PS1Q3

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```
library("quantmod")
```

##(a) Compile quarterly data for the U.S. real gross private domestic investment (DI) from 1947Q1 to 2023Q4.

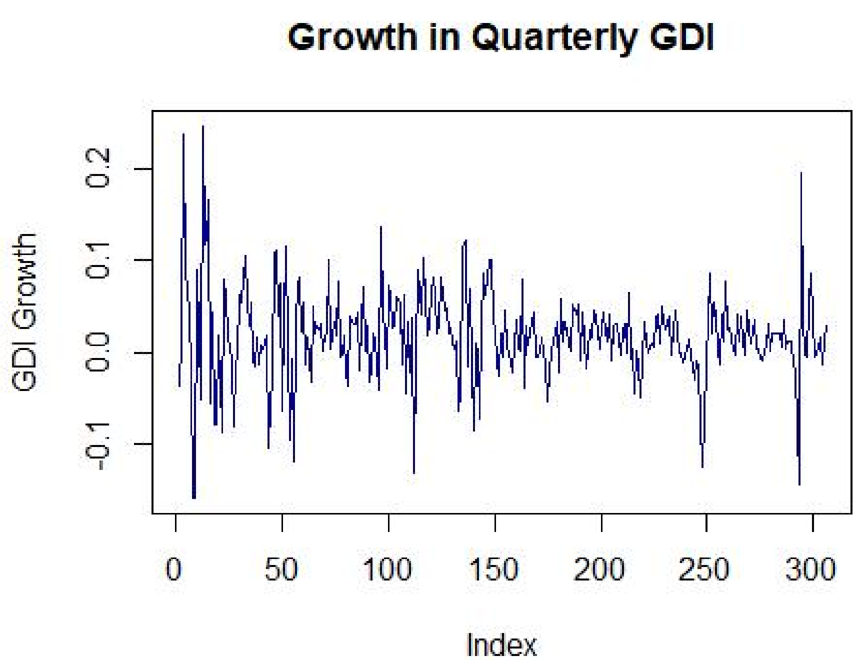
```
getSymbols(Symbols ="GPDI",src = "FRED", from = '1947/01/01')

## [1] "GPDI"

qua_di <- as.matrix(GPDI[,1])
qua_di_date = as.Date(row.names(qua_di))
n_obs_qua_di = length(qua_di_date)
```

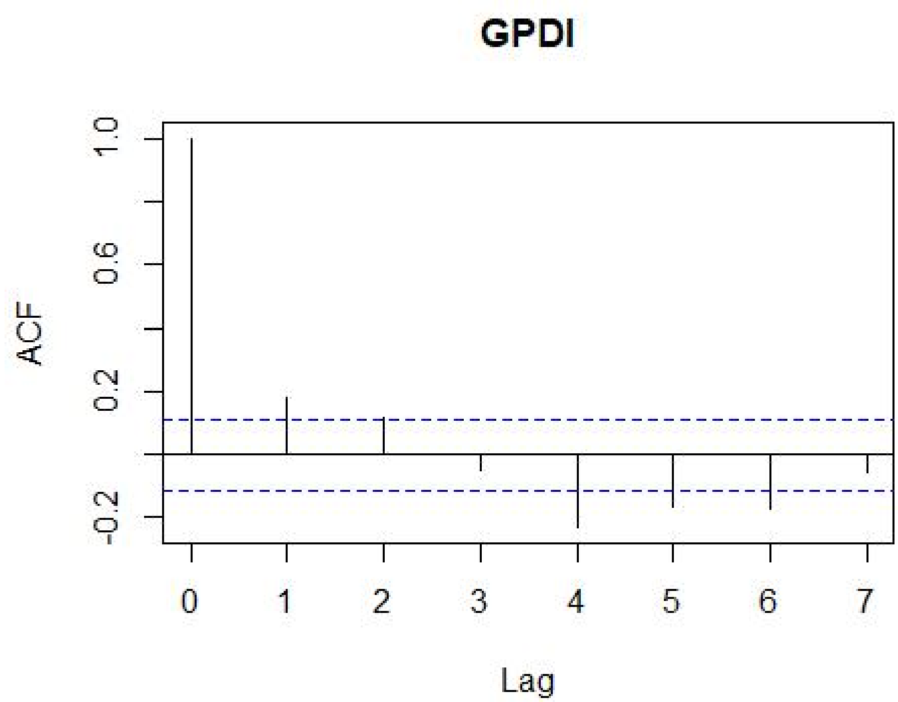
##(b) Compute growth in quarterly DI (GDI), provide its summary statistics and plot the data.

```
di_return <- diff(qua_di)/qua_di[1:n_obs_qua_di-1,1]
di_return_date = qua_di_date[2:n_obs_qua_di]
n_obs_qua_return = length(di_return_date)
plot(di_return, type = "l", col = "darkblue", main = "Growth in Quarterly
GDI", ylab = "GDI Growth")
```



##(c) Compute and plot empirical autocorrelation function. Given the plot, do you expect any time-series correlation among the observations? Explain why?

```
acf(di_return,lag=round(n_obs_qua_return^(1/3)))
```




```
ACF=acf(di_return,lag=round(n_obs_qua_return^(1/3)), plot = FALSE)
ACF$acf

## , , 1
##
##              [,1]
## [1,]  1.00000000
## [2,]  0.18230712
## [3,]  0.11675470
## [4,] -0.04992628
## [5,] -0.22861728
## [6,] -0.16254377
## [7,] -0.17190977
## [8,] -0.05641716
```

Yes I do expect some time-series correlation among the observations. Because there are some lags where the bars extend beyond the dotted lines.

##(d) Set the maximum number of lags to the integer closest to the number of observations to the power one-third. Perform a test for joint autocorrelation in GDI and report your result. Does your finding consistent with that of Part 3c? Explain why?

```
t_ratio <- ACF$acf[2]*sqrt(n_obs_qua_return)
t_ratio

## [1] 3.189072

Box.test(di_return, lag = round(n_obs_qua_return^(1/3)), type = "Ljung-Box")

##
##  Box-Ljung test
##
## data:  di_return
## X-squared = 50.143, df = 7, p-value = 1.354e-08

Box.test(di_return, lag = round(n_obs_qua_return^(1/3)), type = "Box-Pierce")

##
##  Box-Pierce test
##
## data:  di_return
## X-squared = 49.199, df = 7, p-value = 2.074e-08
```

##(e) Consider an AR(1) model and compute the theoretical autocorrelation function. Compare your findings with that of Part 3c.

```
lag_di_return = rbind(NA, as.matrix(di_return[1:(n_obs_qua_return-1),1]))
intercept = matrix(1,n_obs_qua_return)
X = cbind(intercept,lag_di_return)
y = di_return
reg_result = ols(X[2:n_obs_qua_return,],as.matrix(y[2:n_obs_qua_return,1]))
1 - sum(reg_result$u_hat^2)/sum(y^2)

## [1] 0.1381177

beta_hat = reg_result$beta_hat
beta_hat

##             [,1]
## [1,] 0.01449087
## [2,] 0.18233574

var_beta_hat = reg_result$var_beta_hat
test_result = t_test(beta_hat,var_beta_hat)
test_result$t_stat

##           [,1]
## [1,] 4.769901
## [2,] 3.244819
```

```r
test_result$p_value
```

```
##                [,1]
## [1,] 1.843163e-06
## [2,] 1.175253e-03
```

```r
ar_coeff <- as.numeric(beta_hat[2])
ma_coeff <- 0
TACF <- ARMAacf(ar_coeff, ma_coeff, lag.max = round(n_obs_qua_return^(1/3)))
plot(c(0:round(n_obs_qua_return^(1/3))),ACF$acf,type='l',xlab='Lag',ylab='ACF
',ylim=c(-0.1,1))
lines(0:round(n_obs_qua_return^(1/3)),TACF,lty=2)
grid(nx = 4, ny = 4)
```