Problem5

2022-11-14

Problem 5: Computational Finance - Modelling Stock prices

Following piece of code download the prices of TCS since 2007

```
library(quantmod)
```

```
## Warning: package 'quantmod' was built under R version 4.2.2
```

```
## Loading required package: xts
```

```
## Warning: package 'xts' was built under R version 4.2.2
```

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

```
## Warning: package 'zoo' was built under R version 4.2.2
```

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

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

```
## Loading required package: TTR
```

```
## Warning: package 'TTR' was built under R version 4.2.2
```

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

```
getSymbols('TCS.NS')
```

```
## Warning: TCS.NS contains missing values. Some functions will not work if objects
## contain missing values in the middle of the series. Consider using na.omit(),
## na.approx(), na.fill(), etc to remove or replace them.
```

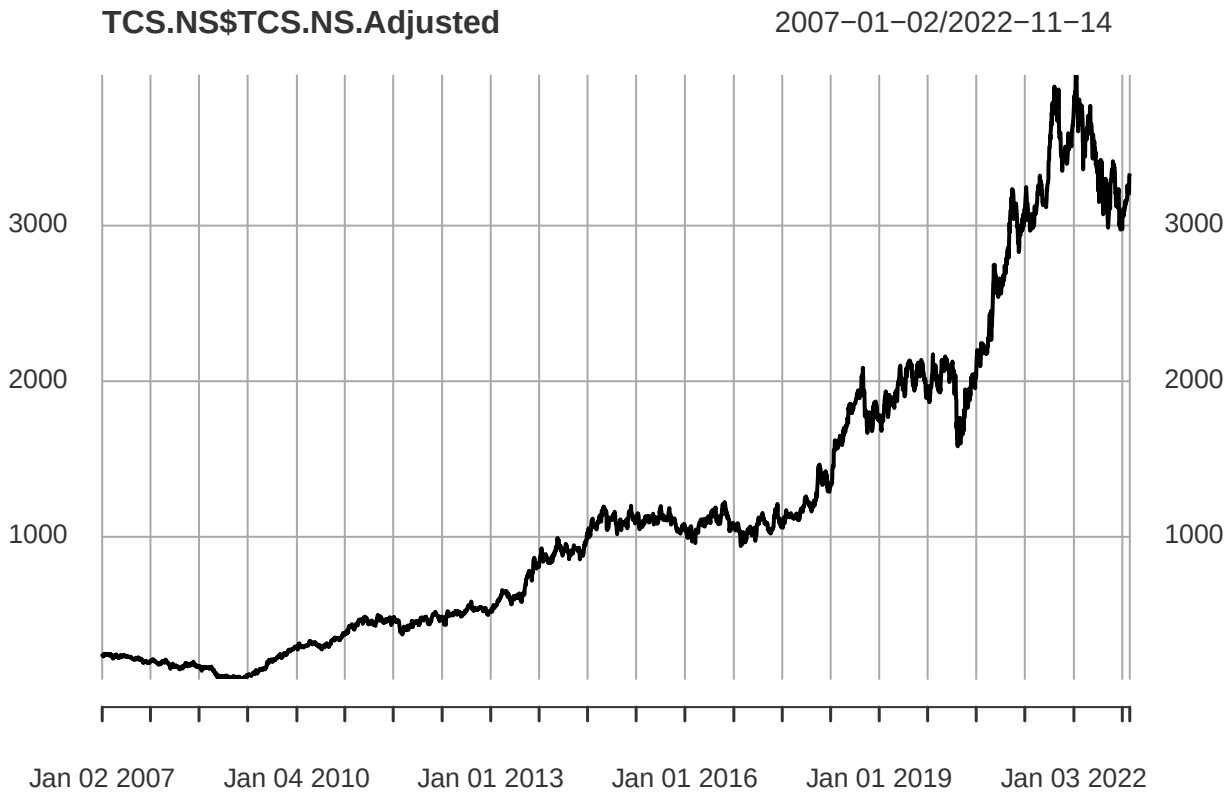
```
## [1] "TCS.NS"
```

```
tail(TCS.NS)
```

```
##            TCS.NS.Open TCS.NS.High TCS.NS.Low TCS.NS.Close TCS.NS.Volume
## 2022-11-04      3217.0     3220.05    3166.15       3217.40       1464013
## 2022-11-07      3229.0     3242.80    3195.10       3233.70       1474498
## 2022-11-09      3249.8     3249.80    3201.65       3216.05       1162267
## 2022-11-10      3170.0     3225.00    3170.00       3205.65       1573092
## 2022-11-11      3269.6     3341.60    3255.05       3315.95       3265394
## 2022-11-14      3324.0     3349.00    3309.00       3335.50       1341958
##            TCS.NS.Adjusted
## 2022-11-04         3217.40
## 2022-11-07         3233.70
## 2022-11-09         3216.05
## 2022-11-10         3205.65
## 2022-11-11         3315.95
## 2022-11-14         3335.50
```

Plot the adjusted close prices of TCS

```
plot(TCS.NS$TCS.NS.Adjusted)
```



Download the data of market index Nifty50. The Nifty 50 index indicates how the over all market has done over the similar period.

```
getSymbols('^NSEI')
```

```
## Warning: ^NSEI contains missing values. Some functions will not work if objects
## contain missing values in the middle of the series. Consider using na.omit(),
## na.approx(), na.fill(), etc to remove or replace them.
```

```
## [1] "^NSEI"
```

```
tail(NSEI)
```

```
##            NSEI.Open NSEI.High NSEI.Low NSEI.Close NSEI.Volume NSEI.Adjusted
## 2022-11-04  18053.40  18135.10 18017.15   18117.15      267900      18117.15
## 2022-11-07  18211.75  18255.50 18064.75   18202.80      314800      18202.80
## 2022-11-09  18288.25  18296.40 18117.50   18157.00      307200      18157.00
## 2022-11-10  18044.35  18103.10 17969.40   18028.20      256500      18028.20
## 2022-11-11  18272.35  18362.30 18259.35   18349.70      378500      18349.70
## 2022-11-14  18376.40  18399.45 18311.40   18329.15           0      18329.15
```

Plot the adjusted close value of Nifty50

```
plot(NSEI$NSEI.Adjusted)
```

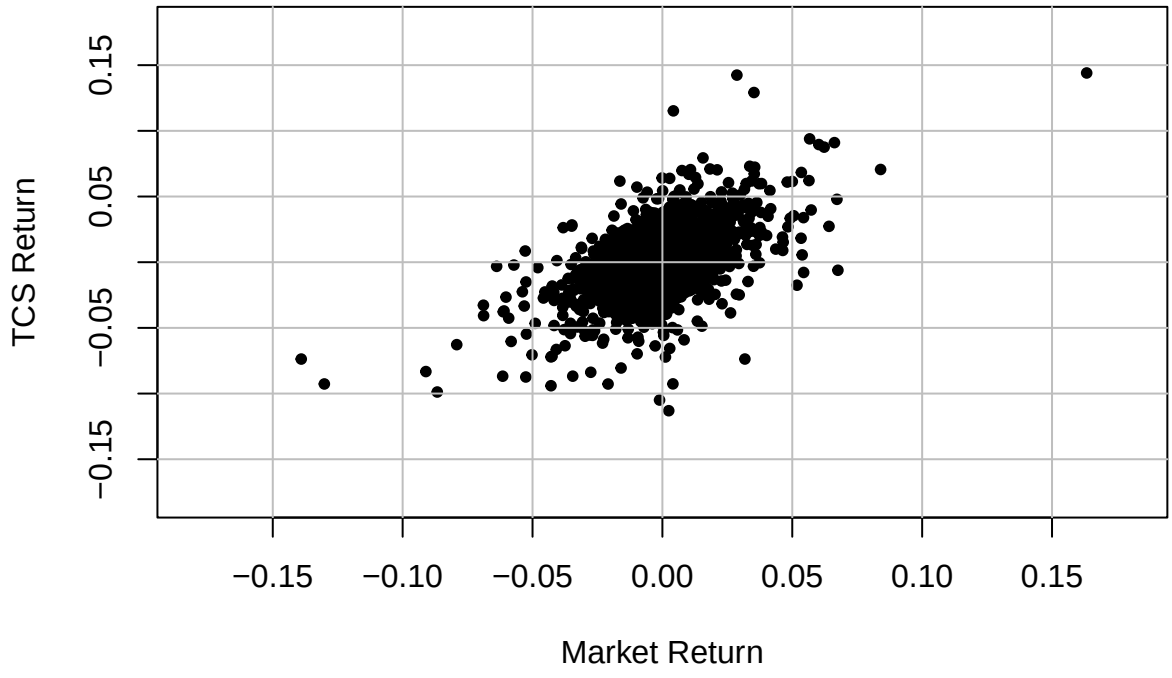
Log-Return

We calculate the daily log-return, where log-return is defined as

$$r_t = \log(P_t) - \log(P_{t-1}) = \Delta \log(P_t),$$

where P_t is the closing price of the stock on t^{th} day.

```
TCS_rt = diff(log(TCS.NS$TCS.NS.Adjusted))
Nifty_rt = diff(log(NSEI$NSEI.Adjusted))
retrn = cbind.xts(TCS_rt,Nifty_rt)
retrn = na.omit(data.frame(retrn))
plot(retrn$NSEI.Adjusted,retrn$TCS.NS.Adjusted
     ,pch=20
     ,xlab='Market Return'
     ,ylab='TCS Return'
     ,xlim=c(-0.18,0.18)
     ,ylim=c(-0.18,0.18))
grid(col='grey',lty=1)
```



- Consider the following model:

$$r_t^{TCS} = \alpha + \beta r_t^{Nifty} + \varepsilon,$$

where $\mathbb{E}(\varepsilon) = 0$ and $\mathbb{V}ar(\varepsilon) = \sigma^2$.

1. Estimate the parameters of the models $\theta = (\alpha, \beta, \sigma)$ using the method of moments type plug-in estimator discussed in the class.

```
ExpY = mean(retrn[,1])
ExpX = mean(retrn[,2])
VarY = var(retrn[,1])
VarX = var(retrn[,2])
CovXY = cov(retrn[,1],retrn[,2])
beta_hat_moments = CovXY/VarX
alpha_hat_moments = ExpY - (beta_hat_moments*ExpX)
sigma_hat_moments = sqrt((sum((retrn[,1]-alpha_hat_moments
                               -beta_hat_moments*retrn[,2])^2))/length(retrn[,1]))
```

The optimal values of parameters are:

```
c(alpha_hat_moments,beta_hat_moments,sigma_hat_moments)
```

```
## [1] 0.0004628225 0.7436840049 0.0161824623
```

2. Estimate the parameters using the `lm` built-in function of `R`. Note that `lm` using the OLS method.

```
fit = summary(lm(retrn[,1]~retrn[,2], data=retrn))
beta_hat_OLS = fit$coef[2,1]
alpha_hat_OLS = fit$coef[1,1]
sigma_hat_OLS = fit$sigma
```

The optimal values of parameters are:

```
c(alpha_hat_OLS,beta_hat_OLS,sigma_hat_OLS)
```

```
## [1] 0.0004628225 0.7436840049 0.0161868591
```

3. Fill-up the following table

Parameters	Method of Moments	OLS
α	0.000461	0.000461
β	0.743697	0.743697
σ	0.016184	0.016188

4. If the current value of Nifty is 18000 and it goes up to 18200. The current value of TCS is Rs. 3200/-. How much you can expect TCS price to go up?

```
TCS_return = alpha_hat_moments + beta_hat_moments * log(18200/18000)
TCS_new = 3200*exp(TCS_return)
```

New TCS price would be expected to be Rs.

```
TCS_new
```

```
## [1] 3227.898
```