VWRET1)
```


```
plot(monthly_stock_returns$EWRET, monthly_stock_returns$EWRET1)
```



#1d. SCATTERPLOT OF ALL THE LOG RETURNS SERIES#

```
monthly_stock_returns_log <- monthly_stock_returns[,c(7:11)]
plot(monthly_stock_returns_log)
```



#1e. SAMPLE MEAN, VARIANCE, SKEWNESS, EXCESS KURTOSIS, MINIMUM AND MAXIMUM OF LOG RETURNS#

```
library(moments)
COCACOLA_log <- c(mean(monthly_stock_returns$COCACOLA1), var(monthly_stock_returns$COCACOLA1), skewness
GE_log <- c(mean(monthly_stock_returns$GE1), var(monthly_stock_returns$GE1), skewness(monthly_stock_retu
IBM_log <- c(mean(monthly_stock_returns$IBM1), var(monthly_stock_returns$IBM1), skewness(monthly_stock_r
VWRET_log <- c(mean(monthly_stock_returns$VWRET1), var(monthly_stock_returns$VWRET1), skewness(monthly_s
EWRET_log <- c(mean(monthly_stock_returns$EWRET1), var(monthly_stock_returns$EWRET1), skewness(monthly_s

summary_df <- data.frame(COCACOLA_log, GE_log, IBM_log, VWRET_log, EWRET_log)
row.names(summary_df) <- c("MEAN", "VARIANCE", "SKEWNESS", "EXCESS KURTOSIS", "MINIMUM", "MAXIMUM")
summary_df
```

```
##                  COCACOLA_log        GE_log       IBM_log     VWRET_log
## MEAN            -2.899334e-05  0.0001845287 -0.0001788354 -7.968444e-05
## VARIANCE         7.497612e-03  0.0094675802  0.0095485492  3.755511e-03
## SKEWNESS         5.483142e-01  0.2465962382  0.2450713625  4.192380e-01
## EXCESS KURTOSIS  6.766125e+00  4.4406753573  5.9861713945  4.352286e+00
## MINIMUM         -3.507570e-01 -0.3227354940 -0.3888763005 -2.343679e-01
## MAXIMUM          5.463954e-01  0.4909426327  0.5596835625  2.694401e-01
##                     EWRET_log
## MEAN            -0.0001513314
## VARIANCE         0.0050531098
## SKEWNESS         0.4110876520
## EXCESS KURTOSIS  5.5793209361
## MINIMUM         -0.3017915746
## MAXIMUM          0.3459855034
```

#1f. TEST OF STATISTICAL DIFFERENCE OF SAMPLE MEAN, SKEWNESS AND EXCESS KURTOSIS OF LOG RETURNS FROM ZERO AT 5% SIGNIFICANCE LEVEL #

SAMPLE MEAN TEST

```r
mean_COCACOLA1 <- t.test(monthly_stock_returns_log$COCACOLA1)
mean_GE1 <- t.test(monthly_stock_returns_log$GE1)
mean_IBM1 <- t.test(monthly_stock_returns_log$IBM1)
mean_VWRET1 <- t.test(monthly_stock_returns_log$VWRET1)
mean_EWRET1 <- t.test(monthly_stock_returns_log$EWRET1)

mean_COCACOLA1
```

```
##
##  One Sample t-test
##
## data:  monthly_stock_returns_log$COCACOLA1
## t = -0.0081194, df = 587, p-value = 0.9935
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.007042211  0.006984224
## sample estimates:
##     mean of x
## -2.899334e-05
```

```r
mean_GE1
```

```
##
##  One Sample t-test
##
## data:  monthly_stock_returns_log$GE1
## t = 0.045987, df = 587, p-value = 0.9633
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.007696362  0.008065419
## sample estimates:
##    mean of x
## 0.0001845287
```

```r
mean_IBM1
```

```
##
##  One Sample t-test
##
## data:  monthly_stock_returns_log$IBM1
## t = -0.044379, df = 587, p-value = 0.9646
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.008093354  0.007735683
## sample estimates:
##     mean of x
## -0.0001788354
```

```r
mean_VWRET1
```

```
##
##  One Sample t-test
##
## data:  monthly_stock_returns_log$VWRET1
## t = -0.03153, df = 587, p-value = 0.9749
```

```
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.005043211  0.004883842
## sample estimates:
##     mean of x
## -7.968444e-05
```

```
mean_EWRET1
```

```
##
##  One Sample t-test
##
## data:  monthly_stock_returns_log$EWRET1
## t = -0.051622, df = 587, p-value = 0.9588
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.005908848  0.005606185
## sample estimates:
##     mean of x
## -0.0001513314
```

Answer: Since the p-value > 5%, at 5% significance level we do not reject the null hypothesis that the sample means of the log returns are statistically equL zero. This means that the true means of the log returns of the variables (COCACOLA, IBM, GE, VWRET AND EWRET) are equal to zero.

SKEWNESS TEST

```
skew_COCACOLA1 <- skewness(monthly_stock_returns_log$COCACOLA1)/sqrt(6/588)
skew_GE1 <- skewness(monthly_stock_returns_log$GE1)/sqrt(6/588)
skew_IBM1 <- skewness(monthly_stock_returns_log$IBM1)/sqrt(6/588)
skew_VWRET1 <- skewness(monthly_stock_returns_log$VWRET1)/sqrt(6/588)
skew_EWRET1 <- skewness(monthly_stock_returns_log$EWRET1)/sqrt(6/588)

skew_COCACOLA1
```

```
## [1] 5.428033
```

```
skew_GE1
```

```
## [1] 2.441178
```

```
skew_IBM1
```

```
## [1] 2.426083
```

```
skew_VWRET1
```

```
## [1] 4.150244
```

```
skew_EWRET1
```

```
## [1] 4.06956
```

Answer: Since the absolute value from the result of the skewness test > 1.96, at 5% significance level we reject the null hypothesis that the skewness of the log returns are equal to zero. This means that the log returns of the variables (COCACOLA, IBM, GE, VWRET AND EWRET) do not follow normal distribution.

EXCESS KURTOSIS TEST

```
kurtosis_COCACOLA1 <- (kurtosis(monthly_stock_returns_log$COCACOLA1)-3)/sqrt(24/588)
kurtosis_GE1 <- (kurtosis(monthly_stock_returns_log$GE1)-3)/sqrt(24/588)
kurtosis_IBM1 <- (kurtosis(monthly_stock_returns_log$IBM1)-3)/sqrt(24/588)
kurtosis_VWRET1 <- (kurtosis(monthly_stock_returns_log$VWRET1)-3)/sqrt(24/588)
kurtosis_EWRET1 <- (kurtosis(monthly_stock_returns_log$EWRET1)-3)/sqrt(24/588)

kurtosis_COCACOLA1
```

```
## [1] 18.64137
```

```
kurtosis_GE1
```

```
## [1] 7.130979
```

```
kurtosis_IBM1
```

```
## [1] 14.78079
```

```
kurtosis_VWRET1
```

```
## [1] 6.693475
```

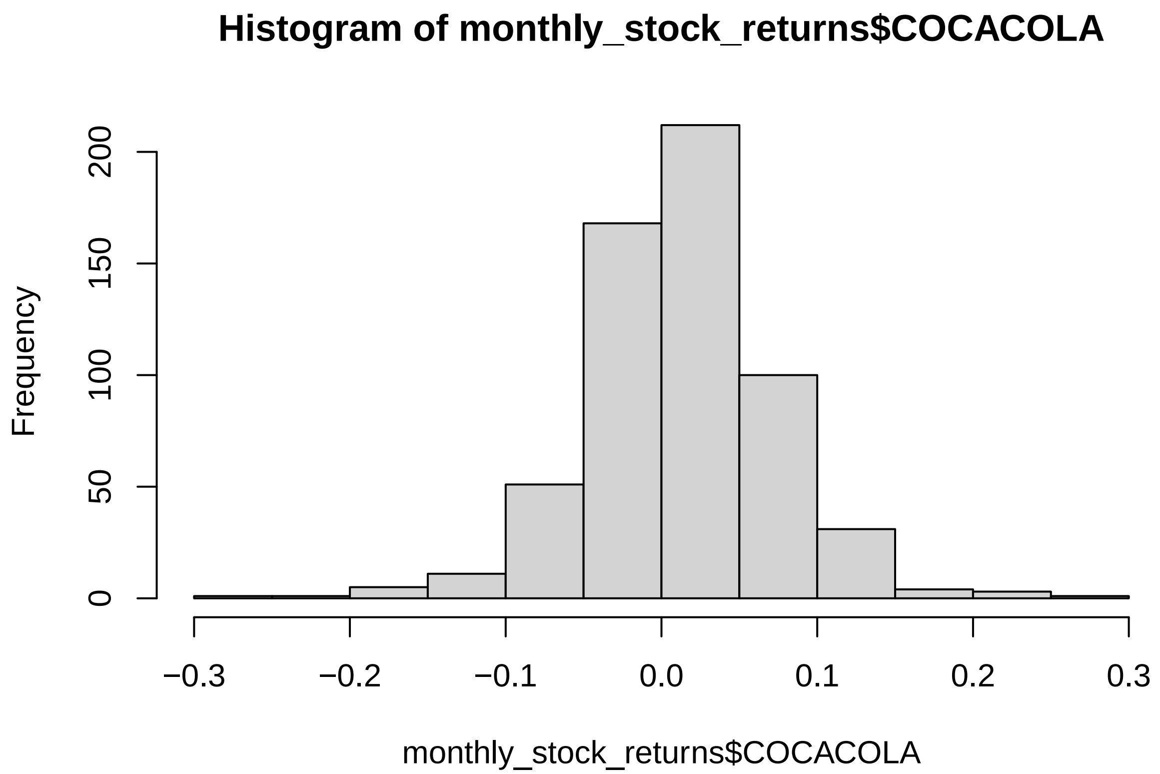
```
kurtosis_EWRET1
```

```
## [1] 12.76699
```

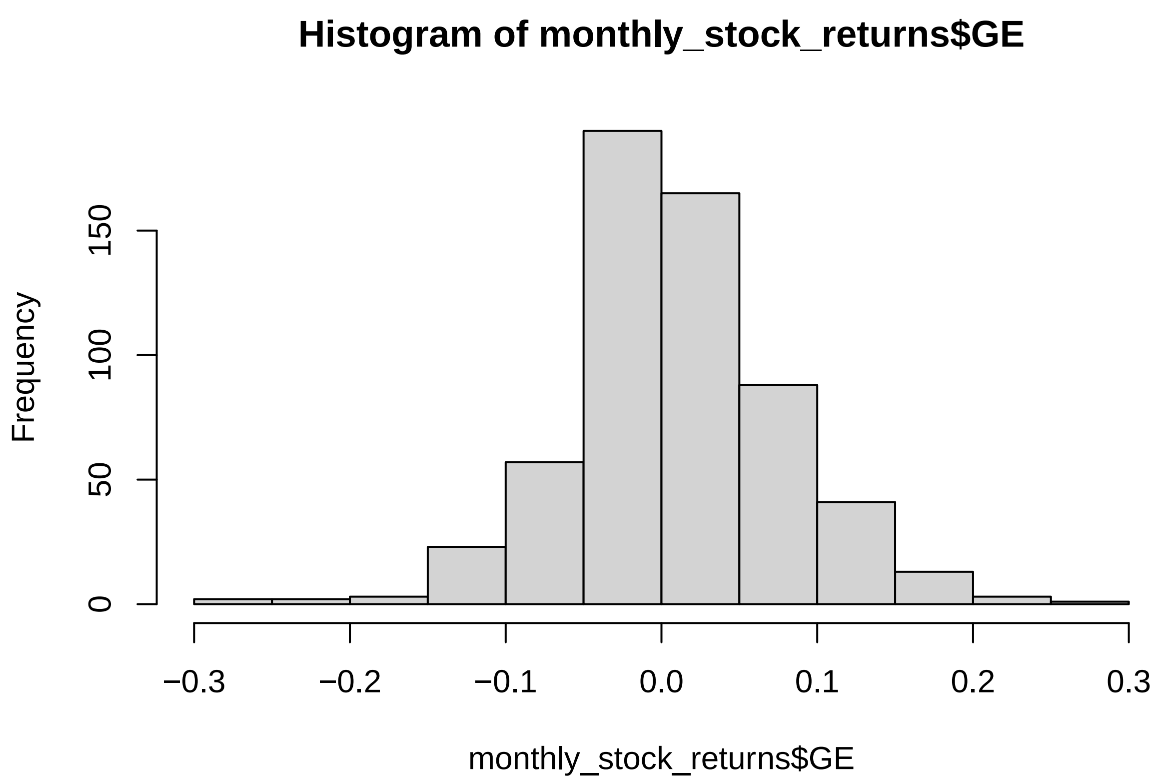
Answer: Since the value from the result of the kurtosis test > 1.96, at 5% significance level we reject the null hypothesis that the kurtosis of the log returns are equal to zero. This means that the log returns of the variables (COCACOLA, IBM, GE, VWRET AND EWRET) do not follow normal distribution.

#1g. HISTOGRAM OF RETURNS IN COMPARISON TO NORMAL AND STUDENT DISTRIBUTIONS #

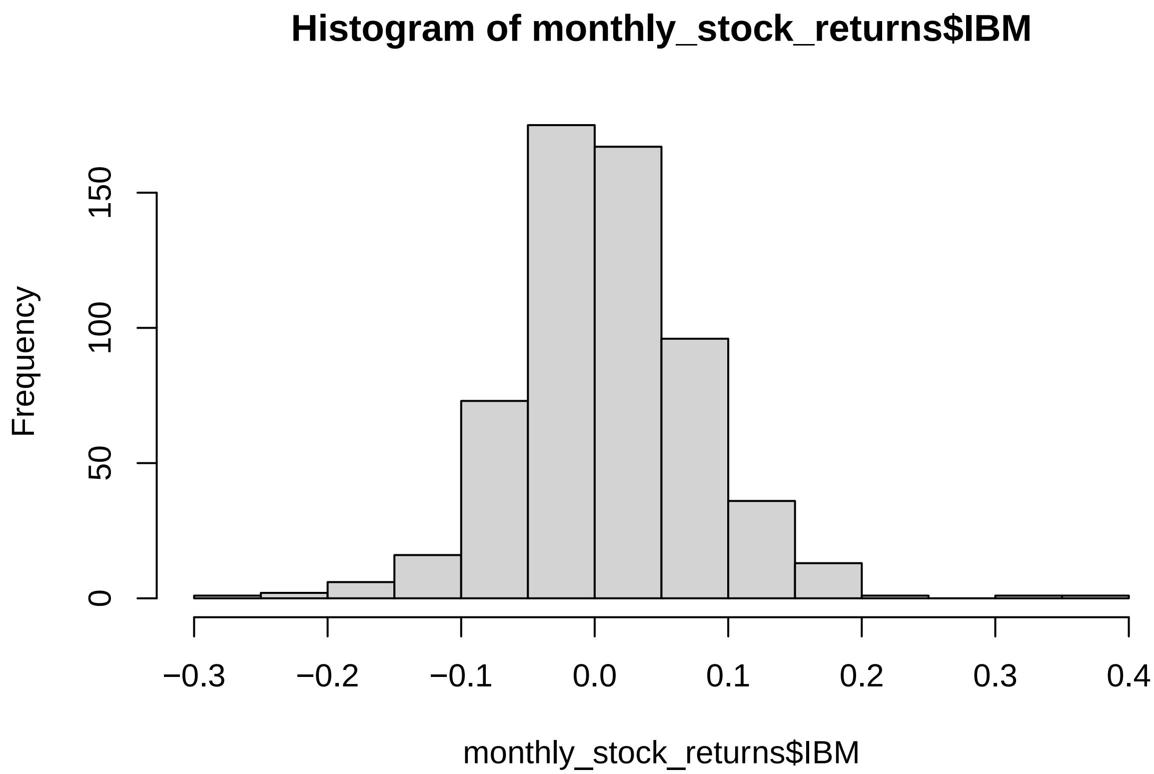
```
hist(monthly_stock_returns$COCACOLA)
```



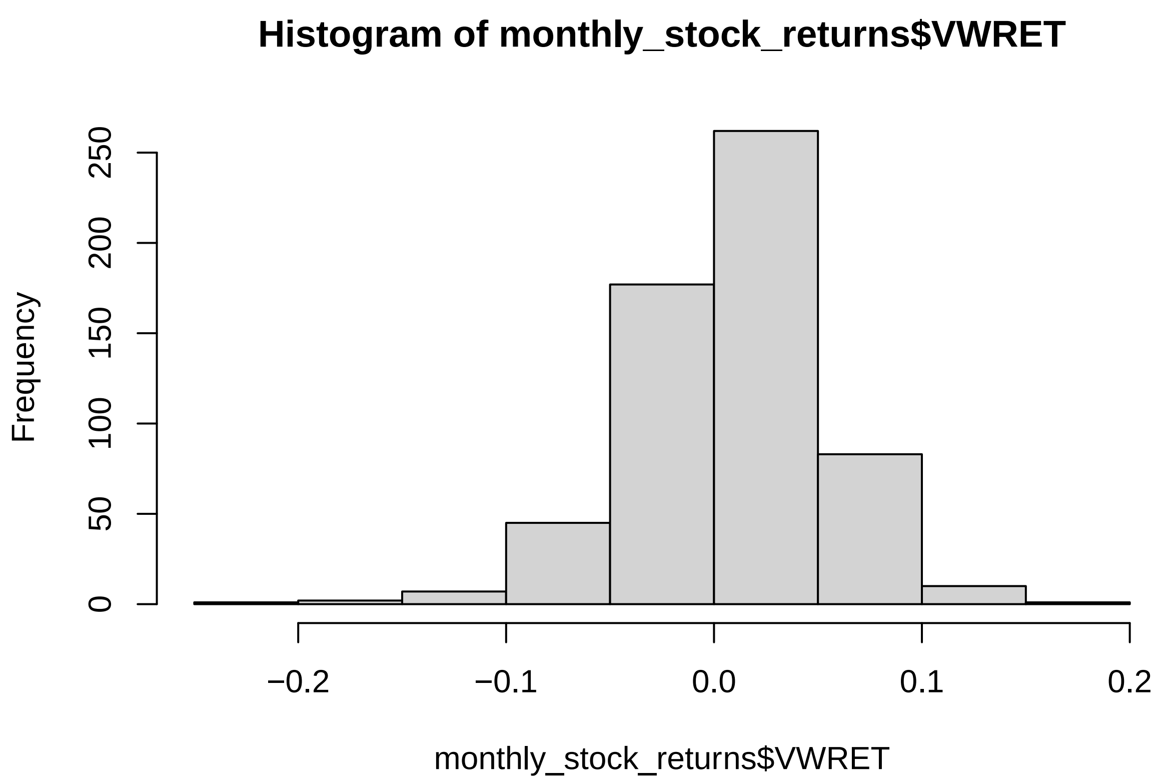

```
hist(monthly_stock_returns$GE)
```



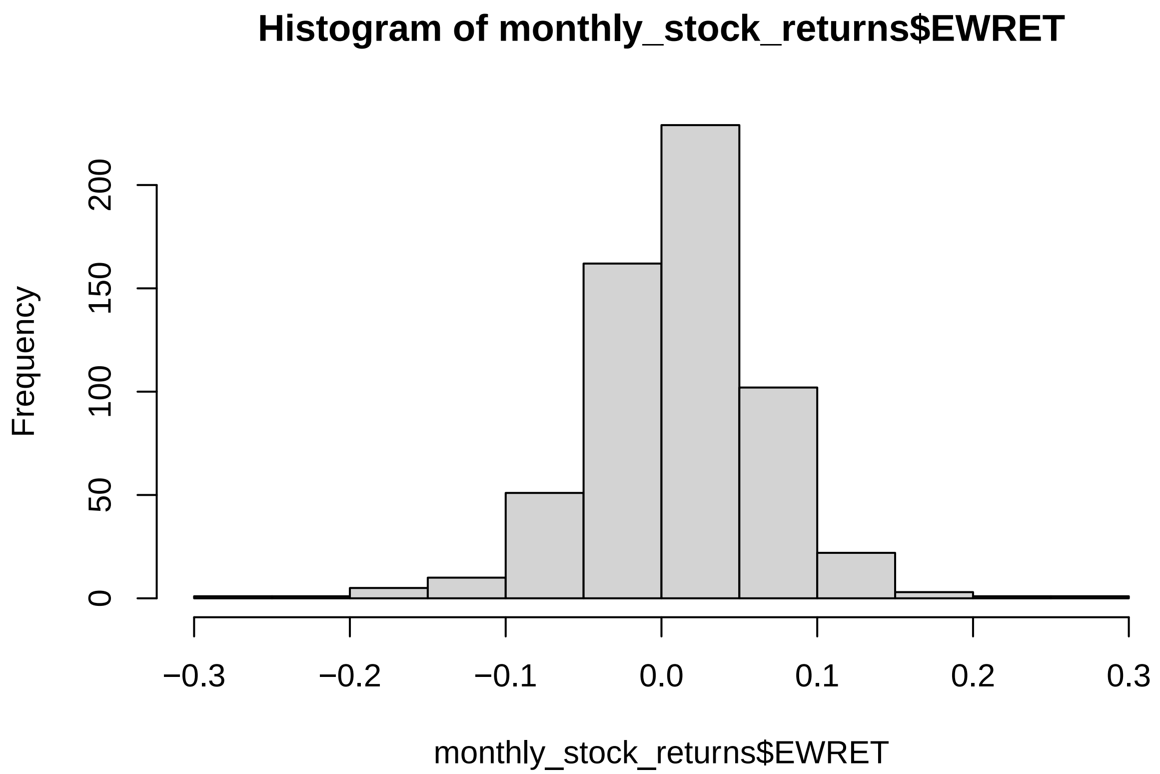

```
hist(monthly_stock_returns$IBM)
```



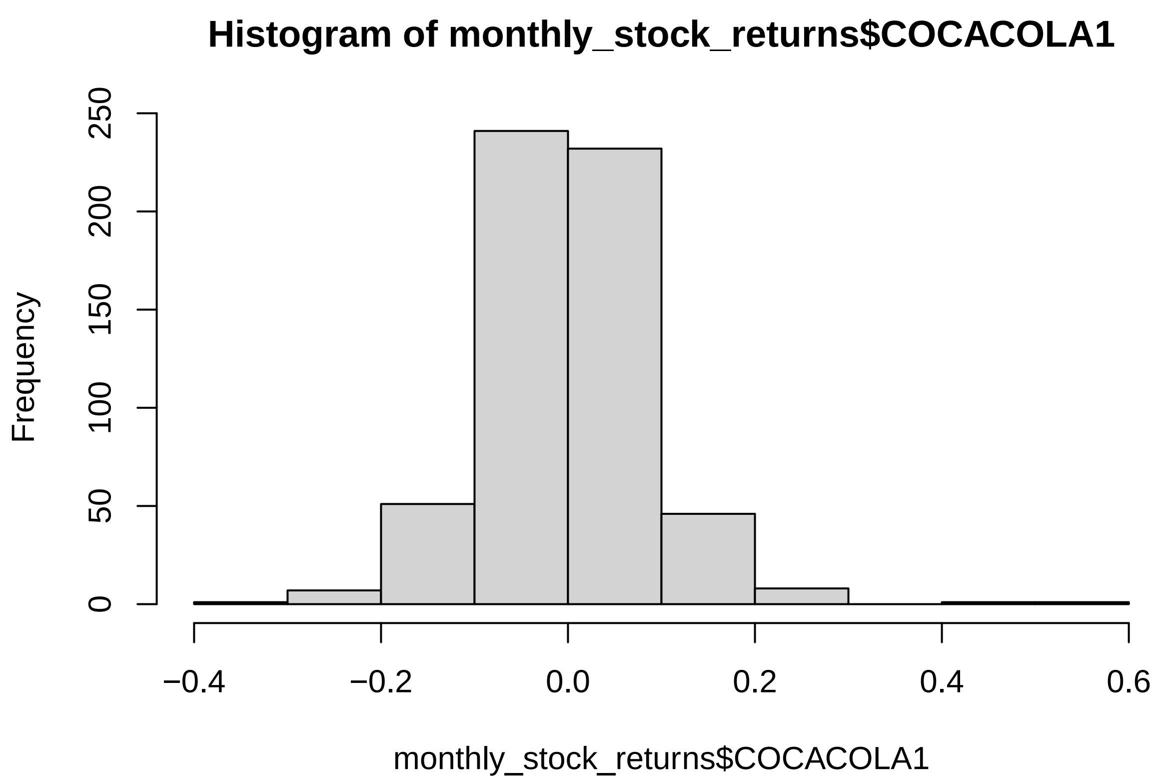

```
hist(monthly_stock_returns$VWRET)
```



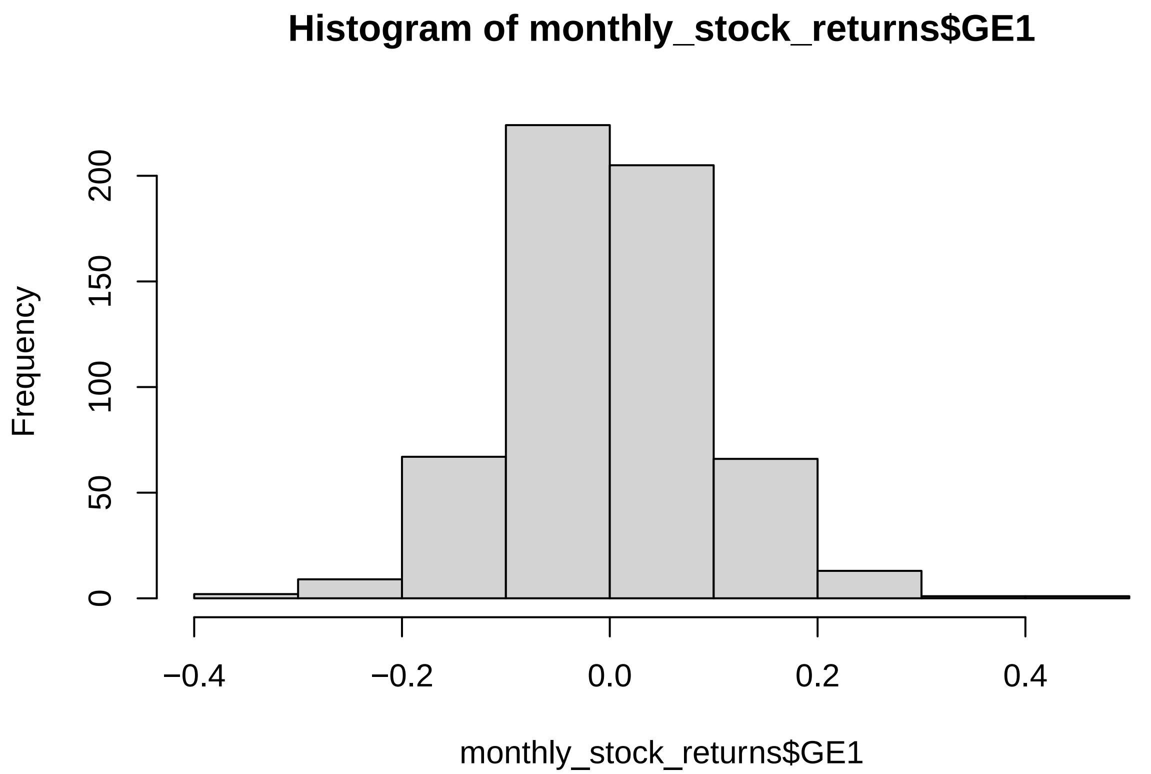

```
hist(monthly_stock_returns$EWRET)
```



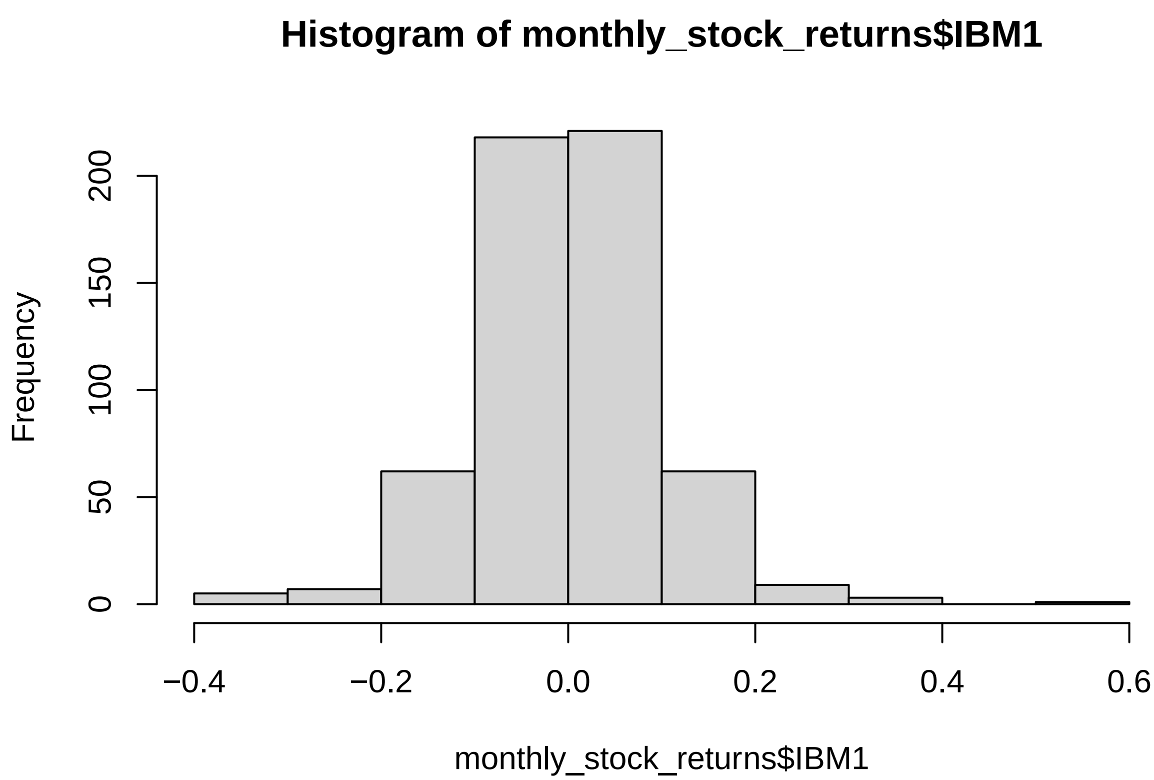

```
hist(monthly_stock_returns$COCACOLA1)
```



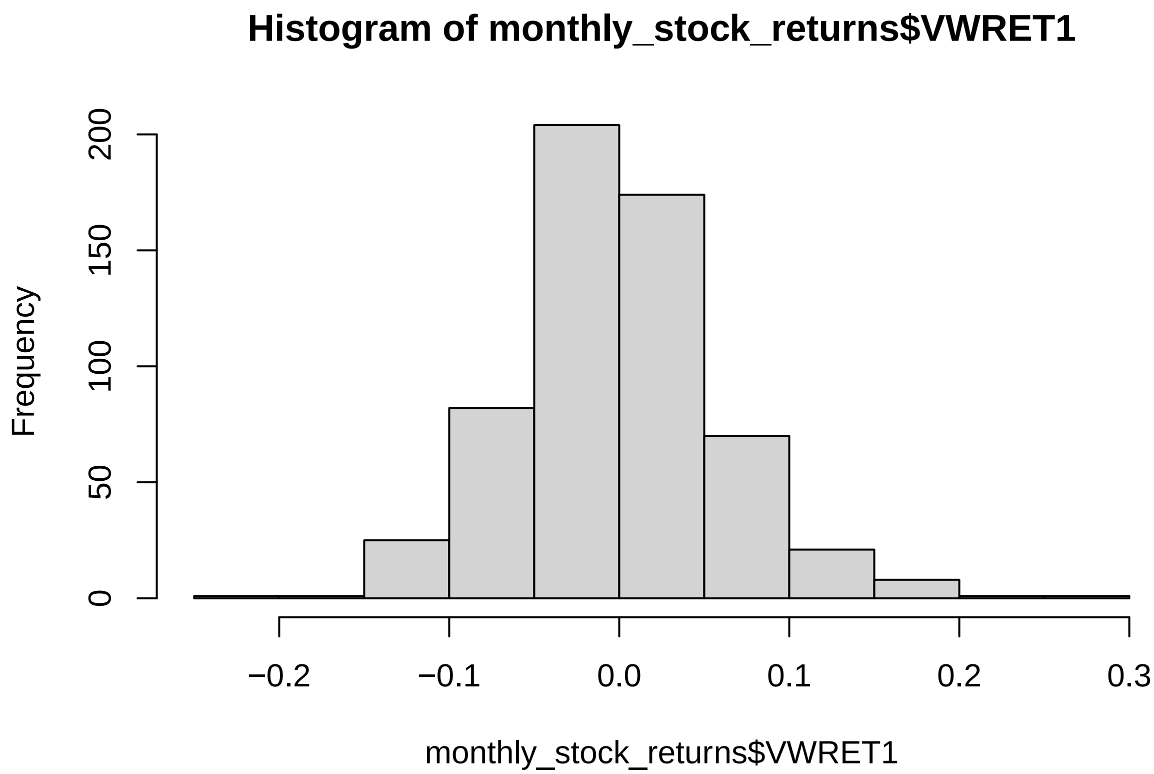

```
hist(monthly_stock_returns$GE1)
```



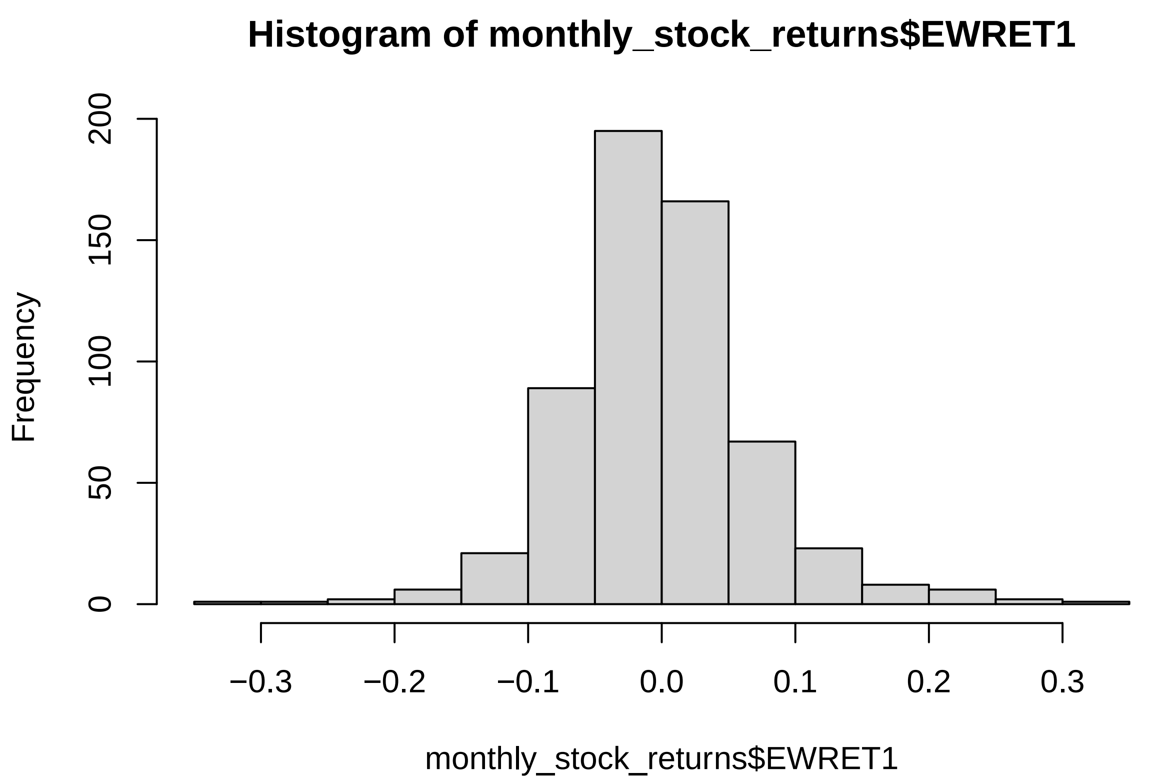

```
hist(monthly_stock_returns$IBM1)
```



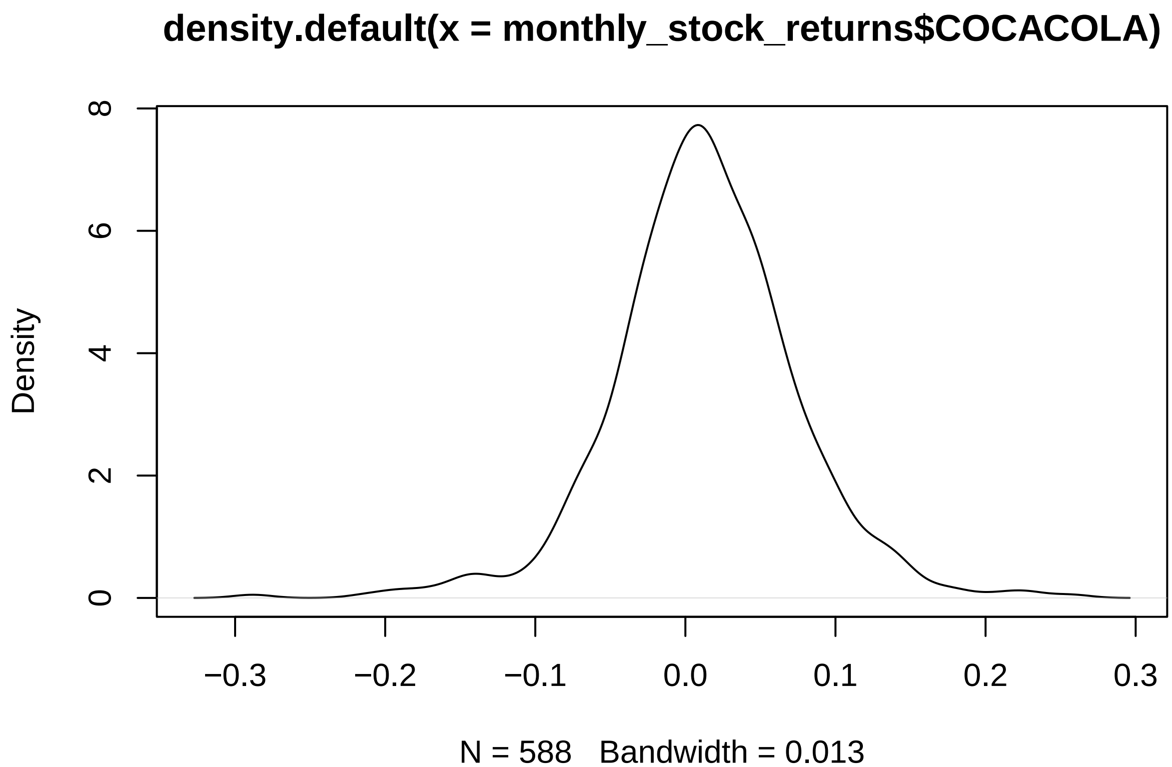

```
hist(monthly_stock_returns$VWRET1)
```



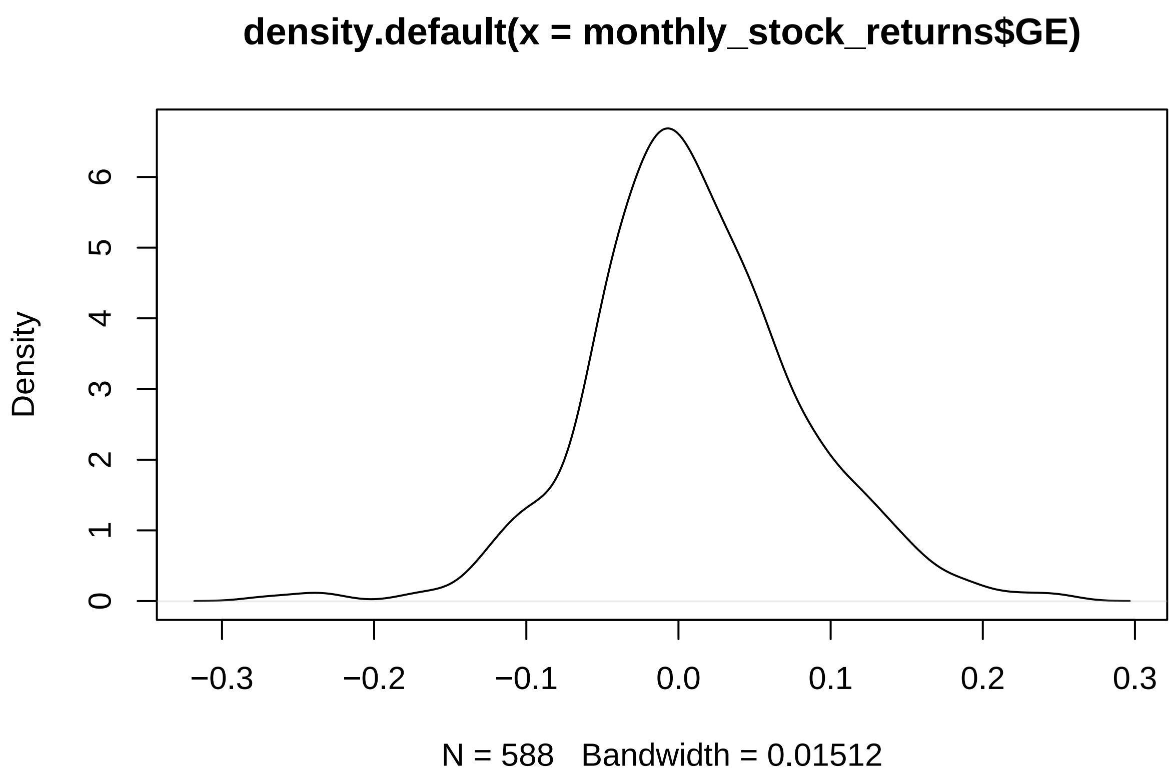

```
hist(monthly_stock_returns$EWRET1)
```



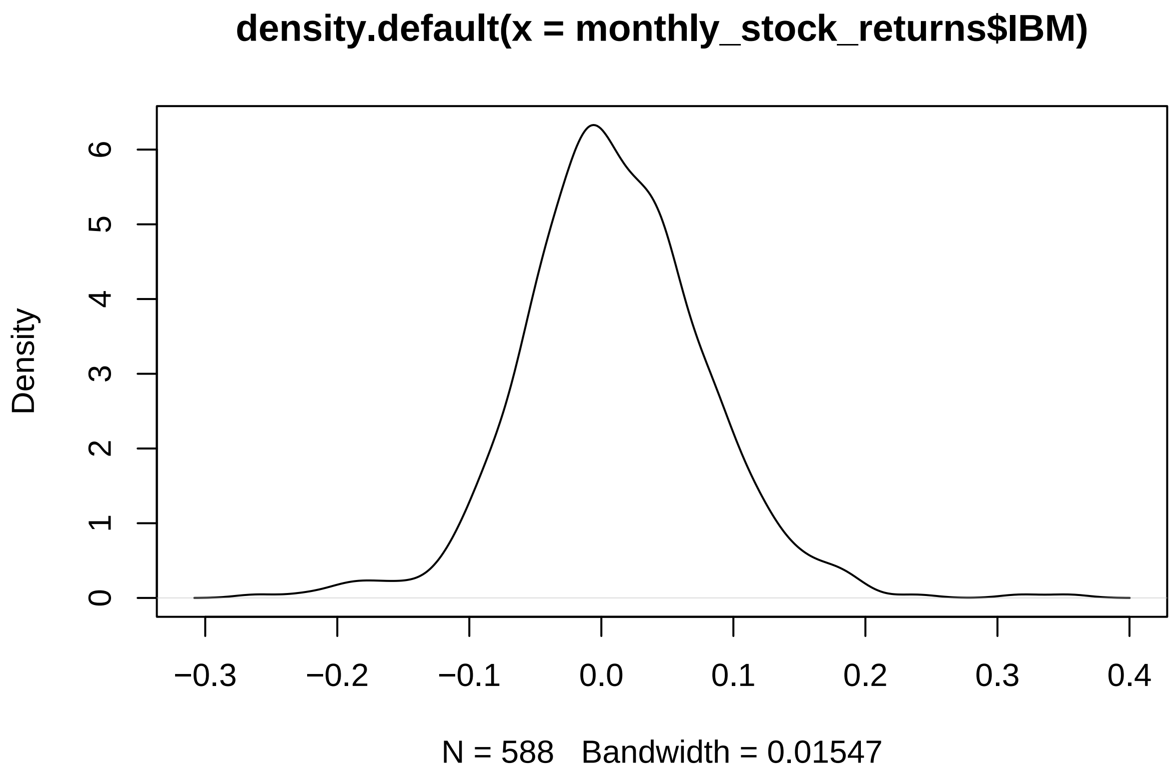

```
plot(density(monthly_stock_returns$COCACOLA))
```



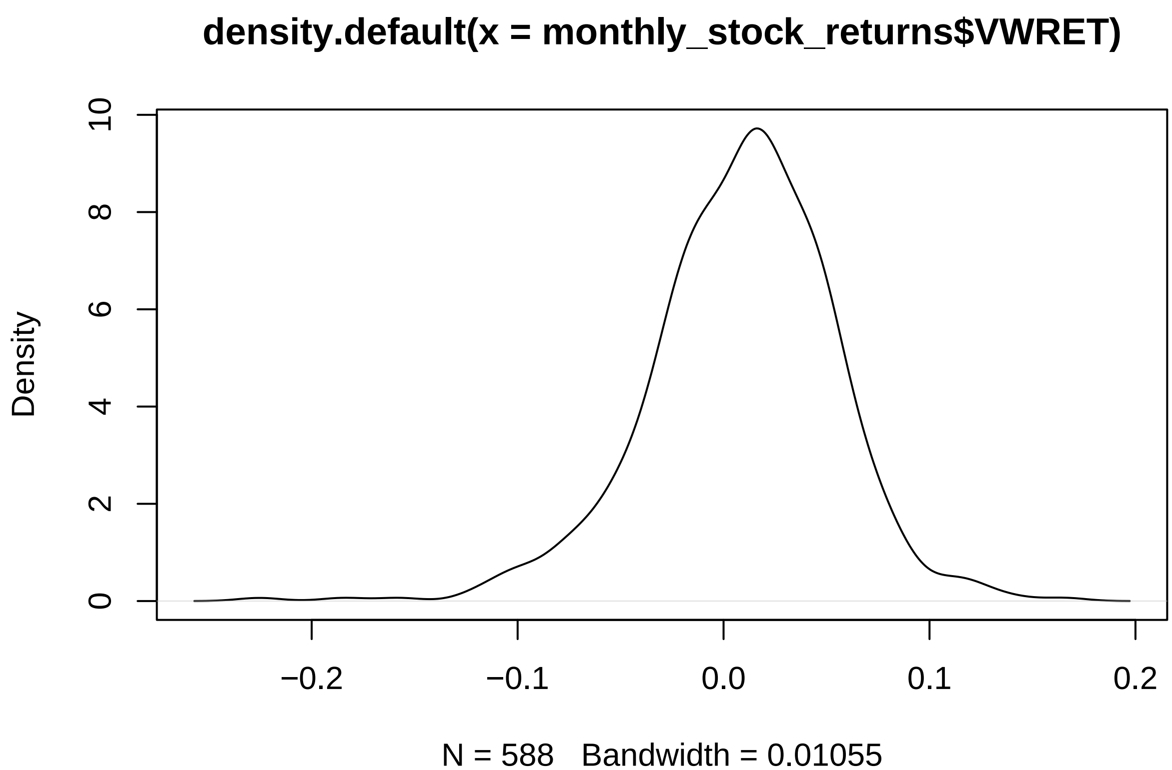

```
plot(density(monthly_stock_returns$GE))
```



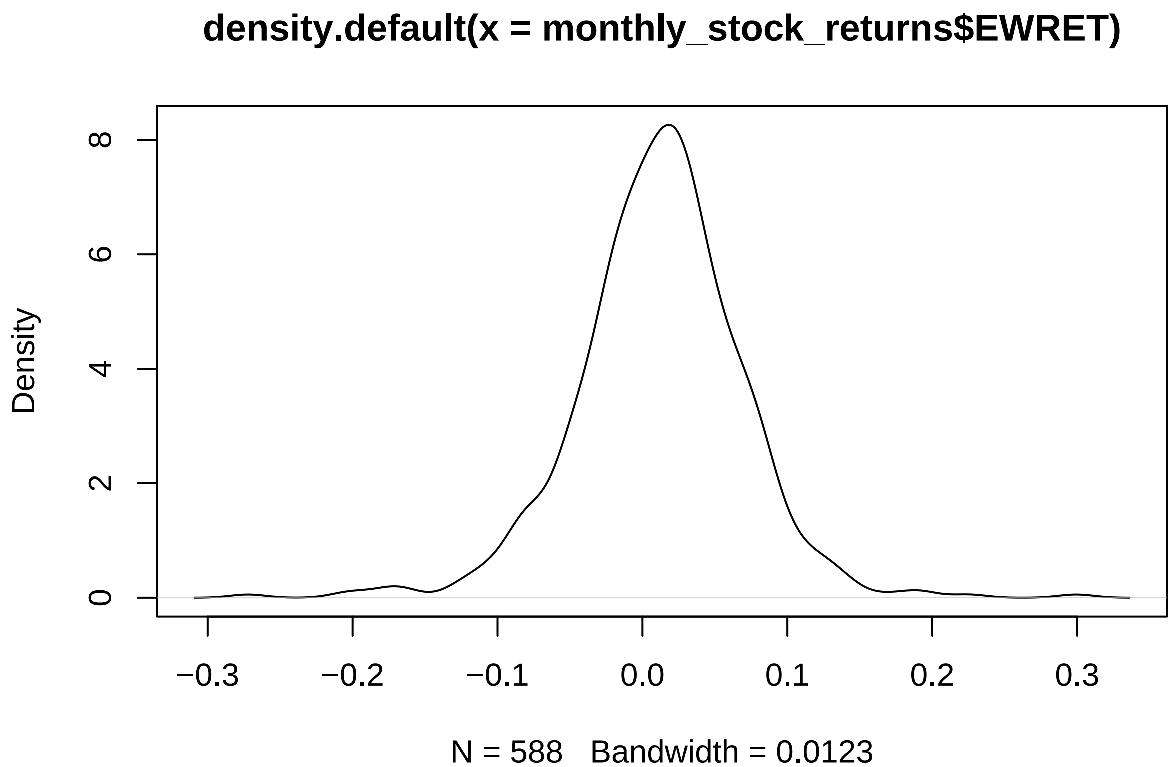

```
plot(density(monthly_stock_returns$IBM))
```



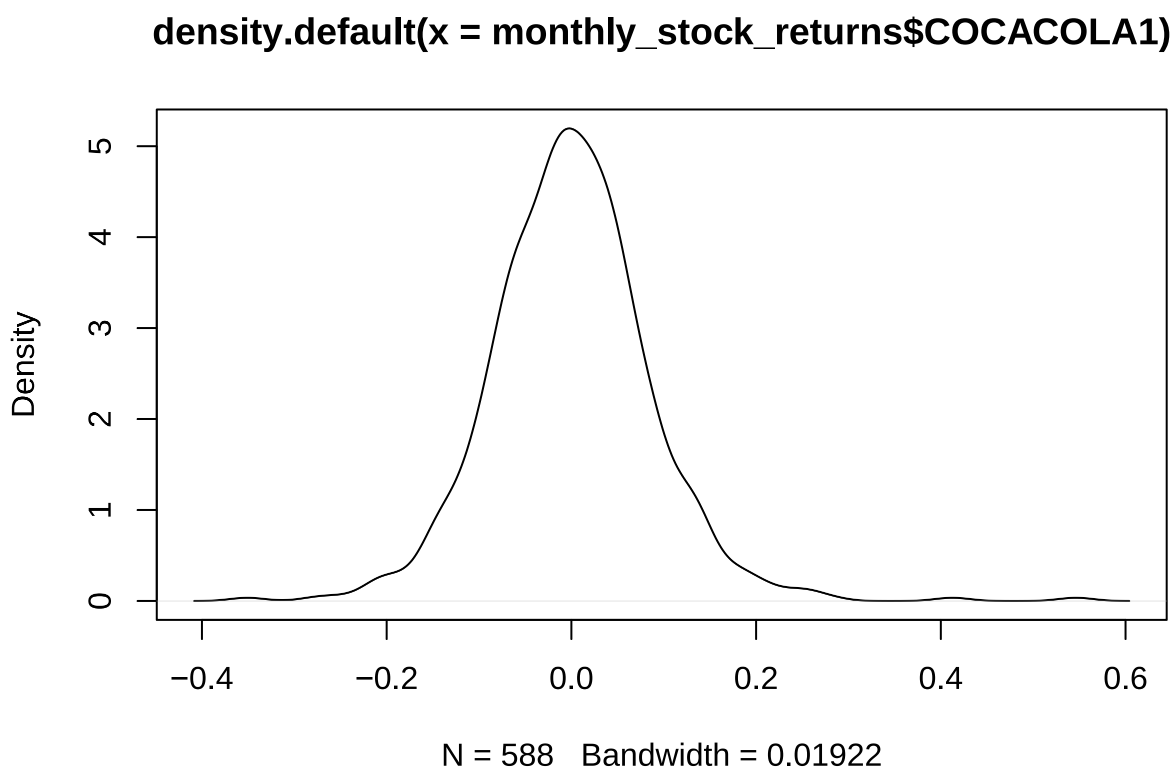

```
plot(density(monthly_stock_returns$VWRET))
```



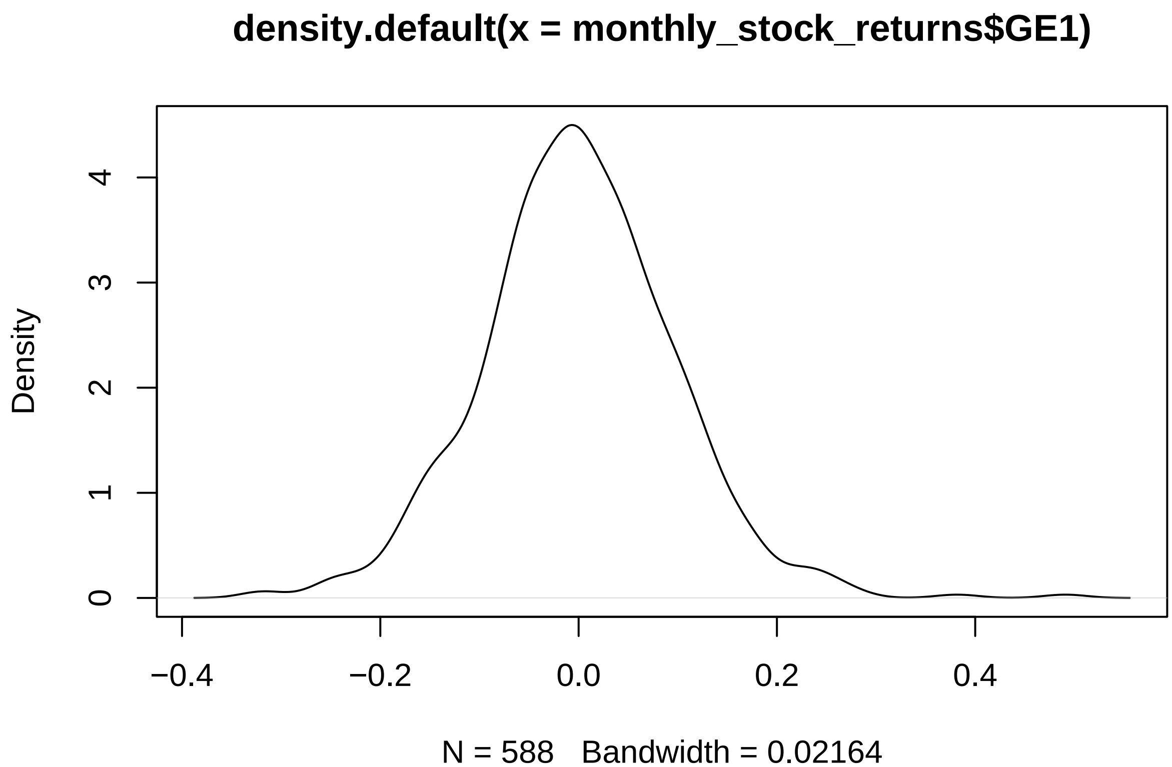

```
plot(density(monthly_stock_returns$EWRET))
```



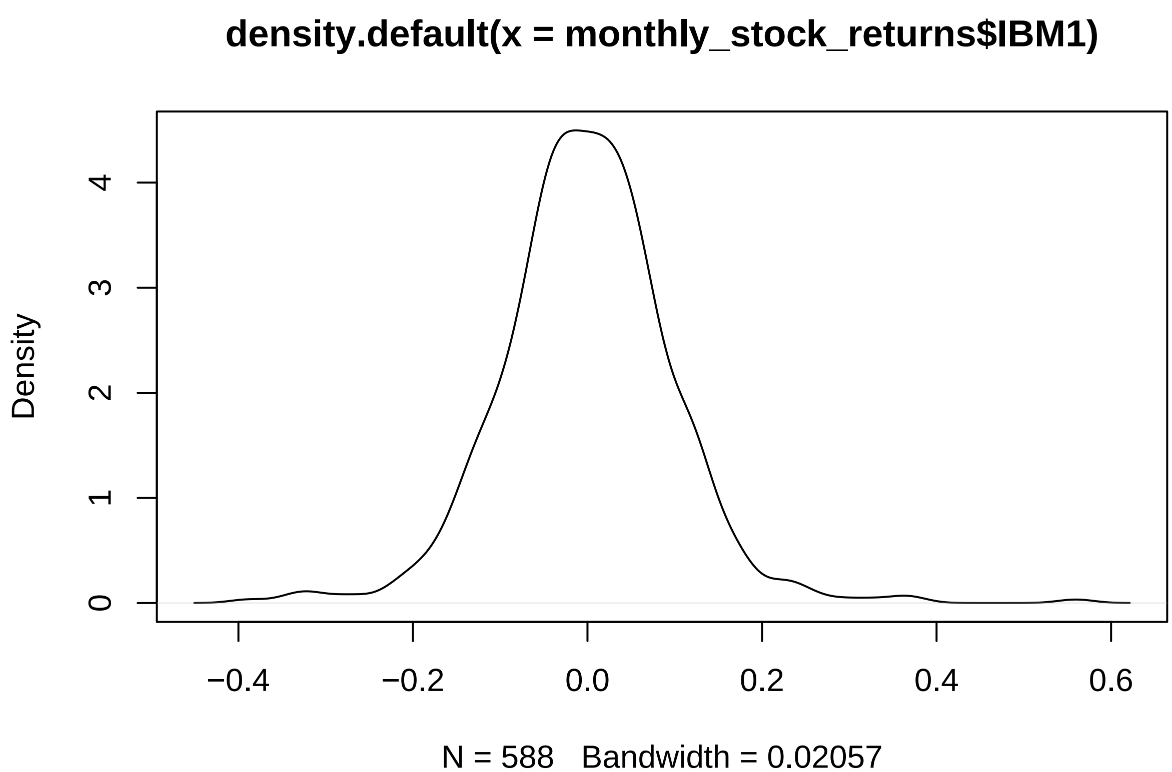

```
plot(density(monthly_stock_returns$COCACOLA1))
```



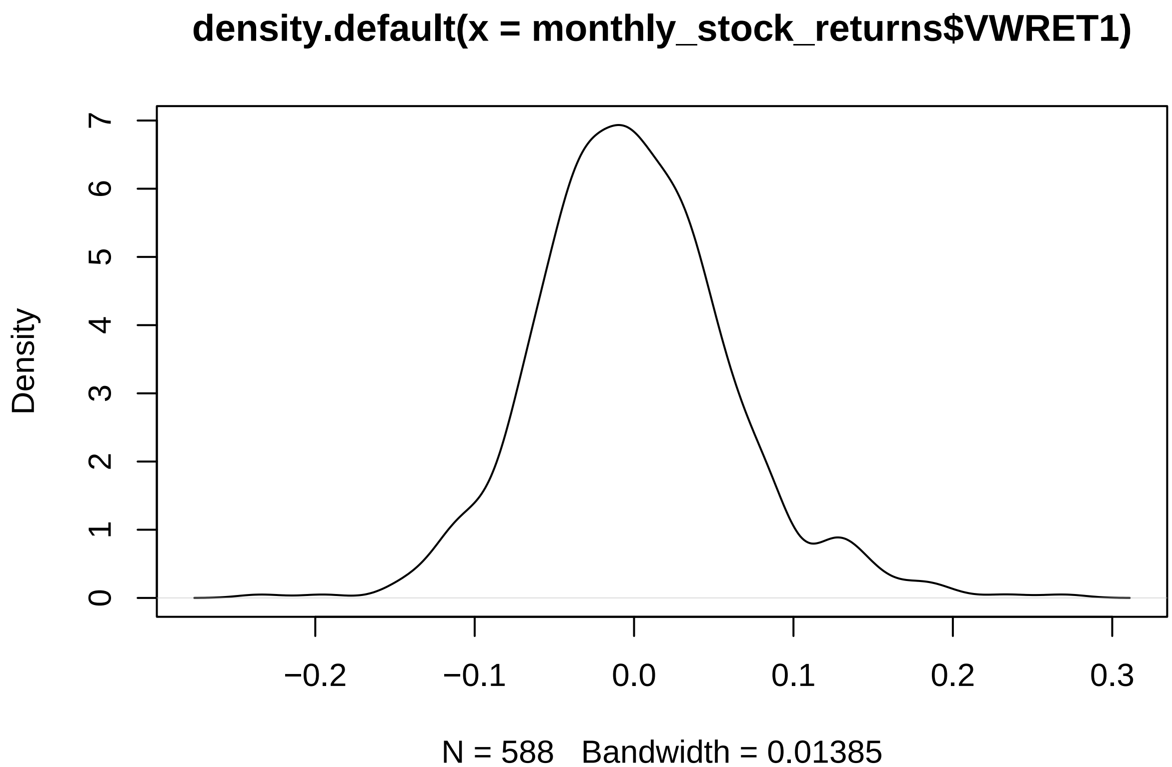

```
plot(density(monthly_stock_returns$GE1))
```




```
plot(density(monthly_stock_returns$IBM1))
```




```
plot(density(monthly_stock_returns$VWRET1))
```

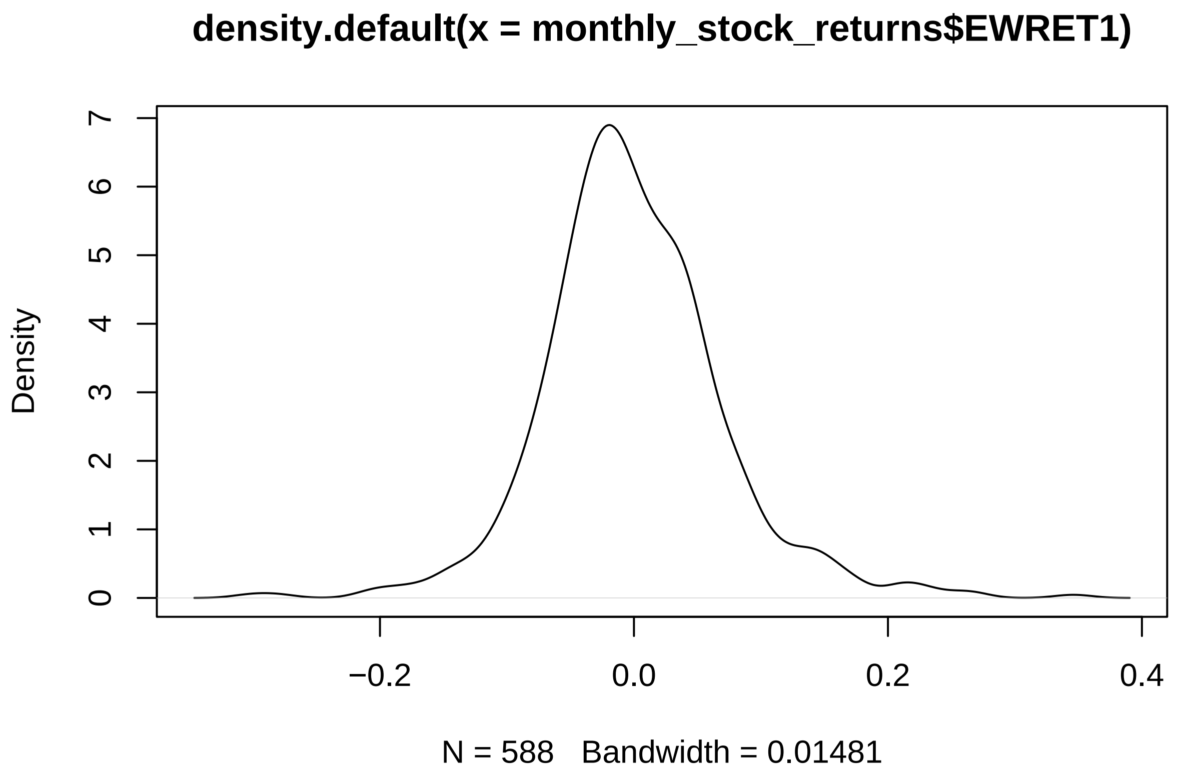



```
plot(density(monthly_stock_returns$EWRET1))

#JARQUE - BERA TEST AT THE 5% SIGNIFICANCE LEVEL #

library(tseries)
```

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




```r
jarque.bera.test(monthly_stock_returns$COCACOLA)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$COCACOLA
## X-squared = 115.67, df = 2, p-value < 2.2e-16
```

```r
jarque.bera.test(monthly_stock_returns$IBM)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$IBM
## X-squared = 102.37, df = 2, p-value < 2.2e-16
```

```r
jarque.bera.test(monthly_stock_returns$GE)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$GE
## X-squared = 37.488, df = 2, p-value = 7.238e-09
```

```r
jarque.bera.test(monthly_stock_returns$EWRET)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$EWRET
## X-squared = 202.95, df = 2, p-value < 2.2e-16
```

```r
jarque.bera.test(monthly_stock_returns$VWRET)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$VWRET
## X-squared = 124.2, df = 2, p-value < 2.2e-16
```

```r
jarque.bera.test(monthly_stock_returns$COCACOLA1)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$COCACOLA1
## X-squared = 376.96, df = 2, p-value < 2.2e-16
```

```r
jarque.bera.test(monthly_stock_returns$IBM1)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$IBM1
## X-squared = 224.36, df = 2, p-value < 2.2e-16
```

```r
jarque.bera.test(monthly_stock_returns$GE1)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$GE1
## X-squared = 56.81, df = 2, p-value = 4.611e-13
```

```r
jarque.bera.test(monthly_stock_returns$EWRET1)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$EWRET1
## X-squared = 179.56, df = 2, p-value < 2.2e-16
```

```r
jarque.bera.test(monthly_stock_returns$VWRET1)
```

```
##
##  Jarque Bera Test
##
## data:  monthly_stock_returns$VWRET1
## X-squared = 62.027, df = 2, p-value = 3.397e-14
```

Answer: Since the p-values from the result of the jarque-bera tests for the returns and log returns of COCACOLA, GE, IBM, VWRET and EWRET are less than 5%, then we reject the null hypothesis and conclude that the returns and log returns do not follow a normal distribution.

#1H. CAPM REGRESSION FOR COCACOLA, GE AND IBM #

```r
COCACOLA_FIT <- lm(COCACOLA ~ VWRET, data = monthly_stock_returns)
GE_FIT <- lm(GE ~ VWRET, data = monthly_stock_returns)
IBM_FIT <- lm(IBM ~ VWRET, data = monthly_stock_returns)
summary(COCACOLA_FIT)
```

```
##
## Call:
## lm(formula = COCACOLA ~ VWRET, data = monthly_stock_returns)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.216102 -0.029532 -0.001404  0.030982  0.171847
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.006496   0.002206   2.944  0.00336 **
## VWRET       0.716446   0.048027  14.918  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.05251 on 586 degrees of freedom
## Multiple R-squared:  0.2752, Adjusted R-squared:  0.274
## F-statistic: 222.5 on 1 and 586 DF,  p-value: < 2.2e-16
```

```
summary(GE_FIT)
```

```
##
## Call:
## lm(formula = GE ~ VWRET, data = monthly_stock_returns)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.174175 -0.030702 -0.003161  0.029411  0.198822
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0004826  0.0020217   0.239    0.811
## VWRET       1.1199868  0.0440096  25.449   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04812 on 586 degrees of freedom
## Multiple R-squared:  0.525,  Adjusted R-squared:  0.5242
## F-statistic: 647.6 on 1 and 586 DF,  p-value: < 2.2e-16
```

```
summary(IBM_FIT)
```

```
##
## Call:
## lm(formula = IBM ~ VWRET, data = monthly_stock_returns)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.280296 -0.031656 -0.001447  0.028898  0.285129
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.002762   0.002421   1.141    0.254
## VWRET       0.879652   0.052696  16.693   <2e-16 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.05762 on 586 degrees of freedom
## Multiple R-squared:  0.3223, Adjusted R-squared:  0.3211
## F-statistic: 278.7 on 1 and 586 DF,  p-value: < 2.2e-16
```

Answer: Please note that the VWRET was selected as the proxy for market returns because the market portfolio is a value-weighted portfolio of all securities traded in the market. The alphas for COCACOLA, GE and IBM are 0.006496, 0.0004826 and 0.002762 respectively while the betas for COCACOLA, GE and IBM are 0.716446, 1.1199868 and 0.879652 respectively. The p-value of the betas are less than 1.96, hence at 5% significance levels we do not reject the null hypothesis and conclude that are statistically significant.

QUESTION 2

#2a. IMPORT DATA INTO R #

```
library("haven")

pension_df <-read_dta("Documents/4328 - Applied Financial Econometrics/Assignment/Assignment 1/HW1data/p
```

#2b. HOW MANY SINGLE PERSON HOUSEHOLDS ARE THERE IN THE DATASET #

```
library("dplyr")
```

```
## Warning: package 'dplyr' was built under R version 4.1.2

##
## 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
```

```
no_of_single_person_households <- length(which(pension_df$marr == 0))

no_of_single_person_households
```

```
## [1] 3445
```

#2c. OLS ESTIMATION OF THE MODEL TO REFLECT RESULTS OF SINGLE-PERSON HOUSEHOLDS #

```
OLS_estimatea <- lm(nettfa ~ inc + age, data = pension_df)

summary(OLS_estimatea)
```

```
##
## Call:
## lm(formula = nettfa ~ inc + age, data = pension_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -509.27  -18.71   -4.09   10.02 1464.74
##
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -60.69654    2.59633  -23.38   <2e-16 ***
## inc           0.95336    0.02528   37.72   <2e-16 ***
## age           1.03078    0.05912   17.43   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 58.31 on 9272 degrees of freedom
## Multiple R-squared:  0.1691, Adjusted R-squared:  0.1689
## F-statistic: 943.2 on 2 and 9272 DF,  p-value: < 2.2e-16
```

```
OLS_estimate_single <- lm(nettfa ~ inc + age, data = subset(pension_df, marr == 0))

summary(OLS_estimate_single)
```

```
##
## Call:
## lm(formula = nettfa ~ inc + age, data = subset(pension_df, marr ==
##     0))
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -182.70  -14.17   -3.73    5.77 1113.35
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -43.97943    3.50496  -12.55   <2e-16 ***
## inc           0.87987    0.05169   17.02   <2e-16 ***
## age           0.80046    0.07884   10.15   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 47.77 on 3442 degrees of freedom
## Multiple R-squared:  0.1076, Adjusted R-squared:  0.1071
## F-statistic: 207.5 on 2 and 3442 DF,  p-value: < 2.2e-16
```

#2d. MEANING OF INTERCEPT FROM THE REGRESSION # Answer: The intercept shows that single people have negative net financial wealth of -43-97943 if income and age equals zero. However, this negative net financial wealth position is worse for married people at an intercept of -60-69654.

#2g. OLS ESTIMATION OF THE MODEL

```
OLS_estimate1 <- lm(nettfa ~ inc, data = pension_df)

summary(OLS_estimate1)
```

```
##
## Call:
## lm(formula = nettfa ~ inc, data = pension_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -504.39  -18.10   -4.29    6.73 1475.04
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept) -20.17948    1.17643  -17.15   <2e-16 ***
## inc           0.99991    0.02554   39.15   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 59.26 on 9273 degrees of freedom
## Multiple R-squared:  0.1418, Adjusted R-squared:  0.1417
## F-statistic:  1532 on 1 and 9273 DF,  p-value: < 2.2e-16
```

#2h. OLS ESTIMATION OF THE UPDATED MODEL

```
OLS_estimate2 <- lm(nettfa ~ inc + age + incsq + agesq + fsize, data = pension_df)

summary(OLS_estimate2)
```

```
##
## Call:
## lm(formula = nettfa ~ inc + age + incsq + agesq + fsize, data = pension_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -523.05  -15.85   -2.97    5.62 1466.00
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 13.9925513  9.9919763   1.400   0.1614
## inc         -0.1266417  0.0732205  -1.730   0.0837 .
## age         -1.2580134  0.4918240  -2.558   0.0105 *
## incsq        0.0094893  0.0005837  16.257  < 2e-16 ***
## agesq        0.0263771  0.0056527   4.666 3.11e-06 ***
## fsize       -1.9792085  0.4011045  -4.934 8.18e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 57.26 on 9269 degrees of freedom
## Multiple R-squared:  0.1989, Adjusted R-squared:  0.1985
## F-statistic: 460.4 on 5 and 9269 DF,  p-value: < 2.2e-16
```

#2i. F-TEST OF THE RESTRICTION IN MODEL (OLS_estimate2) #

```
library(car)
```

```
## Loading required package: carData

## Warning: package 'carData' was built under R version 4.1.2

##
## Attaching package: 'car'

## The following object is masked from 'package:dplyr':
##
##     recode
```

```
nullhyp <- c("incsq", "agesq")
linearHypothesis(OLS_estimate2, nullhyp)
```

```
## Linear hypothesis test
##
## Hypothesis:
```

```
## incsq = 0
## agesq = 0
##
## Model 1: restricted model
## Model 2: nettfa ~ inc + age + incsq + agesq + fsize
##
##   Res.Df      RSS Df Sum of Sq      F    Pr(>F)
## 1   9271 31361180
## 2   9269 30394935  2    966245 147.33 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Answer: The probability value of the f-test is less than 1%, hence we reject the null hypothesis at 1% significance level and conclude that the coefficients of incsq and agesq do not equal zero.

#2j. RE-ESTIMATION OF THE MODEL (OLS_estimate2) AFTER RESCALING inc BY DIVIDING IT BY 10#

```r
pension_df$inc_adjusted <- pension_df$inc/10

OLS_estimate2_adj <- lm(nettfa ~ inc_adjusted + age + I(inc^2) + I(age^2) + fsize, data = pension_df)

summary(OLS_estimate2_adj)
```

```
##
## Call:
## lm(formula = nettfa ~ inc_adjusted + age + I(inc^2) + I(age^2) +
##     fsize, data = pension_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -523.05  -15.85   -2.97    5.62 1466.00
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  13.9925514  9.9919763   1.400   0.1614
## inc_adjusted -1.2664166  0.7322049  -1.730   0.0837 .
## age          -1.2580134  0.4918240  -2.558   0.0105 *
## I(inc^2)      0.0094893  0.0005837  16.257  < 2e-16 ***
## I(age^2)      0.0263771  0.0056527   4.666 3.11e-06 ***
## fsize        -1.9792085  0.4011045  -4.934 8.18e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 57.26 on 9269 degrees of freedom
## Multiple R-squared:  0.1989, Adjusted R-squared:  0.1985
## F-statistic: 460.4 on 5 and 9269 DF,  p-value: < 2.2e-16
```

#2k. TESTING THE MODEL (OLS_estimate) FOR HETEROSKEDASTICITY USING THE BREUSCH-PAGAN TEST #

```r
library(lmtest)
```

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

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

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

```
bptest(OLS_estimatea)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  OLS_estimatea
## BP = 189.51, df = 2, p-value < 2.2e-16
```

Answer: the p-value is less than the significance level at 1% or 5%, hence we reject the null hypothesis and conclude that heteroskedasticity is present

#2l. ESTIMATING THE MODEL (OLS_estimate) WITH HETEROSKEDASTICITY-ROBUST (e.g. WHITE) STANDARD ERRORS #

```
library(lmtest)
library(sandwich)
coeftest(OLS_estimatea, vcov = sandwich)
```

```
##
## t test of coefficients:
##
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept) -60.696537   3.750371 -16.184 < 2.2e-16 ***
## inc           0.953357   0.069936  13.632 < 2.2e-16 ***
## age           1.030777   0.065054  15.845 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

#2m. RE-ESTIMATING THE MODEL (OLS_estimate) AFTER STANDARDISING ALL VARIABLES IN THE MODEL. INTERPRETE COEFFICIENTS ON inc AND age #

```
OLS_estimatea <- lm(nettfa ~ inc + age, data = pension_df)
pension_df$resi <- OLS_estimatea$residuals
varfunc.ols <- lm(log(resi^2) ~ log(inc) + log(age), data = pension_df)
pension_df$varfunc <- exp(varfunc.ols$fitted.values)
OLS_estimatea_gls <- lm(nettfa ~ inc + age, weights = 1/sqrt(varfunc), data = pension_df)

summary(OLS_estimatea)
```

```
##
## Call:
## lm(formula = nettfa ~ inc + age, data = pension_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -509.27  -18.71   -4.09   10.02 1464.74
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -60.69654    2.59633  -23.38   <2e-16 ***
## inc           0.95336    0.02528   37.72   <2e-16 ***
## age           1.03078    0.05912   17.43   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 58.31 on 9272 degrees of freedom
## Multiple R-squared:  0.1691, Adjusted R-squared:  0.1689
## F-statistic: 943.2 on 2 and 9272 DF,  p-value: < 2.2e-16
```

```
summary(OLS_estimatea_gls)
```

```
##
## Call:
## lm(formula = nettfa ~ inc + age, data = pension_df, weights = 1/sqrt(varfunc))
##
## Weighted Residuals:
##      Min       1Q   Median       3Q      Max
## -160.311   -4.565   -1.772    1.881  301.278
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -38.56580    1.69027  -22.82   <2e-16 ***
## inc           0.72560    0.02222   32.65   <2e-16 ***
## age           0.69655    0.04104   16.97   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.85 on 9272 degrees of freedom
## Multiple R-squared:  0.1382, Adjusted R-squared:  0.138
## F-statistic: 743.6 on 2 and 9272 DF,  p-value: < 2.2e-16
```

QUESTION 3

IMPORT DATA INTO R

```
library("haven")
library("sandwich")
library(foreign)
```

```
## Warning: package 'foreign' was built under R version 4.1.2
```

```
library("lmtest")
library("zoo")
library(dplyr)

ceo_salary_df <-read_dta("Documents/4328 - Applied Financial Econometrics/Assignment/Assignment 1/HW1da
```

#3a. Estimation of the model using OLS

```
OLS_estimate_salary <- lm(lsalary ~ lsales + lmktval + ceoten + ceotensq, data = ceo_salary_df)

summary(OLS_estimate_salary)
```

```
##
## Call:
## lm(formula = lsalary ~ lsales + lmktval + ceoten + ceotensq,
##     data = ceo_salary_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -2.41976 -0.28791  0.00253  0.28615  1.74966
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  4.3685503  0.2587397  16.884  < 2e-16 ***
## lsales       0.1646331  0.0386393   4.261 3.35e-05 ***
## lmktval      0.1085285  0.0488257   2.223  0.02753 *
## ceoten       0.0451169  0.0141169   3.196  0.00166 **
## ceotensq    -0.0012102  0.0004747  -2.549  0.01167 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4969 on 172 degrees of freedom
## Multiple R-squared:  0.343,  Adjusted R-squared:  0.3277
## F-statistic: 22.45 on 4 and 172 DF,  p-value: 6.257e-15
```

#3b. COUNT, MEAN, STANDARD DEVIATION, MINIMUM AND MAXIMUM OF EXPLANATORY VARIABLES. EXPLAIN REASON FOR NATURAL LOG

```
lsales. <- c(length(ceo_salary_df$lsales), mean(ceo_salary_df$lsales), sd(ceo_salary_df$lsales), min(ce
lmktval. <- c(length(ceo_salary_df$lmktval), mean(ceo_salary_df$lmktval), sd(ceo_salary_df$lmktval), mi
ceoten. <- c(length(ceo_salary_df$ceoten), mean(ceo_salary_df$ceoten), sd(ceo_salary_df$ceoten), min(ce
ceotensq. <- c(length(ceo_salary_df$ceotensq), mean(ceo_salary_df$ceotensq), sd(ceo_salary_df$ceotensq)

salary_summary_df <- data.frame(lsales., lmktval., ceoten., ceotensq.)
row.names(salary_summary_df) <- c("COUNT", "MEAN", "STANDARD DEVIATION", "MINIMUM", "MAXIMUM")
salary_summary_df
```

```
##                       lsales.    lmktval.     ceoten. ceotensq.
## COUNT              177.000000 177.000000 177.000000  177.0000
## MEAN                 7.231025   7.399410   7.954802  114.1243
## STANDARD DEVIATION   1.432086   1.133414   7.150826  212.5660
## MINIMUM              3.367296   5.958425   0.000000    0.0000
## MAXIMUM             10.845446  10.723268  37.000000 1369.0000
```

#3c. RESTIMATION OF MODEL WITH WHITE STANDARD ERRORS AND THE T-STATS

```
coeftest(OLS_estimate_salary, vcov = sandwich)
```

```
##
## t test of coefficients:
##
##                Estimate  Std. Error t value  Pr(>|t|)
## (Intercept)  4.36855032  0.26010837 16.7951 < 2.2e-16 ***
## lsales       0.16463314  0.03791554  4.3421 2.404e-05 ***
## lmktval      0.10852852  0.04877684  2.2250  0.027382 *
## ceoten       0.04511688  0.01412824  3.1934  0.001672 **
## ceotensq    -0.00121019  0.00054608 -2.2161  0.027994 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
coeftest(OLS_estimate_salary, vcov = vcovHC(OLS_estimate_salary, "HC0"))
```

```
##
## t test of coefficients:
##
##                Estimate  Std. Error t value  Pr(>|t|)
```

```
## (Intercept)  4.36855032  0.26010837 16.7951 < 2.2e-16 ***
## lsales       0.16463314  0.03791554  4.3421 2.404e-05 ***
## lmktval      0.10852852  0.04877684  2.2250  0.027382 *
## ceoten       0.04511688  0.01412824  3.1934  0.001672 **
## ceotensq    -0.00121019  0.00054608 -2.2161  0.027994 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
coeftest(OLS_estimate_salary, vcov = vcovHC(OLS_estimate_salary))
```

```
##
## t test of coefficients:
##
##                Estimate  Std. Error t value  Pr(>|t|)
## (Intercept)  4.36855032  0.27604986 15.8252 < 2.2e-16 ***
## lsales       0.16463314  0.03961859  4.1555 5.108e-05 ***
## lmktval      0.10852852  0.05163631  2.1018  0.037029 *
## ceoten       0.04511688  0.01636159  2.7575  0.006454 **
## ceotensq    -0.00121019  0.00068165 -1.7754  0.077603 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(OLS_estimate_salary)
```

```
##
## Call:
## lm(formula = lsalary ~ lsales + lmktval + ceoten + ceotensq,
##     data = ceo_salary_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.41976 -0.28791  0.00253  0.28615  1.74966
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  4.3685503  0.2587397  16.884  < 2e-16 ***
## lsales       0.1646331  0.0386393   4.261 3.35e-05 ***
## lmktval      0.1085285  0.0488257   2.223  0.02753 *
## ceoten       0.0451169  0.0141169   3.196  0.00166 **
## ceotensq    -0.0012102  0.0004747  -2.549  0.01167 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4969 on 172 degrees of freedom
## Multiple R-squared:  0.343,  Adjusted R-squared:  0.3277
## F-statistic: 22.45 on 4 and 172 DF,  p-value: 6.257e-15
```

#3d. OBTAIN RESIDUALS AND STANDARDIZE

```
residuals <- residuals(OLS_estimate_salary)
residuals
```

```
##             1             2             3             4             5
##  0.0745482432  0.0087696527 -0.1600566223 -0.1995056406  0.0013666286
##             6             7             8             9            10
## -0.1718538017  0.4195761498  0.2619258405 -0.0289205553  0.2237905010
##            11            12            13            14            15
```

```
## -0.0751345583 -0.4910547216  0.9017545887 -0.2879058883  0.0659469317
##            16            17            18            19            20
## -0.6177548927  0.2638780054  0.8461136004  0.2355350816  0.1106099584
##            21            22            23            24            25
## -0.5525803494  0.0914100372  0.0025346251 -0.5289003987 -0.2840587361
##            26            27            28            29            30
## -0.2457134327  0.2917024589 -0.3934139595  0.0074422476 -1.3925994169
##            31            32            33            34            35
##  0.3898379325  0.1076785660 -0.4662147270  0.0451350470 -0.3769320893
##            36            37            38            39            40
##  0.1540314879 -0.1983508542 -0.9945930624  0.3447092973  0.0545626236
##            41            42            43            44            45
## -0.2096120725  0.0752916896  0.3024517243  0.1751854880  0.7778985571
##            46            47            48            49            50
## -0.4092876556 -0.0665065024 -0.0569332802 -0.3050195721 -0.1622872106
##            51            52            53            54            55
## -0.3527929027 -0.6704555158  0.3191934229  0.0870063838  0.6387602152
##            56            57            58            59            60
##  0.1508932495 -0.0648512329 -0.0001929742  0.0825673759  0.6734141736
##            61            62            63            64            65
## -0.0790527852  0.3404305505 -0.2913127871 -0.1156633731 -0.4660592342
##            66            67            68            69            70
##  0.2085487346  0.1531184154 -0.1542875842  0.6367520667 -0.2144786245
##            71            72            73            74            75
##  0.3866402140 -0.0015212773  0.0096457889  1.4453521716 -0.5360540507
##            76            77            78            79            80
## -0.5195719905  0.4484531571 -0.3020273083 -0.0445622912 -0.0144437724
##            81            82            83            84            85
##  0.0052252415  0.5739850587  0.2799007270  0.3831818594 -0.1468072788
##            86            87            88            89            90
## -0.7933580273 -0.4888879508  0.1953072497  0.6119965614 -0.6819625978
##            91            92            93            94            95
## -0.2384441873 -0.1715401714  0.4220239862  0.3861182413 -0.4564460425
##            96            97            98            99           100
## -0.2475566759 -0.0749548485 -0.3302797128  0.1928829140  0.4438447239
##           101           102           103           104           105
##  0.2671760231  0.0214916075  1.7496562215 -0.2152739652 -0.0060845290
##           106           107           108           109           110
##  0.0416992543 -0.0952660488  0.6401604124 -0.0581459973  0.3631657152
##           111           112           113           114           115
##  0.1955686962  0.2861454428 -2.4197629906 -0.2601548728 -0.2179390655
##           116           117           118           119           120
## -0.0959731913  0.5784300415 -0.7325487610  0.4872881785 -0.2373378236
##           121           122           123           124           125
##  0.2477222495 -0.4745729914 -0.4186439442  0.5777408225  0.3506959115
##           126           127           128           129           130
## -0.4865395860 -0.3066477603 -0.3696171351 -0.0441448841  1.1227601097
##           131           132           133           134           135
## -0.1223753913 -0.1788500726 -0.4046291129  0.2596750265  0.1788586731
##           136           137           138           139           140
##  0.4878536866 -0.3841228046  0.1042148250 -0.1251903926 -0.0164320691
##           141           142           143           144           145
## -0.7354238081  0.2860410507  0.4175497064  0.3921764334 -0.2677096983
##           146           147           148           149           150
```

```
##  0.6842659805  0.6810975131  0.0591282829  0.3254489960  0.5329426486
##           151           152           153           154           155
## -0.2972669862  0.2048235407  0.3765686191  0.1474531422  0.4177142940
##           156           157           158           159           160
## -0.3741389456 -0.2562147395 -0.8403145924 -0.5428789985  0.5250499136
##           161           162           163           164           165
##  0.8060669846 -0.5842859240  0.1227519861  0.4799655898  0.6134723818
##           166           167           168           169           170
## -0.4770502259  0.0995704022  0.0416215944 -0.7248350873  0.0688208279
##           171           172           173           174           175
## -0.2124112209 -0.8596249461 -0.5437982863 -0.9722212184 -0.4605385424
##           176           177
##  1.3079955513  0.0919640239
## attr(,"label")
## [1] "log(salary)"
## attr(,"format.stata")
## [1] "%9.0g"
```

```
standardised_residuals <- rstandard(OLS_estimate_salary)
standardised_residuals
```

```
##             1             2             3             4             5
##  0.1537627164  0.0178263441 -0.3267869642 -0.4074059778  0.0027723001
##             6             7             8             9            10
## -0.3512278504  0.8505510750  0.5309998045 -0.0586667840  0.4525889639
##            11            12            13            14            15
## -0.1525508901 -0.9957036137  2.1528202078 -0.5867724651  0.1342193252
##            16            17            18            19            20
## -1.2575305050  0.5340577232  1.7154888376  0.4846139495  0.2247724829
##            21            22            23            24            25
## -1.1160667091  0.1855321639  0.0051281525 -1.0818914339 -0.5770761291
##            26            27            28            29            30
## -0.5102404192  0.5905041483 -0.8033058227  0.0150514529 -2.8813141742
##            31            32            33            34            35
##  0.7925881606  0.2185908134 -0.9491191323  0.0927831452 -0.7654534673
##            36            37            38            39            40
##  0.3131279139 -0.4008619471 -2.0402159042  0.7072065077  0.1134104329
##            41            42            43            44            45
## -0.4253861902  0.1539058558  0.6216351178  0.3631083441  1.5844149320
##            46            47            48            49            50
## -0.8284146227 -0.1360160992 -0.1159230761 -0.6327069977 -0.3351307270
##            51            52            53            54            55
## -0.7170123272 -1.3636324861  0.6472105596  0.1774469810  1.2959091880
##            56            57            58            59            60
##  0.3093756637 -0.1325058772 -0.0003903838  0.1680835095  1.3663694247
##            61            62            63            64            65
## -0.1609851635  0.6986723401 -0.5918317348 -0.2340797765 -0.9417097109
##            66            67            68            69            70
##  0.4252500821  0.3141939400 -0.3124566393  1.3022810687 -0.4382440547
##            71            72            73            74            75
##  0.7825914100 -0.0031073294  0.0200674291  2.9296866253 -1.0844160179
##            76            77            78            79            80
## -1.0499724674  0.9178886591 -0.6140356504 -0.0905215539 -0.0292933890
##            81            82            83            84            85
##  0.0106195242  1.1636551859  0.5665266203  0.7748161526 -0.2997521486
```

```
##           86           87           88           89           90
## -1.6479671869 -0.9879370241  0.3966670349  1.2376762344 -1.3818081388
##           91           92           93           94           95
## -0.4883501827 -0.3483918126  0.8627610744  0.7831483885 -0.9259884038
##           96           97           98           99          100
## -0.5008282826 -0.1520852924 -0.6694739059  0.3945736799  0.8993774245
##          101          102          103          104          105
##  0.5451288813  0.0436587030  3.5522777545 -0.4367748226 -0.0123065805
##          106          107          108          109          110
##  0.0854605068 -0.1956556283  1.2958826924 -0.1181536708  0.7375290244
##          111          112          113          114          115
##  0.4008544625  0.5878715853 -5.0449182642 -0.5285123564 -0.4419209749
##          116          117          118          119          120
## -0.1955726841  1.1970194818 -1.5050156993  0.9921361568 -0.4815370193
##          121          122          123          124          125
##  0.5931891944 -0.9876213219 -0.8476258513  1.1890639423  0.7083833390
##          126          127          128          129          130
## -0.9928729580 -0.6280643880 -0.7584891517 -0.0902097464  2.2801892152
##          131          132          133          134          135
## -0.2488673862 -0.3620685545 -0.8242829121  0.5260487068  0.3756878393
##          136          137          138          139          140
##  1.0883011287 -0.7833841134  0.2127112604 -0.2545212330 -0.0332731061
##          141          142          143          144          145
## -1.4952336813  0.5798309280  0.8460231410  0.7971370503 -0.5439654235
##          146          147          148          149          150
##  1.3975018824  1.3790141943  0.1201795586  0.6611144651  1.0796482172
##          151          152          153          154          155
## -0.6027205460  0.4150867380  0.7684289917  0.3006363144  0.8449449324
##          156          157          158          159          160
## -0.7643260609 -0.5200605645 -1.7056737168 -1.1040363055  1.0682295111
##          161          162          163          164          165
##  1.6447236359 -1.1928278604  0.2486804970  0.9704040578  1.2411025278
##          166          167          168          169          170
## -0.9648321177  0.2033136786  0.0865968456 -1.4710890131  0.1405514993
##          171          172          173          174          175
## -0.4322073847 -1.7433700061 -1.1036728652 -1.9795851440 -0.9367339473
##          176          177
##  2.6691162788  0.1881773844
## attr(,"label")
## [1] "log(salary)"
## attr(,"format.stata")
## [1] "%9.0g"
```

#3e. RE-ESTIMATE MODEL BY ADDING DUMMY “COLLEGE” AND INTERACTION TERM "COLLEGE*LSALES". INTERPRETE COEFFICIENT OF INTERACTION TERM

```
OLS_reestimate_salary <- lm(lsalary ~ lsales + lmktval + ceoten + ceotensq + college + college*sales, da
summary(OLS_reestimate_salary)
```

```
##
## Call:
## lm(formula = lsalary ~ lsales + lmktval + ceoten + ceotensq +
##     college + college * sales, data = ceo_salary_df)
##
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -2.44555 -0.29258  0.00315  0.29093  1.74839
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    4.704e+00  4.724e-01   9.959  < 2e-16 ***
## lsales         1.627e-01  4.319e-02   3.766 0.000229 ***
## lmktval        1.159e-01  5.189e-02   2.234 0.026821 *
## ceoten         4.586e-02  1.421e-02   3.227 0.001503 **
## ceotensq      -1.209e-03  4.764e-04  -2.537 0.012072 *
## college       -3.852e-01  3.357e-01  -1.147 0.252866
## sales         -9.017e-05  5.901e-05  -1.528 0.128363
## college:sales  9.107e-05  5.829e-05   1.562 0.120072
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4977 on 169 degrees of freedom
## Multiple R-squared:  0.3524, Adjusted R-squared:  0.3255
## F-statistic: 13.14 on 7 and 169 DF,  p-value: 1.847e-13
```

#3f. RE-ESTIMATE MODEL WITH VARIABLE "LSALES_ADJUSTED" INSTEAD OF "LSALES". COMPARE COEFFICIENT ON "LSALES_ADJUSTED" WITH "LSALES"

```r
ceo_salary_df$lsales_adjusted <- ceo_salary_df$lsales * 0.9
OLS_reestimate_salary2 <- lm(lsalary ~ lsales_adjusted + lmktval + ceoten + ceotensq + college + college
summary(OLS_reestimate_salary2)
```

```
##
## Call:
## lm(formula = lsalary ~ lsales_adjusted + lmktval + ceoten + ceotensq +
##     college + college * sales, data = ceo_salary_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.44555 -0.29258  0.00315  0.29093  1.74839
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      4.704e+00  4.724e-01   9.959  < 2e-16 ***
## lsales_adjusted  1.807e-01  4.799e-02   3.766 0.000229 ***
## lmktval          1.159e-01  5.189e-02   2.234 0.026821 *
## ceoten           4.586e-02  1.421e-02   3.227 0.001503 **
## ceotensq        -1.209e-03  4.764e-04  -2.537 0.012072 *
## college         -3.852e-01  3.357e-01  -1.147 0.252866
## sales           -9.017e-05  5.901e-05  -1.528 0.128363
## college:sales    9.107e-05  5.829e-05   1.562 0.120072
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4977 on 169 degrees of freedom
## Multiple R-squared:  0.3524, Adjusted R-squared:  0.3255
## F-statistic: 13.14 on 7 and 169 DF,  p-value: 1.847e-13
```

Answer: The original coefficient of lsales is less than the coefficient of lsales_adjusted.

QUESTION 4

IMPORT DATA INTO R

```
library(haven)
library(sandwich)
library(foreign)
library(lmtest)
library(zoo)
library(dplyr)
library("plm")
```

```
## Warning: package 'plm' was built under R version 4.1.2

##
## Attaching package: 'plm'

## The following objects are masked from 'package:dplyr':
##
##     between, lag, lead
```

```
local_returns_df <-read_dta("Documents/4328 - Applied Financial Econometrics/Assignment/Assignment 1/HW
```

#4a. CONFIRM IF BALANCED OR UNBALANCED PANEL. PROVIDE AGGREGATE STATISTICS

```
local_returns_panel <- pdata.frame(local_returns_df, index = c("permno", "date"))
is.pbalanced(local_returns_panel)
```

```
## [1] FALSE
```

```
aggregate(local_returns_panel, list(local_returns_df$year), summary)
```

```
##    Group.1 permno.10001 permno.10012 permno.10016 permno.10025 permno.10026
## 1     2000           12           12           12           12           12
## 2     2001           12           12           12           12           12
## 3     2002           12           12           12           12           12
## 4     2003           12           12           12           12           12
## 5     2004           12           12           12           12           12
## 6     2005           12           12           12           12           12
## 7     2006           12           12           12           12           12
## 8     2007           12           12           12           12           12
## 9     2008           12           12           12           12           12
## 10    2009           12           12           12           12           12
## 11    2010           12           12           12           12           12
##    permno.10028 permno.10035 permno.10037 permno.10039 permno.10042
## 1            12           12           12           12           12
## 2            12           12           12           12           12
## 3            12           12           12           12           12
## 4            12           12           12           12           12
## 5            12           12           12           12           12
## 6            12           12           12           12           12
## 7            12           12           12           12           12
## 8            12           12           12           12           12
## 9            12           12           12           12           12
## 10           12           12           12           12           12
## 11           12           12           12           12           12
##    permno.10056 permno.10065 permno.10078 permno.10085 permno.10089
```

```
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10092 permno.10100 permno.10104 permno.10107 permno.10108
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10114 permno.10119 permno.10122 permno.10123 permno.10127
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10138 permno.10143 permno.10147 permno.10149 permno.10155
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10160 permno.10170 permno.10177 permno.10180 permno.10192
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
```

```
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10200 permno.10205 permno.10216 permno.10225 permno.10230
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10235 permno.10238 permno.10239 permno.10244 permno.10252
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10256 permno.10257 permno.10259 permno.10271 permno.10275
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10294 permno.10297 permno.10299 permno.10302 permno.10304
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10318 permno.10324 permno.10325 permno.10333 permno.10341
```

```
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10346 permno.10353 permno.10355 permno.10362 permno.10363
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10371 permno.10375 permno.10382 permno.10383 permno.10395
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10401 permno.10404 permno.10418 permno.10423 permno.10453
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
## 7           12           12           12           12           12
## 8           12           12           12           12           12
## 9           12           12           12           12           12
## 10          12           12           12           12           12
## 11          12           12           12           12           12
##    permno.10463 permno.10467 permno.10484 permno.10501 permno.10507
## 1           12           12           12           12           12
## 2           12           12           12           12           12
## 3           12           12           12           12           12
## 4           12           12           12           12           12
## 5           12           12           12           12           12
## 6           12           12           12           12           12
```

```
## 7            12           12           12           12           12
## 8            12           12           12           12           12
## 9            12           12           12           12           12
## 10           12           12           12           12           12
## 11           12           12           12           12           12
##    permno.10516 permno.10517 permno.10547 permno.10550 permno.10562
## 1            12           12           12           12           12
## 2            12           12           12           12           12
## 3            12           12           12           12           12
## 4            12           12           12           12           12
## 5            12           12           12           12           12
## 6            12           12           12           12           12
## 7            12           12           12           12           12
## 8            12           12           12           12           12
## 9            12           12           12           12           12
## 10           12           12           12           12           12
## 11           12           12           12           12           12
##    permno.10563 permno.10564 permno.10574 permno.10588 permno.10594
## 1            12           12           12           12           12
## 2            12           12           12           12           12
## 3            12           12           12           12           12
## 4            12           12           12           12           12
## 5            12           12           12           12           12
## 6            12           12           12           12           12
## 7            12           12           12           12           12
## 8            12           12           12           12           12
## 9            12           12           12           12           12
## 10           12           12           12           12           12
## 11           12           12           12           12           12
##    permno.10606 permno.10622 permno.10623 permno.10628 permno.10629
## 1            12           12           12           12           12
## 2            12           12           12           12           12
## 3            12           12           12           12           12
## 4            12           12           12           12           12
## 5            12           12           12           12           12
## 6            12           12           12           12           12
## 7            12           12           12           12           12
## 8            12           12           12           12           12
## 9            12           12           12           12           12
## 10           12           12           12           12           12
## 11           12           12           12           12           12
##    permno.10638 permno.10644 permno.10645 permno.10656 permno.(Other) year.Min.
## 1            12           12           12           12          53911      2000
## 2            12           12           12           12          49672      2001
## 3            12           12           12           12          45674      2002
## 4            12           12           12           12          42583      2003
## 5            12           12           12           12          41804      2004
## 6            12           12           12           12          42084      2005
## 7            12           12           12           12          41871      2006
## 8            12           12           12           12          41753      2007
## 9            12           12           12           12          40823      2008
## 10           12           12           12           12          38012      2009
## 11           12           12           12           12          36327      2010
##    year.1st Qu. year.Median year.Mean year.3rd Qu. year.Max.      ret.Min.
```

```
## 1          2000        2000      2000         2000      2000 -0.9615384340
## 2          2001        2001      2001         2001      2001 -0.9812949896
## 3          2002        2002      2002         2002      2002 -0.9136441946
## 4          2003        2003      2003         2003      2003 -0.9418604374
## 5          2004        2004      2004         2004      2004 -0.9187499881
## 6          2005        2005      2005         2005      2005 -0.7966101766
## 7          2006        2006      2006         2006      2006 -0.8791540861
## 8          2007        2007      2007         2007      2007 -0.9526842237
## 9          2008        2008      2008         2008      2008 -0.9641255736
## 10         2009        2009      2009         2009      2009 -0.9111764431
## 11         2010        2010      2010         2010      2010 -0.8269895911
##      ret.1st Qu.    ret.Median      ret.Mean   ret.3rd Qu.      ret.Max.
## 1  -0.1319444478 -0.0121457493 -0.0100748903  0.0762799233  5.6029410362
## 2  -0.0912109297  0.0041152174  0.0246395190  0.0951333176  8.6666669846
## 3  -0.0986666381 -0.0070422466 -0.0082690645  0.0588293783  5.6399998665
## 4  -0.0297778100  0.0220364723  0.0483819156  0.0924368799  4.6250000000
## 5  -0.0434782617  0.0107526523  0.0166063852  0.0633954648  3.7428572178
## 6  -0.0512122111  0.0006675515  0.0039563130  0.0502267452  3.3032786846
## 7  -0.0381936785  0.0082634622  0.0139527424  0.0573521405  4.0229883194
## 8  -0.0571625941 -0.0044943779 -0.0050265961  0.0421818122  5.8010077477
## 9  -0.1347608566 -0.0310461428 -0.0431089926  0.0432299748  4.8999996185
## 10 -0.0542604206  0.0251198402  0.0481144160  0.1123742256 15.7741928101
## 11 -0.0464502219  0.0150435138  0.0233956206  0.0778974518  6.1071429253
##    city.Min. city.1st Qu. city.Median city.Mean city.3rd Qu. city.Max.
## 1    1.00000      5.00000    11.00000  10.44184     15.00000  20.00000
## 2    1.00000      5.00000    11.00000  10.43189     15.00000  20.00000
## 3    1.00000      5.00000    11.00000  10.42132     15.00000  20.00000
## 4    1.00000      5.00000    11.00000  10.35514     15.00000  20.00000
## 5    1.00000      5.00000    11.00000  10.33350     15.00000  20.00000
## 6    1.00000      5.00000    11.00000  10.34364     15.00000  20.00000
## 7    1.00000      5.00000    12.00000  10.34998     15.00000  20.00000
## 8    1.00000      5.00000    12.00000  10.36830     15.00000  20.00000
## 9    1.00000      5.00000    12.00000  10.40040     15.00000  20.00000
## 10   1.00000      5.00000    11.00000  10.33793     15.00000  20.00000
## 11   1.00000      5.00000    11.00000  10.28741     15.00000  20.00000
##     ind.Min. ind.1st Qu. ind.Median  ind.Mean ind.3rd Qu.  ind.Max. date.480
## 1   1.000000    6.000000   9.000000  8.102216   11.000000 12.000000     4642
## 2   1.000000    6.000000   9.000000  8.112328   11.000000 12.000000     4455
## 3   1.000000    6.000000   9.000000  8.170074   11.000000 12.000000     4032
## 4   1.000000    6.000000  10.000000  8.264376   11.000000 12.000000     3776
## 5   1.000000    6.000000  10.000000  8.321316   11.000000 12.000000     3596
## 6   1.000000    6.000000  10.000000  8.400166   11.000000 12.000000     3618
## 7   1.000000    6.000000  10.000000  8.414710   11.000000 12.000000     3598
## 8   1.000000    6.000000  10.000000  8.444424   11.000000 12.000000     3603
## 9   1.000000    6.000000  10.000000  8.472424   11.000000 12.000000     3570
## 10  1.000000    6.000000  10.000000  8.461531   11.000000 12.000000     3373
## 11  1.000000    6.000000  10.000000  8.429695   11.000000 12.000000     3172
##    date.484 date.481 date.483 date.482 date.488 date.486 date.485 date.487
## 1      4621     4610     4609     4605     4600     4598     4592     4590
## 2      4426     4384     4337     4282     4240     4213     4155     4130
## 3      3998     3972     3948     3934     3919     3894     3864     3853
## 4      3754     3710     3684     3657     3639     3620     3600     3594
## 5      3593     3592     3586     3585     3581     3581     3580     3577
## 6      3612     3610     3608     3607     3607     3606     3606     3605
```

```
## 7      3595     3590     3590     3590     3590     3589     3587     3586
## 8      3597     3591     3588     3583     3579     3577     3574     3569
## 9      3565     3557     3542     3522     3521     3502     3485     3473
## 10     3352     3329     3302     3284     3258     3248     3237     3225
## 11     3157     3151     3142     3140     3138     3125     3119     3112
##    date.489 date.490 date.491 date.492 date.493 date.494 date.495 date.496
## 1      4588     4545     4499        0        0        0        0        0
## 2      4112     4070     4056        0        0        0        0        0
## 3      3824     3820     3804        0        0        0        0        0
## 4      3585     3577     3575        0        0        0        0        0
## 5      3575     3574     3572        0        0        0        0        0
## 6      3603     3597     3593        0        0        0        0        0
## 7      3582     3581     3581        0        0        0        0        0
## 8      3563     3562     3555        0        0        0        0        0
## 9      3454     3423     3397        0        0        0        0        0
## 10     3209     3198     3185        0        0        0        0        0
## 11     3099     3087     3073        0        0        0        0        0
##    date.497 date.498 date.499 date.500 date.501 date.502 date.503 date.504
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
## 7         0        0        0        0        0        0        0        0
## 8         0        0        0        0        0        0        0        0
## 9         0        0        0        0        0        0        0        0
## 10        0        0        0        0        0        0        0        0
## 11        0        0        0        0        0        0        0        0
##    date.505 date.506 date.507 date.508 date.509 date.510 date.511 date.512
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
## 7         0        0        0        0        0        0        0        0
## 8         0        0        0        0        0        0        0        0
## 9         0        0        0        0        0        0        0        0
## 10        0        0        0        0        0        0        0        0
## 11        0        0        0        0        0        0        0        0
##    date.513 date.514 date.515 date.516 date.517 date.518 date.519 date.520
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
## 7         0        0        0        0        0        0        0        0
## 8         0        0        0        0        0        0        0        0
## 9         0        0        0        0        0        0        0        0
## 10        0        0        0        0        0        0        0        0
## 11        0        0        0        0        0        0        0        0
##    date.521 date.522 date.523 date.524 date.525 date.526 date.527 date.528
```

```
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
## 7         0        0        0        0        0        0        0        0
## 8         0        0        0        0        0        0        0        0
## 9         0        0        0        0        0        0        0        0
## 10        0        0        0        0        0        0        0        0
## 11        0        0        0        0        0        0        0        0
##    date.529 date.530 date.531 date.532 date.533 date.534 date.535 date.536
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
## 7         0        0        0        0        0        0        0        0
## 8         0        0        0        0        0        0        0        0
## 9         0        0        0        0        0        0        0        0
## 10        0        0        0        0        0        0        0        0
## 11        0        0        0        0        0        0        0        0
##    date.537 date.538 date.539 date.540 date.541 date.542 date.543 date.544
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
## 7         0        0        0        0        0        0        0        0
## 8         0        0        0        0        0        0        0        0
## 9         0        0        0        0        0        0        0        0
## 10        0        0        0        0        0        0        0        0
## 11        0        0        0        0        0        0        0        0
##    date.545 date.546 date.547 date.548 date.549 date.550 date.551 date.552
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
## 7         0        0        0        0        0        0        0        0
## 8         0        0        0        0        0        0        0        0
## 9         0        0        0        0        0        0        0        0
## 10        0        0        0        0        0        0        0        0
## 11        0        0        0        0        0        0        0        0
##    date.553 date.554 date.555 date.556 date.557 date.558 date.559 date.560
## 1         0        0        0        0        0        0        0        0
## 2         0        0        0        0        0        0        0        0
## 3         0        0        0        0        0        0        0        0
## 4         0        0        0        0        0        0        0        0
## 5         0        0        0        0        0        0        0        0
## 6         0        0        0        0        0        0        0        0
```

```
## 7          0        0        0        0        0        0        0        0
## 8          0        0        0        0        0        0        0        0
## 9          0        0        0        0        0        0        0        0
## 10         0        0        0        0        0        0        0        0
## 11         0        0        0        0        0        0        0        0
##    date.561 date.562 date.563 date.564 date.565 date.566 date.567 date.568
## 1          0        0        0        0        0        0        0        0
## 2          0        0        0        0        0        0        0        0
## 3          0        0        0        0        0        0        0        0
## 4          0        0        0        0        0        0        0        0
## 5          0        0        0        0        0        0        0        0
## 6          0        0        0        0        0        0        0        0
## 7          0        0        0        0        0        0        0        0
## 8          0        0        0        0        0        0        0        0
## 9          0        0        0        0        0        0        0        0
## 10         0        0        0        0        0        0        0        0
## 11         0        0        0        0        0        0        0        0
##    date.569 date.570 date.571 date.572 date.573 date.574 date.575 date.576
## 1          0        0        0        0        0        0        0        0
## 2          0        0        0        0        0        0        0        0
## 3          0        0        0        0        0        0        0        0
## 4          0        0        0        0        0        0        0        0
## 5          0        0        0        0        0        0        0        0
## 6          0        0        0        0        0        0        0        0
## 7          0        0        0        0        0        0        0        0
## 8          0        0        0        0        0        0        0        0
## 9          0        0        0        0        0        0        0        0
## 10         0        0        0        0        0        0        0        0
## 11         0        0        0        0        0        0        0        0
##    date.577 date.578 date.(Other) city_returns.Min. city_returns.1st Qu.
## 1          0        0            0      -0.270534486         -0.069581896
## 2          0        0            0      -0.230681196         -0.052691292
## 3          0        0            0      -0.201631397         -0.060558319
## 4          0        0            0      -0.057042830          0.016218796
## 5          0        0            0      -0.149902940         -0.007337616
## 6          0        0            0      -0.123852029         -0.028083174
## 7          0        0            0      -0.118696563         -0.005877608
## 8          0        0            0      -0.157961637         -0.019134125
## 9          0        0            0      -0.299503535         -0.102640361
## 10         0        0            0      -0.171920344          0.001067523
## 11         0        0            0      -0.123967253         -0.027859902
##    city_returns.Median city_returns.Mean city_returns.3rd Qu. city_returns.Max.
## 1         -0.021834882      -0.009747969          0.055983528       0.344486326
## 2          0.029200688       0.024860797          0.079776831       0.422849029
## 3         -0.012173467      -0.008786427          0.032210965       0.315815747
## 4          0.043276556       0.049337457          0.077847213       0.272160679
## 5          0.015159218       0.017589902          0.050050143       0.187615231
## 6          0.002705623       0.003818538          0.032051869       0.115589522
## 7          0.014673841       0.014150576          0.035127830       0.179933280
## 8          0.001114333      -0.004535199          0.018248394       0.094374500
## 9         -0.027299616      -0.043640268          0.022113474       0.150761425
## 10         0.063041970       0.050115572          0.092088118       0.483421147
## 11         0.038584746       0.024098869          0.071188457       0.200951740
##        MRP.Min.  MRP.1st Qu.   MRP.Median     MRP.Mean  MRP.3rd Qu.
```

```
## 1  -0.107200000 -0.047400000 -0.027600000 -0.013748502  0.046400000
## 2  -0.100500000 -0.072600000 -0.019400000 -0.011749072  0.031300000
## 3  -0.103500000 -0.057600000 -0.014400000 -0.019482284  0.005000000
## 4  -0.025700000 -0.012400000  0.014200000  0.022684816  0.042900000
## 5  -0.040600000  0.000800000  0.014300000  0.008737202  0.021500000
## 6  -0.027600000 -0.019700000  0.004900000  0.002760376  0.036100000
## 7  -0.035700000 -0.003000000  0.014600000  0.008264604  0.020300000
## 8  -0.048300000 -0.019600000  0.009200000  0.001176638  0.032200000
## 9  -0.172300000 -0.078600000 -0.030900000 -0.036624601  0.015300000
## 10 -0.101000000 -0.025900000  0.033300000  0.022435878  0.077200000
## 11 -0.078900000 -0.047700000  0.020000000  0.014747901  0.063100000
##        MRP.Max.      HML.Min.   HML.1st Qu.    HML.Median      HML.Mean
## 1   0.070300000 -0.1261000000 -0.0123000000  0.0481000000  0.0293780268
## 2   0.079400000 -0.0706000000 -0.0436000000  0.0178000000  0.0134248230
## 3   0.078400000 -0.0646000000  0.0115000000  0.0229000000  0.0107105373
## 4   0.082200000 -0.0206000000 -0.0144000000  0.0009000000  0.0027210893
## 5   0.045400000 -0.0167000000 -0.0036000000  0.0039000000  0.0071065012
## 6   0.039200000 -0.0179000000 -0.0069000000  0.0113000000  0.0070781267
## 7   0.032300000 -0.0176000000 -0.0010000000  0.0119000000  0.0102491883
## 8   0.034900000 -0.0299000000 -0.0214000000 -0.0107000000 -0.0101178827
## 9   0.046000000 -0.0493000000 -0.0106000000 -0.0003000000  0.0020498893
## 10  0.101900000 -0.0986000000 -0.0437000000  0.0056000000 -0.0006602551
## 11  0.095400000 -0.0428000000 -0.0235000000  0.0009000000 -0.0013699960
##       HML.3rd Qu.      HML.Max.      RF.Min.   RF.1st Qu.    RF.Median
## 1   0.0765000000  0.1232000000 4.000000e-03 4.300000e-03 4.800000e-03
## 2   0.0564000000  0.1388000000 1.500000e-03 2.800000e-03 3.100000e-03
## 3   0.0387000000  0.0423000000 1.100000e-03 1.300000e-03 1.400000e-03
## 4   0.0146000000  0.0271000000 7.000000e-04 7.000000e-04 9.000000e-04
## 5   0.0167000000  0.0452000000 6.000000e-04 8.000000e-04 1.000000e-03
## 6   0.0175000000  0.0285000000 1.600000e-03 2.100000e-03 2.400000e-03
## 7   0.0252000000  0.0327000000 3.400000e-03 3.600000e-03 4.000000e-03
## 8  -0.0002000000  0.0039000000 2.700000e-03 3.400000e-03 4.000000e-03
## 9   0.0307000000  0.0441000000 0.000000e+00 1.300000e-03 1.500000e-03
## 10  0.0260000000  0.0757000000 0.000000e+00 0.000000e+00 1.000000e-04
## 11  0.0205000000  0.0336000000 0.000000e+00 1.000000e-04 1.000000e-04
##           RF.Mean   RF.3rd Qu.       RF.Max.      MOM.Min.   MOM.1st Qu.
## 1  4.773604e-03 5.000000e-03 5.600000e-03 -0.0906000000 -0.0680000000
## 2  3.163787e-03 3.900000e-03 5.400000e-03 -0.2501000000 -0.0812000000
## 3  1.350708e-03 1.400000e-03 1.500000e-03 -0.1628000000  0.0175000000
## 4  8.517397e-04 1.000000e-03 1.000000e-03 -0.1076000000 -0.0102000000
## 5  9.838900e-04 1.100000e-03 1.600000e-03 -0.0536000000 -0.0150000000
## 6  2.450143e-03 2.900000e-03 3.200000e-03 -0.0131000000  0.0004000000
## 7  3.924729e-03 4.100000e-03 4.300000e-03 -0.0370000000 -0.0182000000
## 8  3.809546e-03 4.200000e-03 4.400000e-03 -0.0133000000 -0.0016000000
## 9  1.324948e-03 1.800000e-03 2.100000e-03 -0.0781000000 -0.0405000000
## 10 7.516582e-05 1.000000e-04 2.000000e-04 -0.3458000000 -0.1153000000
## 11 8.312941e-05 1.000000e-04 1.000000e-04 -0.0536000000 -0.0298000000
##       MOM.Median      MOM.Mean   MOM.3rd Qu.      MOM.Max.  indret.Min.
## 1  -0.0012000000  0.0163667526  0.0570000000  0.1838000000 -0.231696367
## 2   0.0217000000 -0.0038333641  0.0838000000  0.1248000000 -0.199510977
## 3   0.0376000000  0.0239051321  0.0679000000  0.0962000000 -0.198041797
## 4  -0.0019000000 -0.0151266249  0.0152000000  0.0375000000 -0.065995745
## 5   0.0020000000  0.0003643864  0.0259000000  0.0526000000 -0.125920936
## 6   0.0054000000  0.0117245031  0.0246000000  0.0350000000 -0.093874954
```

```
## 7  -0.0026000000 -0.0053262152  0.0124000000  0.0276000000 -0.115569755
## 8   0.0030000000  0.0175373489  0.0279000000  0.0654000000 -0.154650033
## 9   0.0322000000  0.0157833353  0.0611000000  0.1245000000 -0.309580952
## 10 -0.0500000000 -0.0540570281  0.0264000000  0.0531000000 -0.205032170
## 11  0.0136000000  0.0047365454  0.0321000000  0.0368000000 -0.119565889
##    indret.1st Qu. indret.Median  indret.Mean indret.3rd Qu.  indret.Max.
## 1    -0.052548133  -0.007632487 -0.000873050    0.028119655  0.416101128
## 2    -0.032575607   0.023592338  0.025786685    0.071124643  0.480341494
## 3    -0.047627989   0.005931754 -0.005631135    0.035642218  0.285326600
## 4     0.014074927   0.043373980  0.046605819    0.066260874  0.298667014
## 5    -0.004751768   0.018252801  0.018300291    0.040691782  0.260545909
## 6    -0.019288585   0.001436898  0.004841844    0.029061180  0.173220903
## 7    -0.001106735   0.015605695  0.013783091    0.030768951  0.195191547
## 8    -0.028508164  -0.001335449 -0.006057680    0.014753194  0.104822814
## 9    -0.097998999  -0.014430972 -0.040644081    0.010713807  0.232047364
## 10   -0.012664497   0.049110822  0.041098763    0.096727975  0.390912533
## 11   -0.033044849   0.038807660  0.021072395    0.067907922  0.180234089
```

Answer: The panel is unbalanced.

#4c. ESTIMATE PANEL REGRESSION

```
local_returns_estimation <- lm(ret ~ city_returns + indret, data = local_returns_panel)
summary(local_returns_estimation)
```

```
##
## Call:
## lm(formula = ret ~ city_returns + indret, data = local_returns_panel)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.1930 -0.0739 -0.0067  0.0577 15.6429
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.0014572  0.0002687  -5.424 5.83e-08 ***
## city_returns  0.2121668  0.0051632  41.092  < 2e-16 ***
## indret        0.8558370  0.0049870 171.613  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1857 on 487579 degrees of freedom
## Multiple R-squared:  0.1502, Adjusted R-squared:  0.1502
## F-statistic: 4.31e+04 on 2 and 487579 DF,  p-value: < 2.2e-16
```

#4d. ESTIMATE PANEL REGRESSION USING POOLED OLS WITHOUT DUMMIES

```
local_returns_estimation_pooled <- plm(ret ~ city_returns + indret, data = local_returns_panel, model =
summary(local_returns_estimation_pooled)
```

```
## Pooling Model
##
## Call:
## plm(formula = ret ~ city_returns + indret, data = local_returns_panel,
##     model = "pooling")
##
## Unbalanced Panel: n = 6783, T = 1-132, N = 487582
```

```
##
## Residuals:
##       Min.    1st Qu.     Median    3rd Qu.       Max.
## -1.1929686 -0.0739028 -0.0067361  0.0576988 15.6428882
##
## Coefficients:
##                 Estimate  Std. Error  t-value  Pr(>|t|)
## (Intercept)  -0.00145716  0.00026866  -5.4239 5.834e-08 ***
## city_returns  0.21216676  0.00516315  41.0925 < 2.2e-16 ***
## indret        0.85583696  0.00498702 171.6127 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    19778
## Residual Sum of Squares: 16807
## R-Squared:      0.15022
## Adj. R-Squared: 0.15022
## F-statistic: 43095.7 on 2 and 487579 DF, p-value: < 2.22e-16
```

#4e. TEST FOR HETEROSKEDASTICITY IN THE RESIDUALS

```
bptest(local_returns_estimation_pooled, data = local_returns_panel, studentize = F)
```

```
##
##  Breusch-Pagan test
##
## data:  local_returns_estimation_pooled
## BP = 85052, df = 2, p-value < 2.2e-16
```

Answer: The p-value is less than 5%. Hence, at 5% significance level we reject the null hypothesis and conclude that there is heteroskedasticity in the residuals.

#4g. ESTIMATE PANEL REGRESSION USING POOLED OLS WITH TIME AND FIRM FIXED EFFECTS. COMPARE RESULTS

```
library(Matrix)
library(lfe)
```

```
##
## Attaching package: 'lfe'

## The following object is masked from 'package:plm':
##
##     sargan

## The following object is masked from 'package:lmtest':
##
##     waldtest
```

```
local_returns_estimation_pooled_results_bothtimeandfirm <-felm(ret ~ city_returns + indret | permno + ye
summary(local_returns_estimation_pooled_results_bothtimeandfirm)
```

```
##
## Call:
##    felm(formula = ret ~ city_returns + indret | permno + year |      0 | 0, data = local_returns_pane
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.3031 -0.0743 -0.0075  0.0566 14.9957
```

```
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## city_returns 0.211815   0.005294   40.01   <2e-16 ***
## indret       0.854208   0.005032  169.75   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1852 on 480787 degrees of freedom
## Multiple R-squared(full model): 0.166   Adjusted R-squared: 0.1542
## Multiple R-squared(proj model): 0.138   Adjusted R-squared: 0.1258
## F-statistic(full model):14.09 on 6794 and 480787 DF, p-value: < 2.2e-16
## F-statistic(proj model): 3.849e+04 on 2 and 480787 DF, p-value: < 2.2e-16
```

#4h. ESTIMATE PANEL REGRESSION USING POOLED OLS WITH TIME AND FIRM FIXED EFFECTS, AND WITH DOUBLE CLUSTERING ON BOTH FIRM AND TIME DIMENSIONS

```
local_returns_estimation_pooled_results_bothtimeandfirm_clust <-felm(ret ~ city_returns + indret | permn
summary(local_returns_estimation_pooled_results_bothtimeandfirm_clust)
```

```
##
## Call:
##    felm(formula = ret ~ city_returns + indret | permno + year |      0 | permno + year, data = local_
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.3031 -0.0743 -0.0075  0.0566 14.9957
##
## Coefficients:
##              Estimate Cluster s.e. t value Pr(>|t|)
## city_returns  0.21182      0.02087   10.15 1.39e-06 ***
## indret        0.85421      0.05159   16.56 1.35e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1852 on 480787 degrees of freedom
## Multiple R-squared(full model): 0.166   Adjusted R-squared: 0.1542
## Multiple R-squared(proj model): 0.138   Adjusted R-squared: 0.1258
## F-statistic(full model, *iid*):14.09 on 6794 and 480787 DF, p-value: < 2.2e-16
## F-statistic(proj model): 785.5 on 2 and 10 DF, p-value: 1.012e-11
```

#4i. ESTIMATE PANEL REGRESSION USING FIXED EFFECT (FE) ESTIMATOR

```
local_returns_estimation_firmfe <-felm(ret ~ city_returns + indret | permno | 0 | 0, data=local_returns_
summary(local_returns_estimation_firmfe)
```

```
##
## Call:
##    felm(formula = ret ~ city_returns + indret | permno | 0 | 0,      data = local_returns_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.3028 -0.0744 -0.0076  0.0566 14.9962
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
```

```
## city_returns 0.211136   0.005184   40.73   <2e-16 ***
## indret       0.854034   0.005014  170.34   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1852 on 480797 degrees of freedom
## Multiple R-squared(full model): 0.166   Adjusted R-squared: 0.1542
## Multiple R-squared(proj model): 0.1511   Adjusted R-squared: 0.1391
## F-statistic(full model): 14.1 on 6784 and 480797 DF, p-value: < 2.2e-16
## F-statistic(proj model): 4.278e+04 on 2 and 480797 DF, p-value: < 2.2e-16
```

#4j. ESTIMATE PANEL REGRESSION USING FIRST DIFFERENCE (FD) ESTIMATOR

```
local_returns_estimation_firstdiff <- plm(ret ~ city_returns + indret, data=local_returns_df, model = "
```

```
## Warning in pdata.frame(data, index): duplicate couples (id-time) in resulting pdata.frame
##  to find out which, use, e.g., table(index(your_pdataframe), useNA = "ifany")
```

```
coef(summary(local_returns_estimation_firstdiff))
```

```
##                   Estimate   Std. Error     t-value Pr(>|t|)
## (Intercept)  -0.0002495018 0.0003832596  -0.6509997 0.515047
## city_returns  0.2173462840 0.0055628022  39.0713663 0.000000
## indret        0.8473646279 0.0052652998 160.9337866 0.000000
```