Project 3 Economic Modeling

```r
library(readxl)
library(plyr)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:plyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
library(tidyr)
library(ggplot2)
library(lmtest)
```

```
## Loading required package: zoo

##
## Attaching package: 'zoo'

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

```r
library(nlme)
```

```
##
## Attaching package: 'nlme'

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

```r
library(rcompanion)
```

```
## Warning: package 'rcompanion' was built under R version 4.3.2
```

```r
library(data.table)
```

```
## Warning: package 'data.table' was built under R version 4.3.2
```

```
##
## Attaching package: 'data.table'
```

```
## The following objects are masked from 'package:dplyr':
##
##     between, first, last
```

```r
library(e1071)
library(moments)
```

```
##
## Attaching package: 'moments'
```

```
## The following objects are masked from 'package:e1071':
##
##     kurtosis, moment, skewness
```

```r
library(ADGofTest)
library(faraway)
```

```
##
## Attaching package: 'faraway'
```

```
## The following object is masked from 'package:plyr':
##
##     ozone
```

```r
library(dplyr)
library(tidyr)
library(car)
```

```
## Loading required package: carData
```

```
##
## Attaching package: 'car'
```

```
## The following objects are masked from 'package:faraway':
##
##     logit, vif
```

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

```r
library(xts)
```

```
##
## ######################### Warning from 'xts' package #########################
## #                                                                            #
## # The dplyr lag() function breaks how base R's lag() function is supposed to  #
## # work, which breaks lag(my_xts). Calls to lag(my_xts) that you type or       #
## # source() into this session won't work correctly.                           #
## #                                                                            #
## # Use stats::lag() to make sure you're not using dplyr::lag(), or you can add #
## # conflictRules('dplyr', exclude = 'lag') to your .Rprofile to stop           #
## # dplyr from breaking base R's lag() function.                               #
## #                                                                            #
## # Code in packages is not affected. It's protected by R's namespace mechanism #
## # Set 'options(xts.warn_dplyr_breaks_lag = FALSE)' to suppress this warning.  #
## #                                                                            #
## ##############################################################################
```

```
##
## Attaching package: 'xts'
```

```
## The following objects are masked from 'package:data.table':
##
##     first, last
```

```
## The following objects are masked from 'package:dplyr':
##
##     first, last
```

```r
library(PerformanceAnalytics)
```

```
## Warning: package 'PerformanceAnalytics' was built under R version 4.3.2
```

```
##
## Attaching package: 'PerformanceAnalytics'
```

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

```
## The following objects are masked from 'package:e1071':
##
##     kurtosis, skewness
```

```
## The following object is masked from 'package:graphics':
##
##     legend
```

```r
library(sandwich)
```

We took

```r
GOOGLE<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/GOOGL.csv",sep=",")%>%
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
ALIBaba<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/BABA.csv",sep=",")%>%
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
Groupon<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/GRPN(ecommerce).csv",se
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
META<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/META.csv",sep=",")%>%
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
NETFLIX<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/NFLX.csv",sep=",")%>%
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
WALMART<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/WMT(WALMART).csv",sep=
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
AMAZON<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/AMZN.csv",sep=",")%>%
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
MICROSOFT<-read.csv("C:/Users/Siddharth Sharma/Desktop/Project 3 economic modeling/MSFT.csv",sep=",")%>%
  mutate(Date = as.Date(as.character(Date), format = "%d-%m-%Y")) %>%

  arrange(Date)
```

Google (GOOGL), Alibaba (BABA), Groupon (GRPN), Meta (META), Netflix (NFLX), Walmart (WMT), Amazon (AMZN), and Microsoft (MSFT) are among the stocks whose data is read from CSV files by the provided R code. To ensure consistency, the mutate function is used to convert the "Date" column to the Date format. Using the arrange function, the dataframes are then arranged in ascending order based on the date. Overall, this code segment imports and organises stock data, preparing it for integration with other datasets. Consistent date column formatting is critical for aligning time series data and facilitating comparative studies and time-based analyses across these diverse stocks. Here we took E-Commerce and Social media marketing as the combined market because there were a lot of bubbles in this market and it will be more effective to take both markets combined as the early 2010s had the trend of evaluating these companies above the actual value as people thaught that these will be most important sector in upcoming times. thus it created a bubble and after the buble was over many social media companies were shut doun due to losses and few companies took over the market so we take those few companies

```r
#REMOVING UNNECACARY COLUMNS
choose=c("Volume","Open","High","Low","Adj.Close")
GOOGLE<-GOOGLE[, !(names(GOOGLE) %in% choose)]
```

```r
ALIBaba<-ALIBaba[, !(names(ALIBaba) %in% choose)]
Groupon<-Groupon[, !(names(Groupon) %in% choose)]
META<-META[, !(names(META) %in% choose)]
NETFLIX<-NETFLIX[, !(names(NETFLIX) %in% choose)]
WALMART<-WALMART[, !(names(WALMART) %in% choose)]
AMAZON<-AMAZON[, !(names(AMAZON) %in% choose)]
MICROSOFT<-MICROSOFT[, !(names(MICROSOFT) %in% choose)]
```

In this code we choose only close value along with date to do the code so we remove the rest of columns to make it simpler

```r
#merging all of data into one
merged_df <- merge(GOOGLE, ALIBaba, by="Date")
merged_df<-merge(merged_df,Groupon)
merged_df<-merge(merged_df,META)
merged_df<-merge(merged_df,NETFLIX)
merged_df<-merge(merged_df,WALMART)
merged_df<-merge(merged_df,AMAZON)
merged_df<-merge(merged_df,MICROSOFT)
```

Using the merge function, the code merges multiple stock dataframes (GOOGLE, ALIBABA, Groupon, META, NETFLIX, WALMART, AMAZON, MICROSOFT) based on the "Date" column. Each subsequent merge adds a new dataframe to the consolidated merged_df dataframe, combining stock data from various companies into a unified dataset.

```r
# Check for non-numeric values in merged_df
non_numeric_columns <- sapply(merged_df, function(x) any(!is.numeric(x)))
print(non_numeric_columns)
```

```
##       Date     GOOGLE    ALIBABA    GROUPON       META    NETFLIX    WALMART     AMAZON
##       TRUE      FALSE      FALSE      FALSE      FALSE      FALSE      FALSE      FALSE
## MICROSOFT
##      FALSE
```

```r
#all are numeric accept date as it is date
# Convert the object into xts object (time series object)
merged_df$Date <- as.Date(merged_df$Date)
time_series_xts <- xts(merged_df[, -1], order.by = merged_df$Date)
merged_df <- na.omit(merged_df)
close.prices.zoo  <- as.zoo(time_series_xts)
#Return calculation
return = Return.calculate( close.prices.zoo , method = "log") # automatically calculate return
print(return)
```

```
##                    GOOGLE         ALIBABA        GROUPON            META
## 2014-11-19             NA              NA              NA              NA
## 2014-11-20  -6.306430e-03   9.147521e-03   0.0231460909   3.675169e-03
## 2014-11-21   3.909517e-03   8.252171e-03   0.0107095467   2.035997e-03
## 2014-11-24   2.908478e-03   2.840160e-02  -0.0013324253   3.519251e-03
## 2014-11-25   3.191329e-03  -3.957936e-03   0.0053191814   2.165274e-02
## 2014-11-26  -2.734869e-03  -7.075319e-03  -0.0039867561   2.597217e-02
## 2014-11-28   2.461722e-03  -9.183775e-03   0.0026596358   1.030054e-03
```

```
## 2014-12-01 -1.732337e-02 -5.193467e-02 -0.0187673264 -3.403469e-02
## 2014-12-02 -1.966131e-03  3.613513e-02 -0.0067888922  4.782169e-03
## 2014-12-03 -3.012461e-03  6.801822e-03  0.0202299545 -7.715909e-03
## 2014-12-04  1.039335e-02 -1.337540e-02 -0.0120888173  4.796186e-03
## 2014-12-05 -2.708779e-02 -1.170139e-02 -0.0177237499  1.477603e-02
## 2014-12-08  5.005706e-03 -2.657810e-02 -0.0307286335  2.093093e-03
## 2014-12-09  1.008591e-02  2.267802e-02  0.0348467313  4.173180e-03
## 2014-12-10 -1.516733e-02 -3.406845e-02 -0.0165749233 -8.626325e-03
## 2014-12-11  7.678159e-03  1.043825e-02  0.0110803833  2.014236e-02
## 2014-12-12 -2.012175e-02  1.332826e-03 -0.0055248968  1.285665e-03
## 2014-12-15 -1.093181e-02 -3.908341e-03 -0.0295172317 -1.085147e-02
## 2014-12-16 -3.487529e-02  1.016781e-02 -0.0260129621 -3.032928e-02
## 2014-12-17  1.650425e-02  3.026443e-02  0.0513664751  1.883343e-02
## 2014-12-18  1.600320e-02  2.107510e-03  0.0801496865  2.964428e-02
## 2014-12-19  1.047697e-02  1.273325e-02  0.0165502888  1.870152e-02
## 2014-12-22  2.330147e-02 -1.713655e-02  0.0037807607  1.946383e-02
## 2014-12-23  1.208149e-02 -3.033505e-02  0.0100126367 -1.036657e-02
## 2014-12-24 -3.420994e-03  4.066776e-03 -0.0175884114  1.982849e-03
## 2014-12-26  8.512268e-03  0.000000e+00  0.0311940446  1.238254e-04
## 2014-12-29 -7.804828e-03  2.831690e-04  0.0134230019 -9.452832e-03
## 2014-12-30 -3.785197e-03 -2.172607e-03 -0.0036430278 -1.004776e-02
## 2014-12-31 -8.668422e-03 -1.726399e-02  0.0048543968 -1.526364e-02
## 2015-01-02 -2.093925e-03 -3.276518e-03 -0.0294861849  5.496275e-03
## 2015-01-05 -1.923782e-02 -2.541679e-02 -0.0290975053 -1.619150e-02
## 2015-01-06 -2.498908e-02  2.271045e-02  0.0152868837 -1.356484e-02
## 2015-01-07 -2.945317e-03 -1.158449e-02  0.0050441659  0.000000e+00
## 2015-01-08  3.478098e-03  2.799953e-02 -0.0139330752  2.630875e-02
## 2015-01-09 -1.228649e-02 -1.932290e-02 -0.0128371465 -5.643961e-03
## 2015-01-12 -7.336239e-03 -1.368272e-02 -0.0422226902 -1.320746e-02
## 2015-01-13  9.490851e-03 -8.399733e-03  0.0080538153 -3.525550e-03
## 2015-01-14  8.196646e-03 -1.187930e-02 -0.0148151666 -2.226126e-03
## 2015-01-15 -3.802171e-03 -3.338923e-02 -0.0095433173 -2.967019e-02
## 2015-01-16  1.271621e-02  6.004169e-03  0.0054645149  1.514466e-02
## 2015-01-20 -1.019247e-03  3.199381e-02 -0.0095826128  1.400099e-02
## 2015-01-21  2.028550e-02  3.197046e-02 -0.0152462903  6.536826e-03
## 2015-01-22  3.197803e-02  6.850323e-03  0.0463930605  1.178852e-02
## 2015-01-23  8.617149e-03 -8.594510e-03 -0.0242927336  2.315411e-03
## 2015-01-26 -9.697203e-03  8.498332e-03 -0.0165292610 -4.249050e-03
## 2015-01-27 -2.936188e-02 -1.014841e-02 -0.0168070759 -2.244354e-02
## 2015-01-28 -1.695054e-02 -4.459754e-02 -0.0185322905  6.051841e-03
## 2015-01-29  1.560010e-03 -9.185247e-02  0.0545972035  2.282259e-02
## 2015-01-30  4.629769e-02 -8.161441e-03 -0.0248289030 -2.716035e-02
## 2015-02-02 -1.000242e-02  1.171817e-02  0.0083449513 -1.219374e-02
## 2015-02-03  2.064759e-03  5.311554e-03  0.0273241054  5.452557e-03
## 2015-02-04 -1.359285e-02 -6.754923e-03 -0.0163046686  3.045689e-03
## 2015-02-05  7.064929e-03 -3.390155e-02  0.0216810460 -2.644274e-04
## 2015-02-06  7.614856e-03 -1.528869e-02 -0.0094276389 -1.519219e-02
## 2015-02-09 -8.653464e-03  3.727870e-03  0.0094276389 -4.029145e-04
## 2015-02-10  2.034772e-02  1.454489e-02 -0.0053763774  1.002481e-02
## 2015-02-11 -4.006795e-03 -1.454489e-02  0.0213342225  1.740321e-02
## 2015-02-12  1.477877e-02  1.270956e-02 -0.0159578451 -3.666352e-03
## 2015-02-13  9.387857e-03  2.214118e-02  0.0661290611 -6.448729e-03
## 2015-02-17 -1.122104e-02 -2.501557e-02  0.0112290827 -1.850139e-03
## 2015-02-18 -4.339598e-03 -1.267354e-03 -0.0327898042  1.457581e-02
```

```
## 2015-02-19  6.978267e-03  1.727824e-03  0.0089342906  3.471814e-02
## 2015-02-20 -8.545882e-03 -2.881348e-03  0.0349599029  6.025677e-03
## 2015-02-23 -1.263018e-02 -1.359614e-02  0.0048959889 -1.335545e-02
## 2015-02-24  6.799300e-03 -9.167894e-03 -0.0135220065 -4.958991e-03
## 2015-02-25  1.598590e-02  1.755663e-02  0.0220326597  1.404999e-02
## 2015-02-26  2.161617e-02 -9.559399e-03  0.0048309454  1.062717e-02
## 2015-02-27  5.954096e-03 -2.932725e-03 -0.0145633275 -1.807055e-02
## 2015-03-02  2.178257e-02 -1.324526e-02 -0.0061312268  9.828695e-03
## 2015-03-03  6.534964e-03 -2.923264e-02 -0.0098888690 -1.882674e-03
## 2015-03-04 -7.951120e-04  4.681523e-02 -0.0087336424  1.619978e-02
## 2015-03-05  5.345981e-03  7.110002e-03 -0.0062853756  3.824531e-03
## 2015-03-06 -1.477944e-02 -1.994196e-02 -0.0050569196 -1.488673e-02
## 2015-03-09  2.092416e-03 -2.240557e-02  0.0037950141 -7.149607e-03
## 2015-03-10 -2.513471e-02  5.317257e-03 -0.0076045806 -2.407912e-02
## 2015-03-11 -7.458306e-03 -1.188184e-02  0.0176549543  2.578262e-04
## 2015-03-12  9.813305e-03 -8.541273e-04 -0.0138453878  1.738063e-02
## 2015-03-13 -1.466589e-02 -7.326536e-04 -0.0153260281 -1.121170e-02
## 2015-03-16  1.550311e-02  2.580632e-02  0.0064143904  2.561747e-04
## 2015-03-17 -7.201282e-03  5.934736e-03  0.0038290156  1.638862e-02
## 2015-03-18  1.521693e-02  1.064475e-03 -0.0141118248  1.934300e-02
## 2015-03-19 -4.407785e-03  1.350343e-02 -0.0130040842  2.248654e-02
## 2015-03-20  2.268222e-03 -6.318039e-03 -0.0052493755  1.260903e-02
## 2015-03-23  7.431524e-04 -1.121283e-02  0.0078637169  7.489745e-03
## 2015-03-24  2.129739e-02 -7.386298e-03 -0.0131407938  1.036887e-02
## 2015-03-25 -1.841843e-02  1.433899e-03  0.0235305366 -2.841539e-02
## 2015-03-26 -5.943589e-03  5.002369e-03 -0.0208884677  1.084843e-03
## 2015-03-27 -1.086349e-02  4.859316e-03  0.0039499129  3.487479e-03
## 2015-03-30  6.418172e-03 -8.072218e-03 -0.0239372531 -1.201273e-03
## 2015-03-31 -1.154293e-02 -7.897660e-03 -0.0300569686 -1.184872e-02
## 2015-04-01 -9.436851e-03 -1.062808e-02 -0.0267057552 -6.711881e-03
## 2015-04-02 -1.499848e-02 -9.718417e-04  0.0056818550 -1.347792e-03
## 2015-04-06  4.865203e-03 -5.606340e-03  0.0070571925  1.073186e-02
## 2015-04-07  1.671550e-03  4.755224e-03  0.0111889699 -1.456689e-03
## 2015-04-08  7.278043e-03  3.795205e-02  0.0151831556 -4.860389e-04
## 2015-04-09 -1.495177e-03  8.744882e-03  0.0054645149 -1.337805e-03
## 2015-04-10  9.484571e-04 -1.827601e-02  0.0054348162 -1.583302e-03
## 2015-04-13  1.822490e-04 -3.553279e-03 -0.0177722104  1.175416e-02
## 2015-04-14 -1.628080e-02  8.506679e-03  0.0000000000  6.124982e-03
## 2015-04-15  2.331564e-03 -3.889932e-03  0.0041294346 -9.745587e-03
## 2015-04-16  4.573328e-03 -7.230518e-03  0.0095694098 -4.847919e-03
## 2015-04-17 -2.003308e-02 -2.603179e-02 -0.0206192872 -1.876318e-02
## 2015-04-20  2.188957e-02  3.656250e-03  0.0069204428  2.819491e-02
## 2015-04-21 -2.961058e-03  2.672836e-03 -0.0166901924  6.358452e-03
## 2015-04-22  1.146428e-02 -4.499248e-03 -0.0084508390  1.200602e-02
## 2015-04-23  1.496446e-02  2.799199e-03  0.0112519192 -2.658194e-02
## 2015-04-24  2.864621e-02  2.745154e-02 -0.0042046734 -1.073580e-02
## 2015-04-27 -1.323085e-02  3.894523e-03 -0.0155700036  4.650094e-03
## 2015-04-28 -3.096005e-03  2.117897e-03 -0.0014275306 -1.513042e-02
## 2015-04-29 -5.294214e-03 -3.140000e-02  0.0099502884 -2.606257e-03
## 2015-04-30 -2.273648e-02 -1.416899e-02 -0.0214447112 -2.135228e-02
## 2015-05-01  4.345811e-03 -1.477324e-03 -0.0189647626  2.789061e-03
## 2015-05-04  3.043444e-03 -7.171173e-03  0.0361572278 -2.281370e-03
## 2015-05-05 -1.788565e-02 -1.311447e-02 -0.0288204379 -1.598806e-02
## 2015-05-06 -1.476671e-02  5.766582e-03 -0.0790685296  6.938227e-03
```

```
## 2015-05-07  1.292349e-02   7.232066e-02   0.0141400236   4.216476e-03
## 2015-05-08  1.266760e-02   1.225022e-02   0.0337456019   1.019523e-03
## 2015-05-11 -5.791399e-03  -3.912964e-03   0.0238461142  -6.388981e-03
## 2015-05-12 -1.300141e-02   5.763560e-04  -0.0088757754  -7.075388e-03
## 2015-05-13  1.409731e-03   8.720675e-03   0.0000000000   1.257237e-02
## 2015-05-14  1.783835e-02   9.890412e-03  -0.0179915571   3.667266e-02
## 2015-05-15 -4.946665e-03   6.784689e-04   0.0000000000  -1.174381e-02
## 2015-05-18  3.293571e-04  -1.537876e-02  -0.0106464428   5.703661e-03
## 2015-05-19  4.763036e-03   1.254862e-02   0.0136676610  -3.095786e-03
## 2015-05-20  5.863167e-03   2.783700e-02  -0.0136676610  -9.926046e-04
## 2015-05-21  7.752536e-03   3.446001e-02  -0.0045977552  -8.694032e-04
## 2015-05-22 -4.121194e-03  -6.518858e-03   0.0045977552   7.452242e-04
## 2015-05-26 -1.330675e-02  -8.073676e-03  -0.0107611263  -1.513758e-02
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## 2023-03-17 -2.138421e-02  8.066847e-03 -1.095547e-02  1.162650e-02
## 2023-03-20  5.356321e-03  1.070292e-02 -1.261074e-02 -2.610445e-02
## 2023-03-21  2.160690e-03 -3.412459e-03  2.924777e-02  5.677523e-03
## 2023-03-22 -3.965907e-02 -6.429929e-03 -1.916675e-02 -5.457153e-03
## 2023-03-23  8.623701e-02  8.066503e-03  1.013323e-04  1.952965e-02
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## 2023-03-28 -1.271560e-02 -3.891846e-03 -8.193440e-03 -4.169597e-03
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## 2023-04-12 -2.145798e-02 -4.876340e-03 -2.113855e-02  2.330849e-03
## 2023-04-13  4.477876e-02  1.003976e-03  4.565543e-02  2.215222e-02
## 2023-04-14 -2.207968e-02 -6.779292e-03  1.073642e-03 -1.284778e-02
## 2023-04-17 -1.760678e-02  6.979948e-03  2.241131e-03  9.253112e-03
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## 2023-04-25 -1.986038e-02 -7.820419e-03 -3.487276e-02 -2.279384e-02
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## 2023-07-03  2.154394e-03  6.468435e-03 -1.074526e-03 -7.516340e-03
## 2023-07-05  1.005258e-02 -5.690367e-04  1.227966e-03  4.732866e-04
```

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## 2023-08-09 -2.167980e-02  1.617179e-03 -1.504759e-02 -1.178510e-02
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## 2023-08-31 -2.280234e-03  8.708891e-03  2.153290e-02 -3.137613e-03
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```

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## 2023-09-26 -1.452807e-02 -3.501598e-03 -4.113311e-02 -1.715197e-02
## 2023-09-27 -4.386678e-03 -4.811551e-03  0.000000e+00  2.080214e-03
## 2023-09-28 -3.262848e-03  5.057631e-03  0.000000e+00  2.713812e-03
## 2023-09-29  3.289358e-03 -1.618791e-02  9.008358e-03  6.704882e-03
## 2023-10-02  7.203813e-03  1.062482e-03  1.824046e-02  1.897944e-02
## 2023-10-03 -9.457425e-03 -6.328603e-03 -3.730077e-02 -2.648173e-02
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## 2023-11-02  1.069957e-02  3.934803e-03  7.779928e-03  6.480531e-03
## 2023-11-03  1.785198e-02 -5.209291e-03  3.831276e-03  1.277967e-02
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## 2023-11-07 -2.990855e-04  4.659126e-03  2.103106e-02  1.115678e-02
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## 2023-11-10  2.740456e-02  1.375323e-02  2.083403e-02  2.459188e-02
## 2023-11-13 -5.875367e-03  8.925635e-03 -6.779701e-03 -8.121237e-03
## 2023-11-14  9.023087e-03 -1.789223e-04  2.226249e-02  9.742926e-03
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## 2023-11-16  1.078719e-02 -8.439114e-02 -2.587108e-03  1.743045e-02
## 2023-11-17 -2.229720e-03 -4.431665e-03  1.631918e-02 -1.694367e-02
```

```
plot(return)
```

return
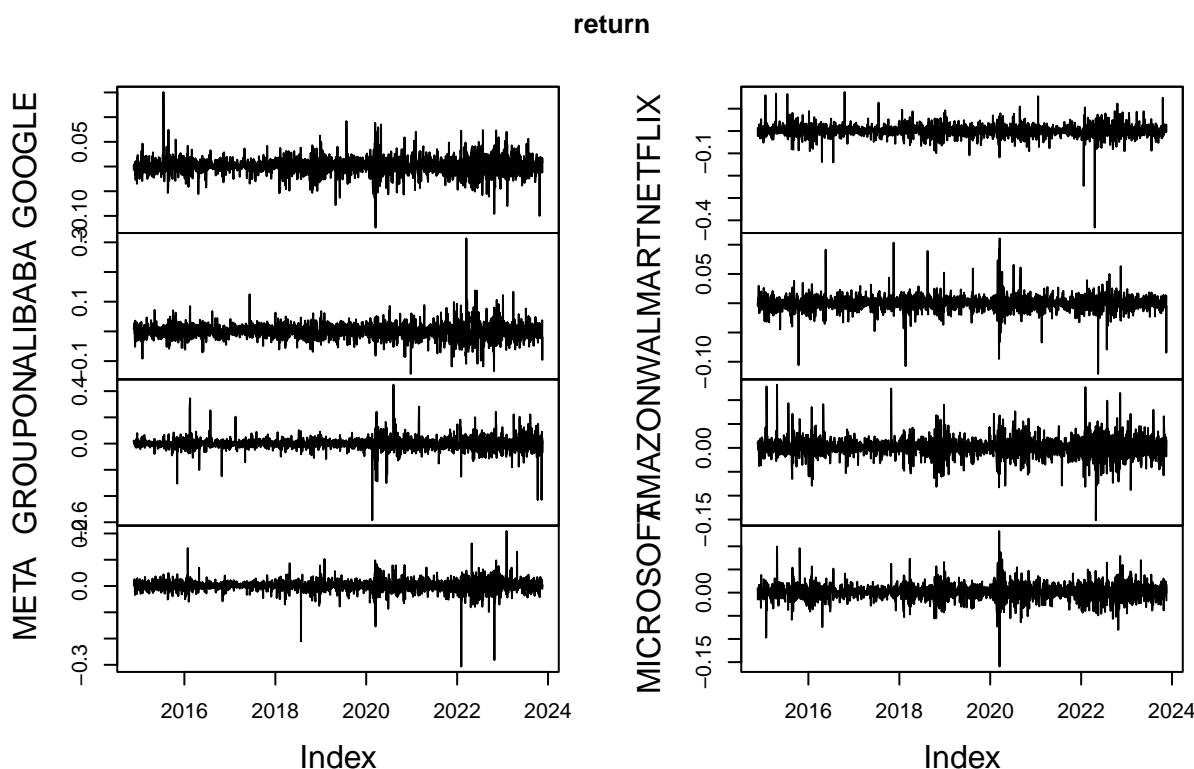
The code first checks the merged_df dataframe for non-numeric values, identifying columns that are not numeric. The "Date" column is kept because it is non-numeric but necessary for time series analysis. The code then converts the "Date" column to a Date format before converting the remaining numeric columns to an xts (time series) object. The time series that results, denoted as time_series_xts, is used to compute daily log returns. The plot function plots the results. A visual representation of the calculated log returns over time is shown and guarantees that the data is in a format appropriate for time series analysis. there were different bubble formations with different reasons the bubbles can be seen in returns time series representation

GOOGLE Google announced a significant corporate reorganisation in August 2015, creating Alphabet Inc. as a new holding company. In August 2015, Sundar Pichai was named Google's CEO after the company underwent restructuring. This might be one of the causes of the 2015 return bubble.

ALIBABA Alibaba may have caused a bubble but the reasons are still unkown so we cannot confirm the reason behind the buble in 2023-23

GROUPON The impact of COVID 19 is most probably the reason for the negative shock(bubble) in 2020 returns for GROUPON

META one of the reasons for meta may be due to meta lost $13.7 billion in 2022 and Facebook Changing its name to meta

NETFLIX There is a buble in 2022 due to the account sharing policy change that netflix made in 2022

Walmart There were many in waqlmart on of the bubble formed in 2018 was due to walmart acquiring flipkart and in 2020 covid 19 hit

AMAZON In 2022 Amazon prime changed its package subscription model which led to a bubble in 2022

MICROSOFT In 2020 COVID-19 Lead to formation of bubble for microsoft

```r
# a function to create CSAD and Rm
exchange.herd = function(return)
{
  n=ncol(return)
  Rm = rowMeans(return)
  temp_dif =abs(return-Rm)
  temp_sum = rowSums(temp_dif)
  CSAD = temp_sum / ncol(return)
  CSAD = cbind (CSAD, Rm)
  return (CSAD)
}

f = exchange.herd(return) # calling the function "exchange.herd" that calculates CSAD and Rm
head (f) # show the first 6 rows
```

```
##              CSAD             Rm
## [1,]           NA             NA
## [2,] 0.007556628  0.0075865091
## [3,] 0.008841720 -0.0005548816
## [4,] 0.008507751  0.0040666598
## [5,] 0.007971943 -0.0005748390
## [6,] 0.007618228  0.0025263629
```

```r
CSAD.df = fortify.zoo(f) # converting f into a dataframe (to simplify further calculations)
CSAD.df$Rm2 = CSAD.df$Rm^2 # calculating Rm^2
CSAD.df = CSAD.df[-c(1),] # removing the first row with NAs
head (CSAD.df) # show the first 6 rows
```

```
##   Index        CSAD            Rm          Rm2
## 2     2 0.007556628  0.0075865091 5.755512e-05
## 3     3 0.008841720 -0.0005548816 3.078936e-07
## 4     4 0.008507751  0.0040666598 1.653772e-05
## 5     5 0.007971943 -0.0005748390 3.304399e-07
## 6     6 0.007618228  0.0025263629 6.382510e-06
## 7     7 0.009323140  0.0037360867 1.395834e-05
```

```r
tail (CSAD.df) # show the  last 6 rows
```

```
##         Index        CSAD            Rm          Rm2
## 2260     2260 0.097825407 -0.037324771 1.393139e-03
## 2261     2261 0.020362613  0.008705614 7.578771e-05
## 2262     2262 0.007515851  0.011124200 1.237478e-04
## 2263     2263 0.018119892  0.012389545 1.535008e-04
## 2264     2264 0.043549719 -0.025423203 6.463392e-04
## 2265     2265 0.011225558 -0.001975218 3.901488e-06
```

The function exchange.herd in this R code determines the average return (Rm) and the Cross-Sectional Absolute Deviation (CSAD) for a given stock return matrix. The function starts by calculating the absolute differences between the returns on each stock and the average return on each stock. It then computes the total of these differences for every row, normalising it according to the quantity of stocks. The average return matrix and the resulting CSAD matrix are combined. The output is then transformed into a dataframe, the

91

square of the average return (Rm^2) is computed, and the first row is eliminated. Lastly, the first and last six rows of the generated dataframe are shown.

RESULT CSAD Values: The degree of dispersion between the returns of individual stocks is indicated by CSAD values. A higher CSAD value denotes a more divergent performance of the stocks. Average Return (Rm): The average return is a measure of the stocks' overall performance. Positive or negative values signify whether the stocks are providing positive or negative returns on average. Interpretation: Rows 2, 4, and 6's positive CSAD values imply that individual stock returns are dispersed or divergent. This may be seen as a sign of herding behaviour or a lack of consensus, as investors are choosing different investments over a similar trend. Rm Values: Rows 2, 4, and 6 have positive average returns (Rm), indicating a general upward trend in stock performance. contrast: the positive average returns combined with positive CSAD values could point to a situation in which investors are acting in a herding-like manner, even in the face of an overall positive trend. '

```r
# reassign my columns as Y and Xs to look better in the regression model
y = CSAD.df$CSAD   # reassign my columns as Y and Xs to look better in the regression model
x1 = abs (CSAD.df$Rm)
x2 = CSAD.df$Rm2

#Linear model
linearMod <- lm(y~x1+x2)   # build linear regression model on full data
print(linearMod)
```

```
##
## Call:
## lm(formula = y ~ x1 + x2)
##
## Coefficients:
## (Intercept)            x1            x2
##    0.008422      0.330204      1.262349
```
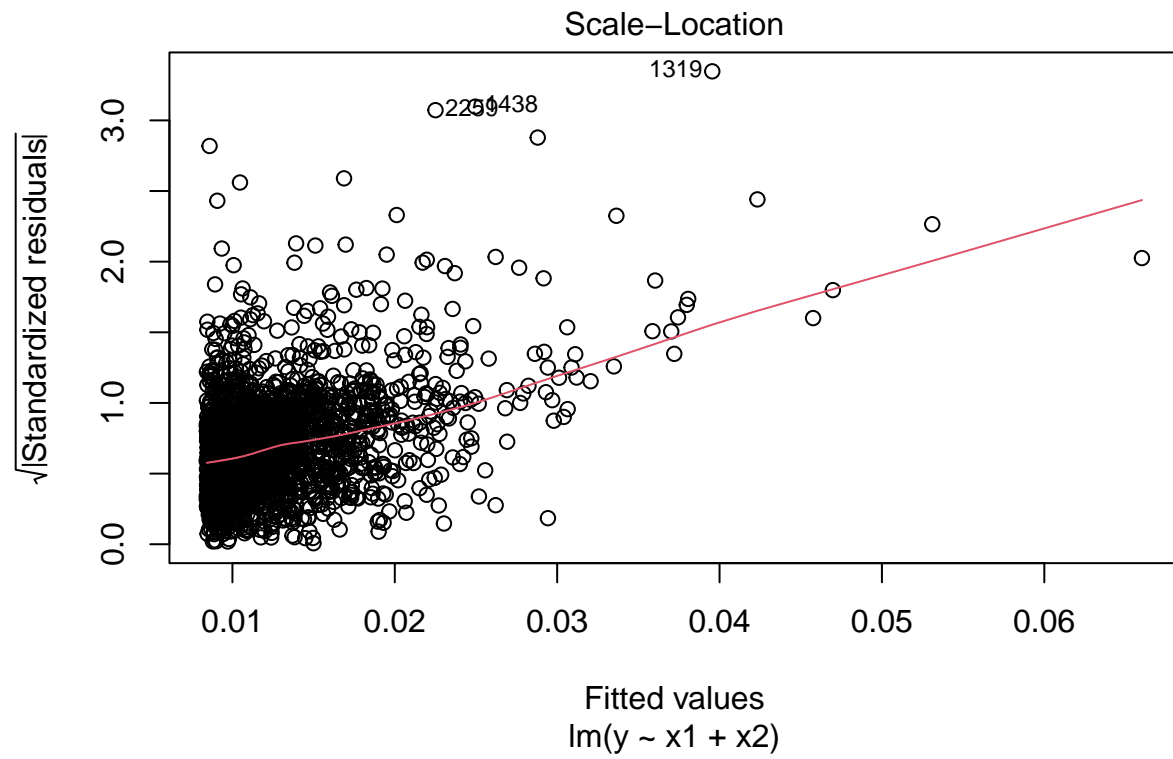
```r
summary(linearMod)
```
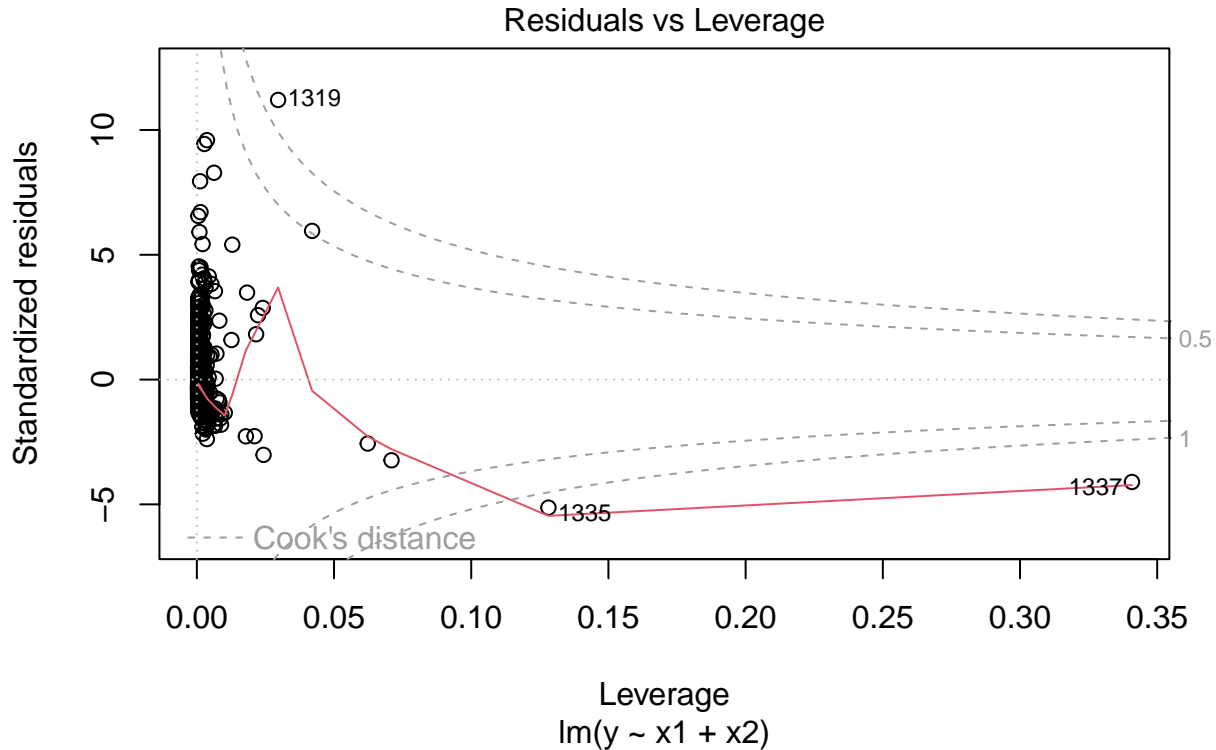
```
##
## Call:
## lm(formula = y ~ x1 + x2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.038282 -0.004323 -0.001540  0.002183  0.088184
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0084224  0.0002866  29.383   <2e-16 ***
## x1          0.3302039  0.0296387  11.141   <2e-16 ***
## x2          1.2623486  0.5114671   2.468   0.0137 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.007991 on 2261 degrees of freedom
## Multiple R-squared:  0.2482, Adjusted R-squared:  0.2475
## F-statistic: 373.2 on 2 and 2261 DF,  p-value: < 2.2e-16
```

```
plot(linearMod)
```


Residuals vs Fitted

Residuals

Fitted values
lm(y ~ x1 + x2)

Q–Q Residuals

Standardized residuals

Theoretical Quantiles
lm(y ~ x1 + x2)

Scale–Location

1319

225⑨438

√|Standardized residuals|

Fitted values
lm(y ~ x1 + x2)

Residuals vs Leverage
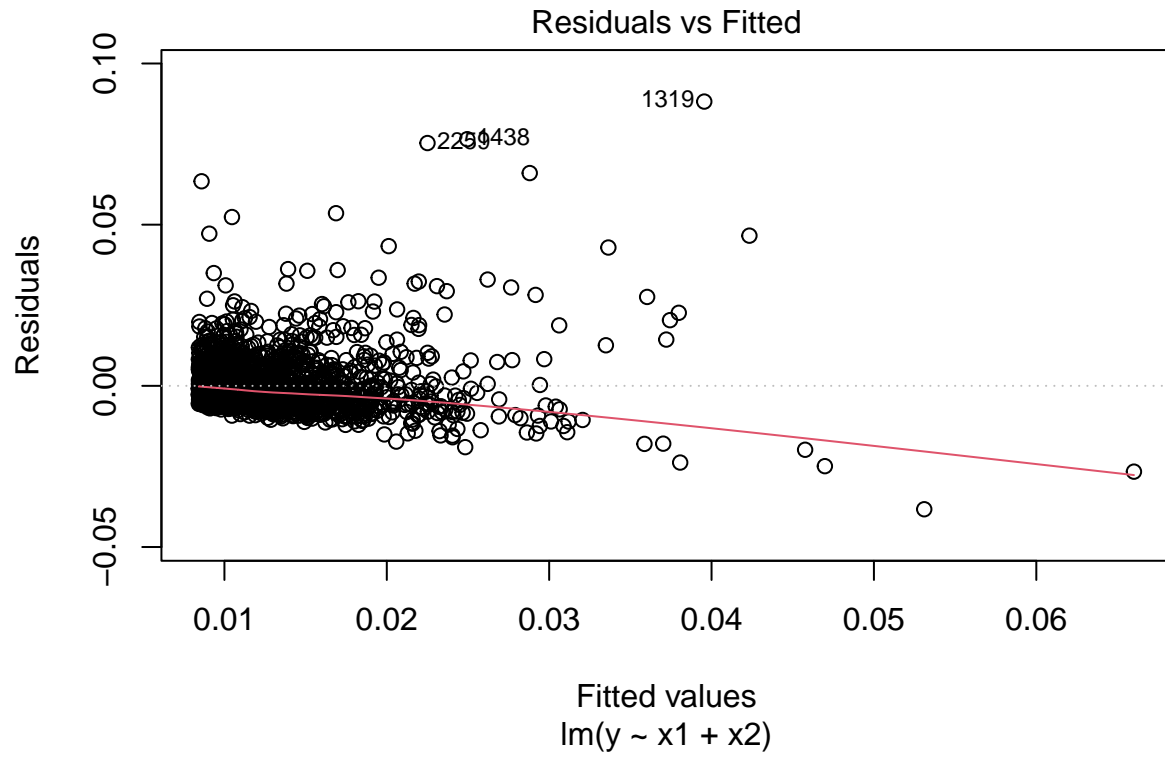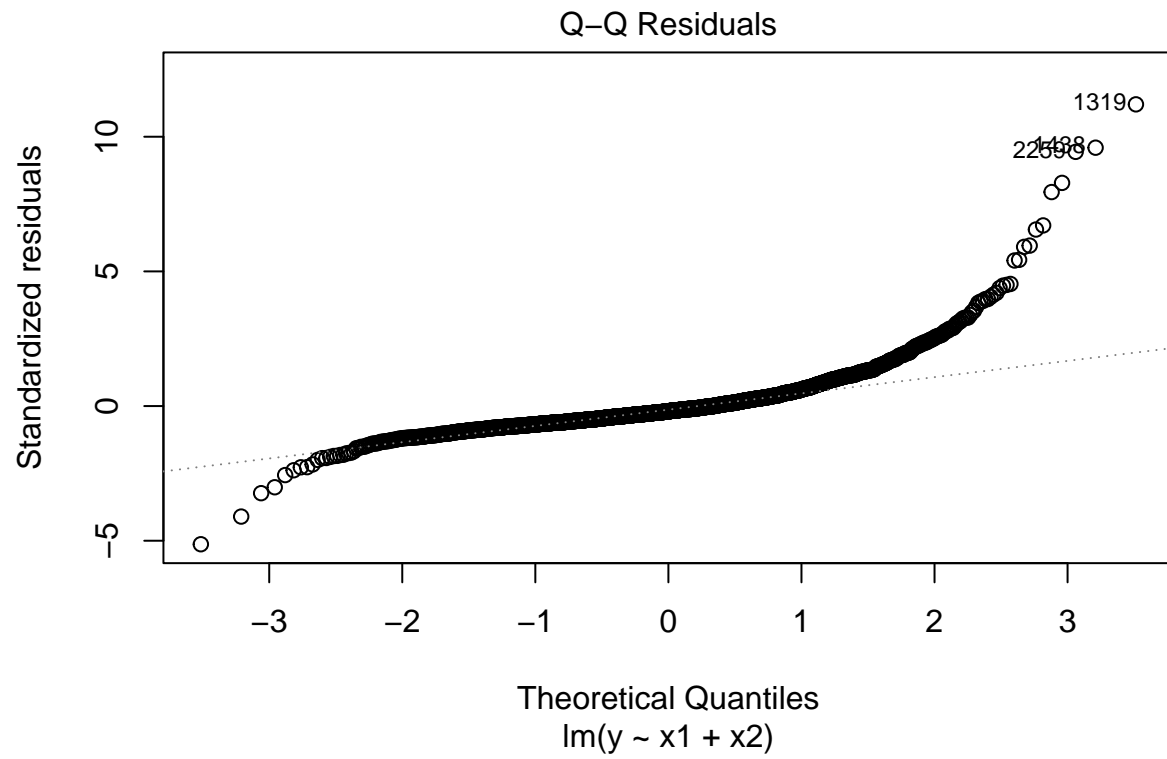
The variables for analysis are subjected to linear regression by the code. A dependent variable (Y) denoted by CSAD and two independent variables (Xs) denoted as x1 (absolute values of Rm) and x2 (Rm squared) are created by reassigning columns from the dataframe CSAD.df. The dependent variable is then regressed on the two independent variables in a linear regression model (linearMod) constructed using the lm function. The code generates a summary with statistical data and prints the model's details. To further visualise the relationship between the variables, a plot of the regression model is created.

According to the results of the linear regression, the variables' coefficients are 1.2623 for x2 (Rm squared) and 0.3302 for x1 (absolute values of Rm). The intercept is 0.0084. There may be a significant relationship because the p-values for both coefficients are statistically significant ($p < 0.05$). With an R-squared value of 0.2482 and a residual standard error of 0.007991, the model can account for roughly 24.82% of the variance in the dependent variable (CSAD). With a very low p-value of 373.2, the F-statistic confirms the model's overall significance. The findings imply that in order to fully explain herding behaviour, Rm and its squared term are both significant.

Residuals vs Fitted: The plot shows two groups of data points, one in the top right and the other in the bottom left. There is a red line of best fit passing through the points. Data points are represented by black and white circles. The plot suggests a linear relationship between independent and dependent variables, equal variances of error terms, and no outliers in the data.

Q-Q Residuals: The plot shows a curve with a group of points in the upper-right corner. There is a dashed line going from the bottom-left angle to the upper-right angle. The points do not align along the diagonal line but form a curve. This suggests that the data has a distribution different from the normal distribution.

Scale-Location: The plot shows two sets of data points, one in black and the other in pink. Black points are clustered around the line of best fit, while white points are scattered on the plot. The plot suggests a linear relationship between independent and dependent variables, equal variances of error terms, and no outliers in the data.

Leverage: The x-axis is labeled "Leverage," and the y-axis is labeled "Standardized residuals." The graph

has a dotted line labeled "Cook's distance" curving from the top left to the bottom right. There are two solid lines labeled "0.1319" and "0.1336" intersecting at the top right of the graph. There is a cluster of black circles in the bottom left of the graph. There is a single red circle labeled "1337" in the bottom right of the graph. Observations with high leverage have a strong influence on the coefficients of the regression model. Removing these observations would significantly change the model coefficients. Standardized residuals refer to the standardized difference between a predicted value for an observation and the actual value of the observation. If a point in this plot falls outside the Cook's distance (dashed red lines), it is considered an influential observation.

```
coeftest(linearMod,vcov=NeweyWest(linearMod,verbose=T))
```

```
##
## Lag truncation parameter chosen: 3
```

```
##
## t test of coefficients:
##
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept) 0.00842237 0.00048647 17.3134 < 2.2e-16 ***
## x1          0.33020389 0.08519002  3.8761 0.0001092 ***
## x2          1.26234857 2.22620673  0.5670 0.5707432
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The coeftest function performs heteroscedasticity-robust inference for the coefficients of the linear regression model (linearMod) after adjusting for the NeweyWest covariance matrix. The Newey-West robust standard errors are specified in the vcov=NeweyWest(linearMod,verbose=T) section. When there is a possibility that the residuals are heteroscedastic, this is very important. In the event that the homoscedasticity assumption is broken, the robust standard errors guarantee that hypothesis tests and confidence intervals for the coefficients remain valid and allow for more trustworthy inference in the presence of heteroscedasticity. The verbose=T option provides more diagnostic data while calculating the Newey-West standard errors.

The final output shows the outcomes of the Newey-West robust standard errors t-tests for the coefficients in the linear regression model. At conventional significance levels ($p < 0.05$), the intercept and coefficient for variable x1 are statistically significant, suggesting a strong correlation with the dependent variable (CSAD). Rm^2, the squared term, may not significantly contribute to explaining variations in CSAD, as the coefficient for x2 is not statistically significant ($p > 0.05$).

```
# estimate TV Linear Regression
require (tvReg)
```

```
## Loading required package: tvReg
```

```
## Warning: package 'tvReg' was built under R version 4.3.2
```

```
## Loading required package: Matrix
```

```
##
## Attaching package: 'Matrix'
```

```
## The following objects are masked from 'package:tidyr':
##
##     expand, pack, unpack
```
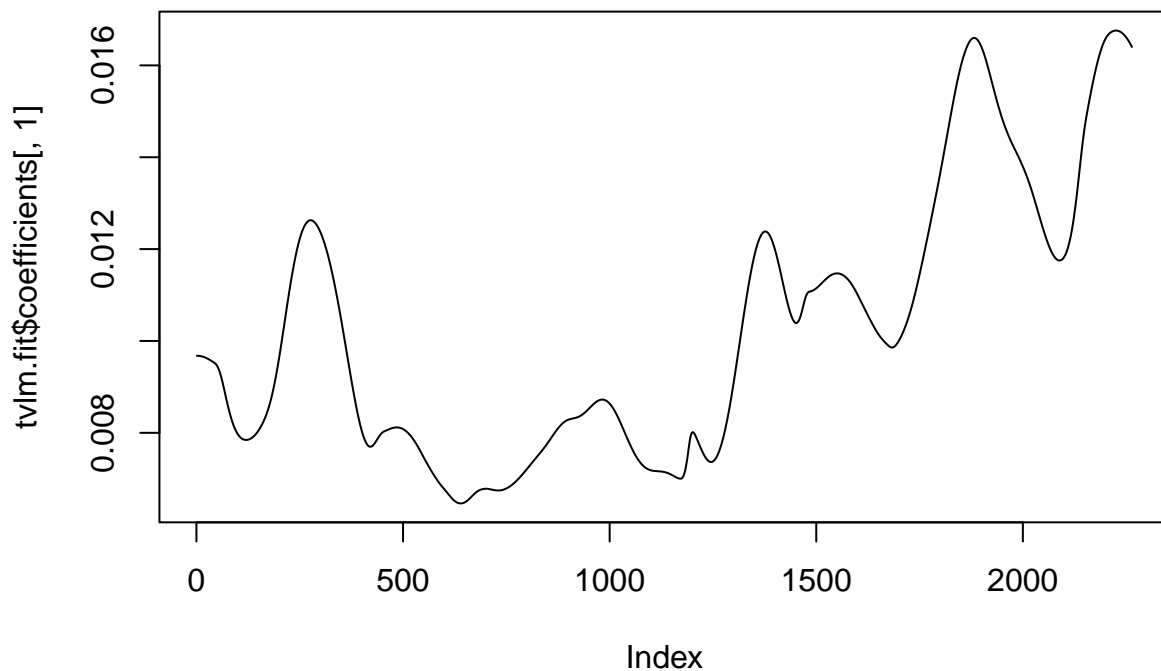
```r
tvlm.fit <- tvLM(y~x1+x2, bw = NULL  )
```

```
## Calculating regression bandwidth... bw =  0.06572343
```
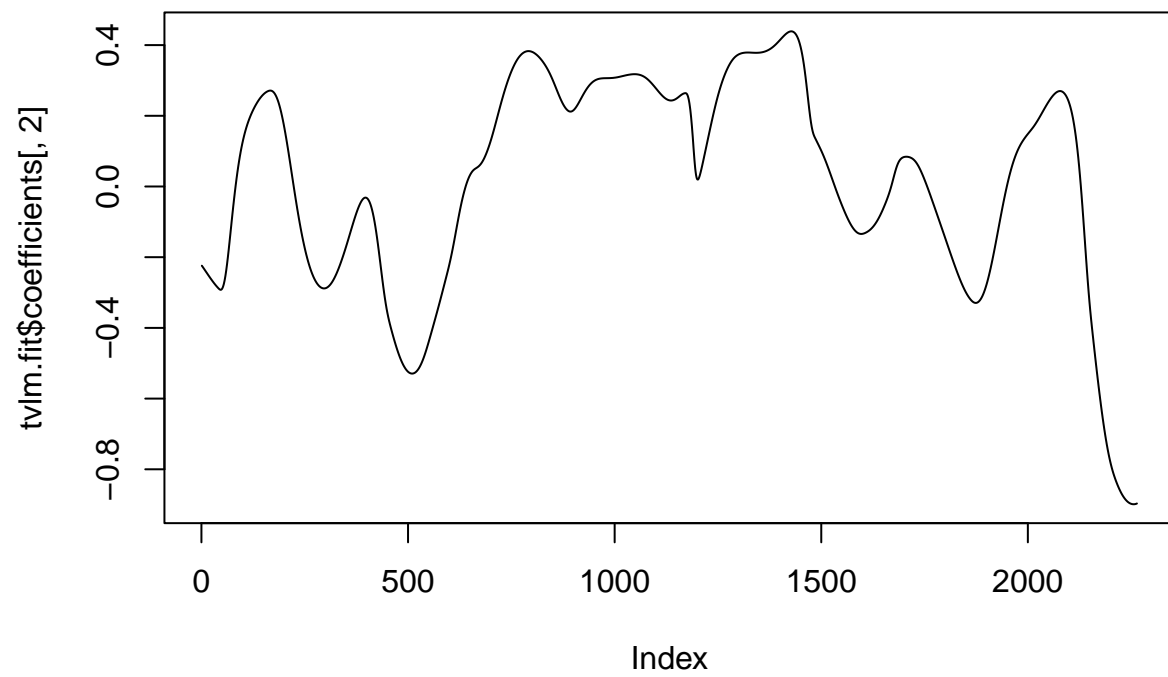
```r
head (tvlm.fit$coefficients)
```

```
##       (Intercept)         x1       x2
## [1,] 0.009678043 -0.2240134 21.27639
## [2,] 0.009677837 -0.2256841 21.40288
## [3,] 0.009677447 -0.2273629 21.53026
## [4,] 0.009676877 -0.2290499 21.65849
## [5,] 0.009676132 -0.2307450 21.78752
## [6,] 0.009675215 -0.2324481 21.91731
```
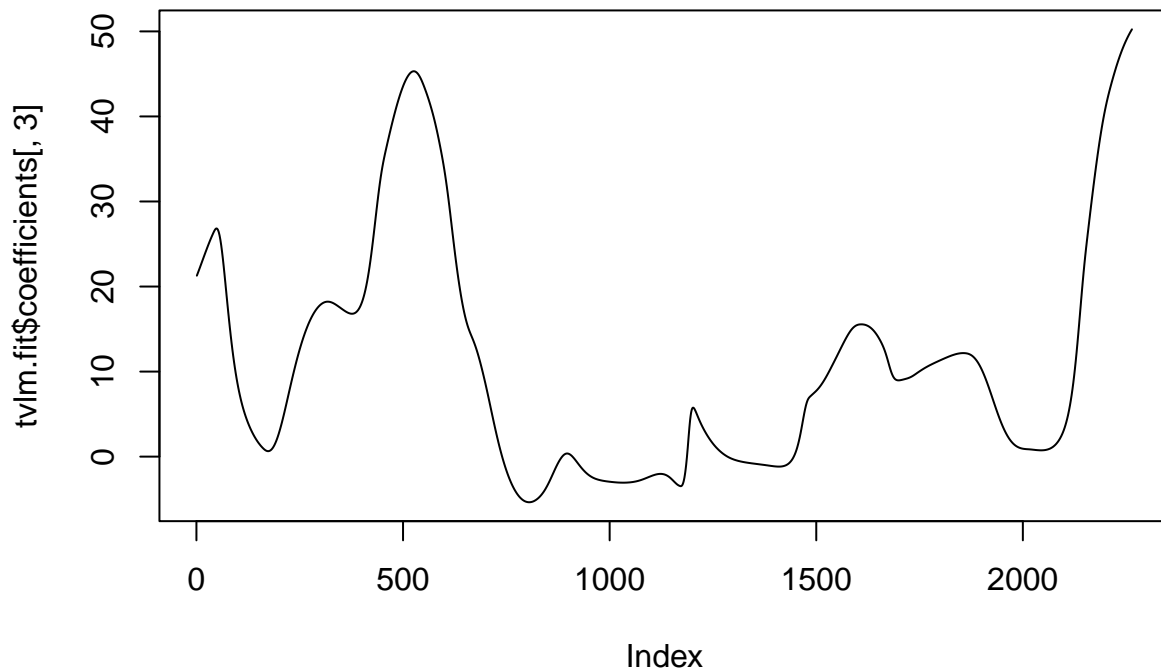
```r
plot(tvlm.fit$coefficients[,1], type="l")
```



```r
plot(tvlm.fit$coefficients[,2], type="l")
```

```r
plot(tvlm.fit$coefficients[,3], type="l")
```

Using the tvReg package, the code estimates a Time-Varying Linear Regression model (tvLM). Based on two independent variables (x1 and x2, or absolute returns and squared returns), the model predicts the dependent variable (y, or CSAD). When the bandwidth (bw) parameter is set to NULL, the model is free to select the bandwidth on its own. The first few rows of the coefficients are shown by the head function. The time-varying coefficients for every independent variable are plotted in the following plot functions, which show how the relationship between the variables in the time-varying regression model evolves with time. TV Linear Regression:

The coefficients x1 and x2:

x1 Coefficient: A negative correlation with herding behaviour is suggested by the negative values. Herding behaviour increases as x1 (probably representing absolute returns) decreases. x2 Coefficient (21.27639, 21.40288,...): The positive values show that herding behaviour and squared returns (x2) have a positive relationship. (bw = 0.06572343) Bandwidth The smoothness of the estimated coefficients over time in a TV regression model is dependent on its bandwidth. While a large bandwidth might produce smoother trajectories, a small one might capture quick changes in the coefficients.

```r
#Bayesian regression in R
# Bayesian models
library (brms)
```

```
## Warning: package 'brms' was built under R version 4.3.2
```

```
## Loading required package: Rcpp
```

```
## Loading 'brms' package (version 2.20.4). Useful instructions
## can be found by typing help('brms'). A more detailed introduction
## to the package is available through vignette('brms_overview').
```

```
##
## Attaching package: 'brms'

## The following object is masked from 'package:faraway':
##
##     epilepsy

## The following object is masked from 'package:e1071':
##
##     rwiener

## The following object is masked from 'package:stats':
##
##     ar
```

```r
hourly = cbind(y, x1, x2)
model <- brm(formula = y ~ x1+x2,
             data = hourly,
             seed = 123)
```

```
## Compiling Stan program...


## Start sampling


##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 4.3e-05 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 0.43 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 0.836 seconds (Warm-up)
## Chain 1:                0.47 seconds (Sampling)
## Chain 1:                1.306 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 2).
## Chain 2:
```

```
## Chain 2: Gradient evaluation took 1.7e-05 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0.17 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 0.83 seconds (Warm-up)
## Chain 2:                0.526 seconds (Sampling)
## Chain 2:                1.356 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 1.6e-05 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 0.16 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 0.717 seconds (Warm-up)
## Chain 3:                0.495 seconds (Sampling)
## Chain 3:                1.212 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 1.5e-05 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0.15 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
```

```
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 0.771 seconds (Warm-up)
## Chain 4:                0.564 seconds (Sampling)
## Chain 4:                1.335 seconds (Total)
## Chain 4:
```

```
summary(model)
```

```
##  Family: gaussian
##   Links: mu = identity; sigma = identity
## Formula: y ~ x1 + x2
##    Data: hourly (Number of observations: 2264)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Population-Level Effects:
##           Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept     0.01      0.00     0.01     0.01 1.00     1780     1857
## x1            0.33      0.03     0.28     0.39 1.00     1018     1289
## x2            1.25      0.51     0.21     2.21 1.00     1023     1303
##
## Family Specific Parameters:
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.01      0.00     0.01     0.01 1.00     1285     1687
##
## Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

The code performs Bayesian regression using the brm function from the brms package in R. It specifies a Bayesian model where the dependent variable (y or CSAD) is predicted by two independent variables (x1 and x2 or absolute returns and squared returns). The data used for modeling is stored in the hourly matrix. The seed parameter is set for reproducibility. The summary function is then used to display a summary of the Bayesian regression model, providing information about parameter estimates, uncertainty, and other relevant statistics obtained through the Bayesian inference process.

The output displays a Bayesian regression model's findings. The estimated coefficients for the intercept, squared returns (x2), and absolute returns (x1) are given, together with the corresponding 95% credible intervals and uncertainties (Est. Error). Good convergence across chains is indicated by Rhat values close to 1. Effective sample sizes are represented by Bulk_ESS and Tail_ESS, indicating adequate samples for trustworthy inference. A positive correlation with the dependent variable (y or CSAD) is indicated by

the positive coefficient for x1 When both the absolute and squared returns are zero, the baseline CSAD is represented by the intercept (0.01). It implies a starting point for herding behaviour. Absolute Returns (x1): A positive correlation is suggested by the coefficient of 0.33, which shows that an increase in absolute returns of one unit is linked to an increase in CSAD of 0.33. This suggests that stronger herding behaviour in the market is a result of higher absolute returns. Squared Returns (x2): A one-unit increase in squared returns is correlated with a 1.25 increase in CSAD, according to the coefficient of 1.25. This positive correlation implies that increased herding behaviour is also a result of higher volatility, as measured by squared returns. To sum up, the analysis indicates that herding behaviour is positively impacted by both absolute and squared returns. Higher absolute returns and more market volatility may cause traders to show stronger herding instincts. When extrapolating causality from correlation in observational data, care must be taken.

```r
#usin markov regime switching model to check for herding
library(MSwM)
```

```
## Warning: package 'MSwM' was built under R version 4.3.2
```

```
## Loading required package: parallel
```

```r
sw <- rep(TRUE, length(coef(linearMod)))
print(sw)
```

```
## [1] TRUE TRUE TRUE
```

```r
nstates <- 2
msEuro = msmFit(linearMod, k = nstates, sw = rep(TRUE,4))
summary(msEuro)
```

```
## Markov Switching Model
##
## Call: msmFit(object = linearMod, k = nstates, sw = rep(TRUE, 4))
##
##         AIC       BIC  logLik
##   -17105.16 -17024.46 8558.58
##
## Coefficients:
##
## Regime 1
## ---------
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)(S)   0.0076     0.0002 38.0000   <2e-16 ***
## x1(S)            0.2084     0.0160 13.0250   <2e-16 ***
## x2(S)           -0.1003     0.2549 -0.3935    0.694
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.00336853
## Multiple R-squared: 0.302
##
## Standardized Residuals:
##           Min            Q1           Med            Q3           Max
## -0.0122756774 -0.0019108131  0.0001276178  0.0024808094  0.0083226920
##
```

```
## Regime 2
## ---------
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)(S)   0.0164     0.0011 14.9091 < 2.2e-16 ***
## x1(S)            0.1360     0.1049  1.2965    0.1948
## x2(S)           10.1356     1.7684  5.7315 9.955e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.01075721
## Multiple R-squared: 0.4275
##
## Standardized Residuals:
##          Min            Q1          Med            Q3          Max
## -0.022510446 -0.002761489 -0.001889562 -0.001434849  0.062179381
##
## Transition probabilities:
##             Regime 1  Regime 2
## Regime 1 0.8564495 0.5029266
## Regime 2 0.1435505 0.4970734
```

```
plotProb(msEuro ,which=1)
```
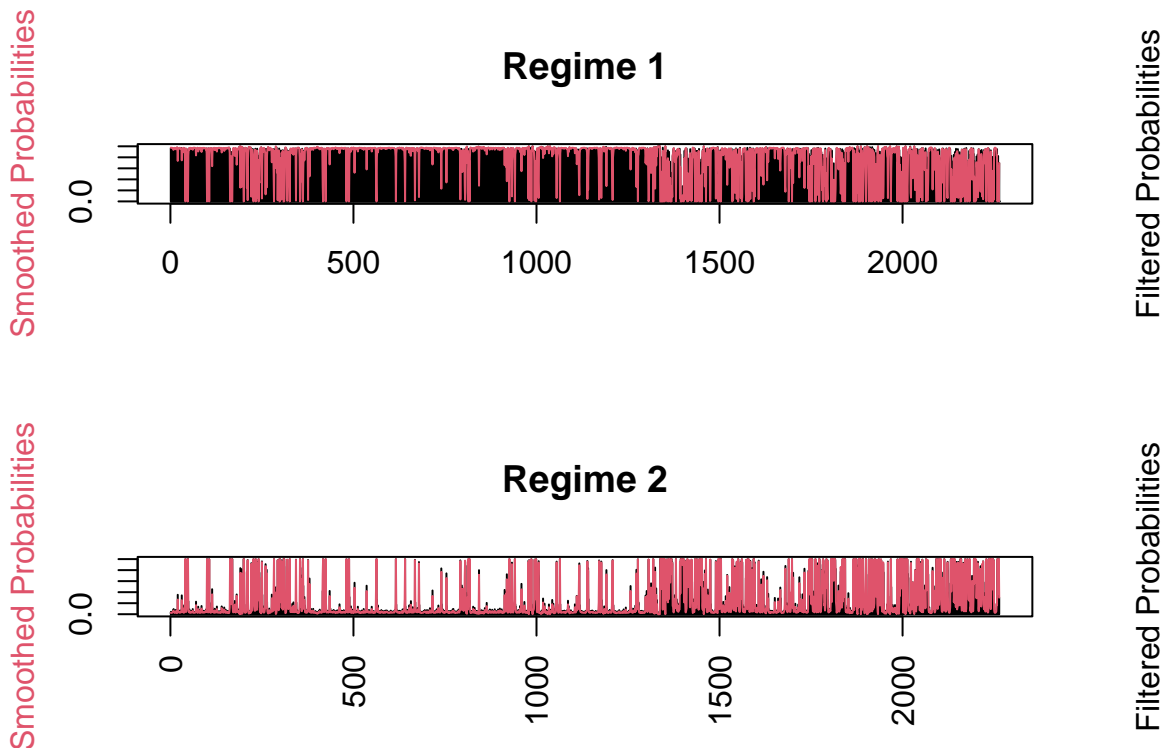


```
library(quantreg)
```

```
## Loading required package: SparseM
```

```
##
## Attaching package: 'SparseM'

## The following object is masked from 'package:base':
##
##      backsolve
```

```r
taus<-seq(from = .1, to = .9, by = .1)
coef0 <- rq( y ~ x1+x2, tau=taus);
summary (coef0); plot (coef0, type = "l")
```

```
## Warning in summary.rq(xi, U = U, ...): 1 non-positive fis

##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.1
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.00401  0.00020    20.32387  0.00000
## x1           0.19122  0.03761     5.08423  0.00000
## x2          -0.62211  1.18142    -0.52658  0.59854
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.2
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.00495  0.00020    25.01774  0.00000
## x1           0.21913  0.03318     6.60509  0.00000
## x2          -0.19109  0.91352    -0.20918  0.83433
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.3
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.00584  0.00017    35.36821  0.00000
## x1           0.22996  0.02288    10.05106  0.00000
## x2           0.24095  0.46352     0.51982  0.60324
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.4
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.00674  0.00018    37.66428  0.00000
## x1           0.24040  0.02392    10.04858  0.00000
## x2           0.25062  0.49606     0.50522  0.61345
```

```
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.5
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.00752  0.00021    36.27026  0.00000
## x1           0.29204  0.03546     8.23617  0.00000
## x2          -0.21437  0.95530    -0.22440  0.82246
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.6
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.00854  0.00044    19.51212  0.00000
## x1           0.27751  0.08697     3.19069  0.00144
## x2           0.68581  3.03023     0.22632  0.82097
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.7
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.01037  0.00043    23.99592  0.00000
## x1           0.16155  0.09692     1.66685  0.09568
## x2           6.31219  3.37085     1.87258  0.06126
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.8
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.01204  0.00046    26.06027  0.00000
## x1           0.17800  0.08413     2.11586  0.03447
## x2           8.75951  2.46179     3.55818  0.00038
##
## Call: rq(formula = y ~ x1 + x2, tau = taus)
##
## tau: [1] 0.9
##
## Coefficients:
##              Value    Std. Error t value  Pr(>|t|)
## (Intercept)  0.01566  0.00121    12.99154  0.00000
## x1           0.22514  0.25090     0.89734  0.36963
## x2          12.30724  8.54237     1.44073  0.14980
```

(Intercept)

x1

x2
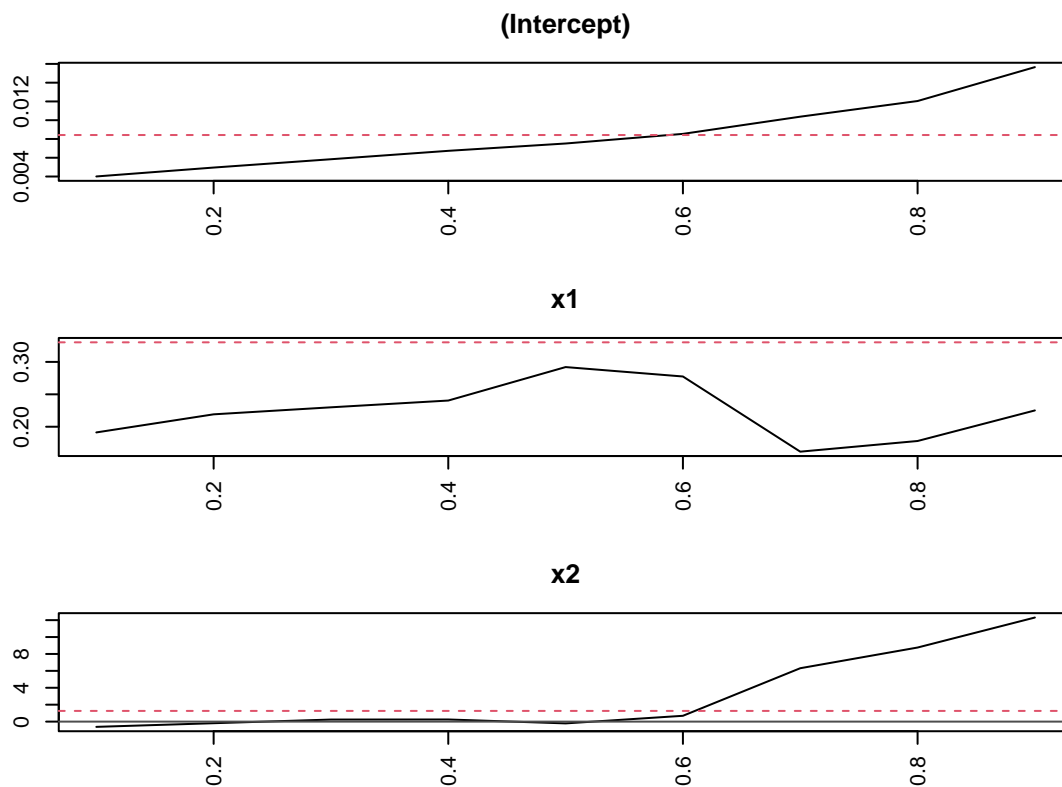
This R code looks into herding behaviour in financial markets using quantile regression and a Markov regime-switching model: A two-state Markov model (nstates = 2) with a switching structure based on the coefficients of a linear model (linearMod) is defined by the Markov Regime-Switching Model (msmFit). The sw parameter indicates that regime switching should apply to every coefficient. Fitting quantile regression models (coef0) for various quantiles (taus) of the conditional distribution of the CSAD is known as quantile regression (rq). This helps to capture the influence of the predictors (x1 and x2) at different distributional points. Visualization: The code plots and summarises statistics for the quantile regression and Markov regime-switching model results, providing insight into the dynamics of herding behavior in various market scenarios.

The first regime of the Markov Switching Model (MSM) shows a positive and highly significant intercept ((Intercept)(S)) that suggests a higher baseline for herding behaviour. 1x(S) Positive coefficient but lack of statistical significance indicates that absolute returns (x1) have little effect on herding under this regime. (x2S) Squared returns (x2) and herding in this regime appear to be strongly positively correlated, according to the coefficient, which is positive and highly significant. Regime 2: Intercept ((Intercept)(S)): This regime's baseline for herding behaviour is clearly defined and is positive and highly significant. 1x(S) Absolute returns (x1) and herding in this regime have a positive correlation, as indicated by the coefficient, which is positive and highly significant. (x2S) Coefficient: Negative but not statistically significant, indicating that herding in this regime and squared returns (x2) have a weak relationship. Probabilities of Transition: The likelihood of switching from one regime to another is shown by the transition probabilities. In this instance, switching between Regimes 1 and 2 and vice versa is feasible.

Quantile Regression (0.1 to 0.9 quantiles): The coefficients for the intercept, x1, and x2 are estimated for each quantile. Notable findings: The effect of absolute returns (x1) on herding tends to diminish as the quantile rises. Squared returns (x2) have different effects on different quantiles; they can be positive or negative. According to the transition probabilities

Akaike Information Criterion, or AIC: AIC, which penalises for the number of parameters in the model, is

a measure of how well the model fits the data. Its current value is -17105.16. A better trade-off between model complexity and goodness of fit is indicated by lower AIC values.

Interpretation: The model fit and complexity appear to be well-balanced, as indicated by the relatively low AIC value. This implies that the model is providing a logical explanation for the data.

Byesian Information Criterion, or BIC: Value (-17024.46): BIC penalises for model complexity in a similar way to AIC, but it penalises more severely for more parameters. A model that fits better is indicated by lower BIC values. Interpretation: The idea that the model fits well is supported by the BIC value, which is likewise rather low. This takes complexity penalty into account. Recommendation: The log-likelihood, AIC, and BIC values suggest that the model is a good option.

Overall Conclusion:

Absolute and squared returns(x2) have a positive effect on herding behaviour, according to data from Bayesian regression, MSM, and quantile regression. When absolute returns are higher and market volatility is higher, traders tend to show stronger herding instincts. Possible transitions between various herding regimes are suggested by the transition probabilities in the MSM.