VAR Analysis

Contents

Data

Load Base Data

```
# 1. Load Political Social Media

#contains posts from Twitter & TruthSocial
social <- read.csv(here("data/mothership", "social.csv"))

social_hourly <- read.csv(here("data/mothership", "socialhourly.csv"))


# 2. Load Financial

#S&P500
SPY <- read.csv(here("data/mothership", "SPY.csv"))

#STOXX50
VGK <- read.csv(here("data/mothership", "VGK.csv"))

#CSI 300 (China)
ASHR <- read.csv(here("data/mothership", "ASHR.CSV"))
```

```
#make posixct
SPY$timestamp = as.POSIXct(SPY$timestamp,format = "%Y-%m-%d %H:%M:%S")
VGK$timestamp = as.POSIXct(VGK$timestamp,format = "%Y-%m-%d %H:%M:%S")
ASHR$timestamp = as.POSIXct(ASHR$timestamp,format = "%Y-%m-%d %H:%M:%S")
social$timestamp = as.POSIXct(social$timestamp,format = "%Y-%m-%d %H:%M:%S")
social_hourly$timestamp = as.POSIXct(social_hourly$timestamp,format = "%Y-%m-%d %H:%M:%S")
```

Volatility

```
#find hourly volatility
#NOTE: this ignores tweets made outside trading hours!!
SPY_volatility_alltime = dplyr::select(SPY,timestamp,r_vol_h)

#aggregating per hour
SPY_volatility_alltime = SPY_volatility_alltime %>%
          mutate(timestamp = floor_date(timestamp, unit = "hour")) %>%
          distinct(timestamp, .keep_all = TRUE)

#select time period
SPY_volatility = filter(SPY_volatility_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

```
#find hourly volatility
#NOTE: this ignores tweets made outside trading hours!!
VGK_volatility_alltime = dplyr::select(VGK,timestamp,r_vol_h)
```

```r
#aggregating per hour
VGK_volatility_alltime = VGK_volatility_alltime %>%
          mutate(timestamp = floor_date(timestamp, unit = "hour")) %>%
          distinct(timestamp, .keep_all = TRUE)

#select time period
VGK_volatility = filter(VGK_volatility_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

```r
#find hourly volatility
#NOTE: this ignores tweets made outside trading hours!!
ASHR_volatility_alltime = dplyr::select(ASHR,timestamp,r_vol_h)

#aggregating per hour
ASHR_volatility_alltime = ASHR_volatility_alltime %>%
          mutate(timestamp = floor_date(timestamp, unit = "hour")) %>%
          distinct(timestamp, .keep_all = TRUE)

#select time period
ASHR_volatility = filter(ASHR_volatility_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

Number of Posts

```r
#find count
tweetcount_alltime = dplyr::select(social_hourly,timestamp,N)

#select time period
tweetcount = filter(tweetcount_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

Dummy for Social Media Post

```r
#find dummy
tweetdummy_alltime = dplyr::select(social_hourly,timestamp,dummy)

#select time period
tweetdummy = filter(tweetdummy_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

Number of Tweets Mentioning Tariffs

```
#find count
tariff_alltime = dplyr::select(social_hourly,timestamp,total_tariff)

#select time period
tariff = filter(tariff_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

Number of Tweets Mentioning Trade

```
#find count
trade_alltime = dplyr::select(social_hourly,timestamp,total_trade)

#select time period
trade = filter(trade_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

Proportion of Positive

```
#find count
positive_alltime = dplyr::select(social_hourly,timestamp,prop_positive)

#select time period
positive = filter(positive_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

Proportion of Negative

```
#find count
negative_alltime = dplyr::select(social_hourly,timestamp,prop_negative)

#select time period
negative = filter(negative_alltime,
                  between(timestamp,
                          as.Date('2014-01-01'),
                          as.Date('2025-04-10')))
```

Merge

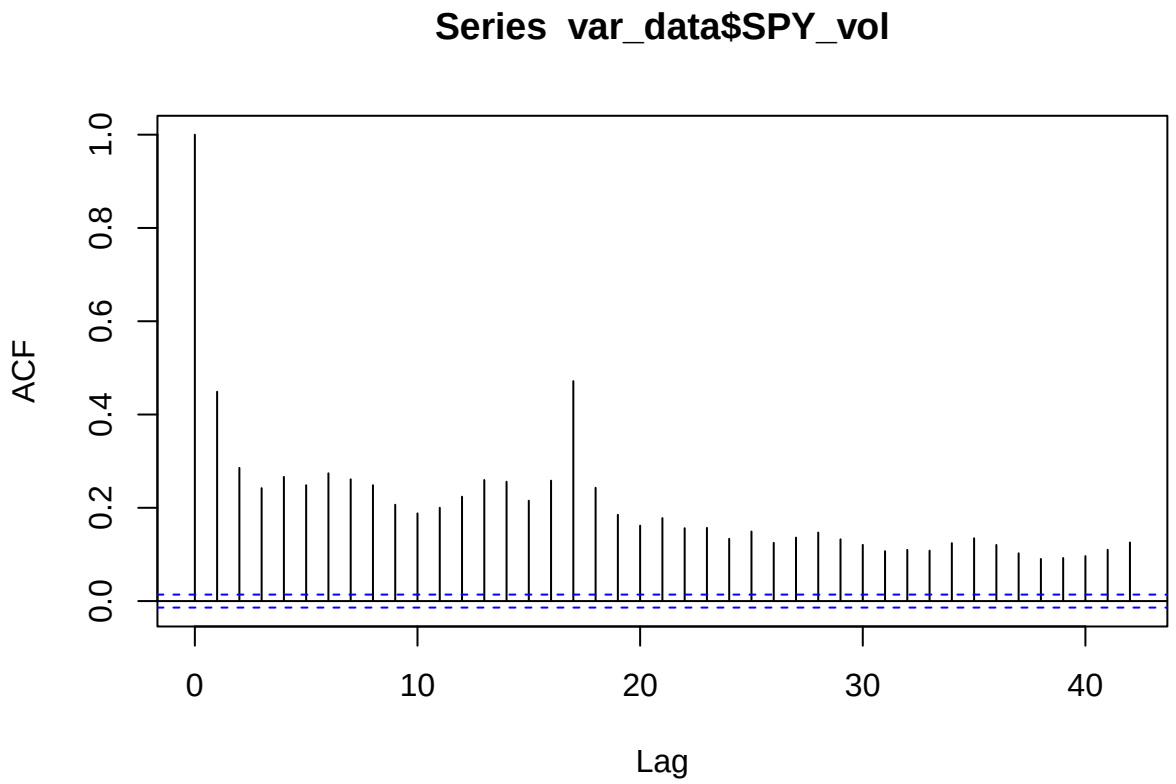
```
#merge our dependant and independant vars
var_data = left_join(SPY_volatility, VGK_volatility, by="timestamp")
var_data = left_join(var_data, ASHR_volatility, by="timestamp")
var_data = left_join(var_data, tweetdummy, by="timestamp")
var_data = left_join(var_data, tweetcount, by="timestamp")
var_data = left_join(var_data, tariff, by="timestamp")
var_data = left_join(var_data, trade, by="timestamp")
var_data = left_join(var_data, positive, by="timestamp")
var_data = left_join(var_data, negative, by="timestamp")

#rename volatility columns
names(var_data)[2] <- "SPY_vol"
names(var_data)[3] <- "VGK_vol"
names(var_data)[4] <- "ASHR_vol"

#convert NA to zeroes
var_data$N[is.na(var_data$N)] = 0
var_data$dummy[is.na(var_data$dummy)] = 0
var_data$total_tariff[is.na(var_data$total_tariff)] = 0
var_data$total_trade[is.na(var_data$total_trade)] = 0
var_data$prop_positive[is.na(var_data$prop_positive)] = 0
var_data$prop_negative[is.na(var_data$prop_negative)] = 0
```

S&P500 VAR Models

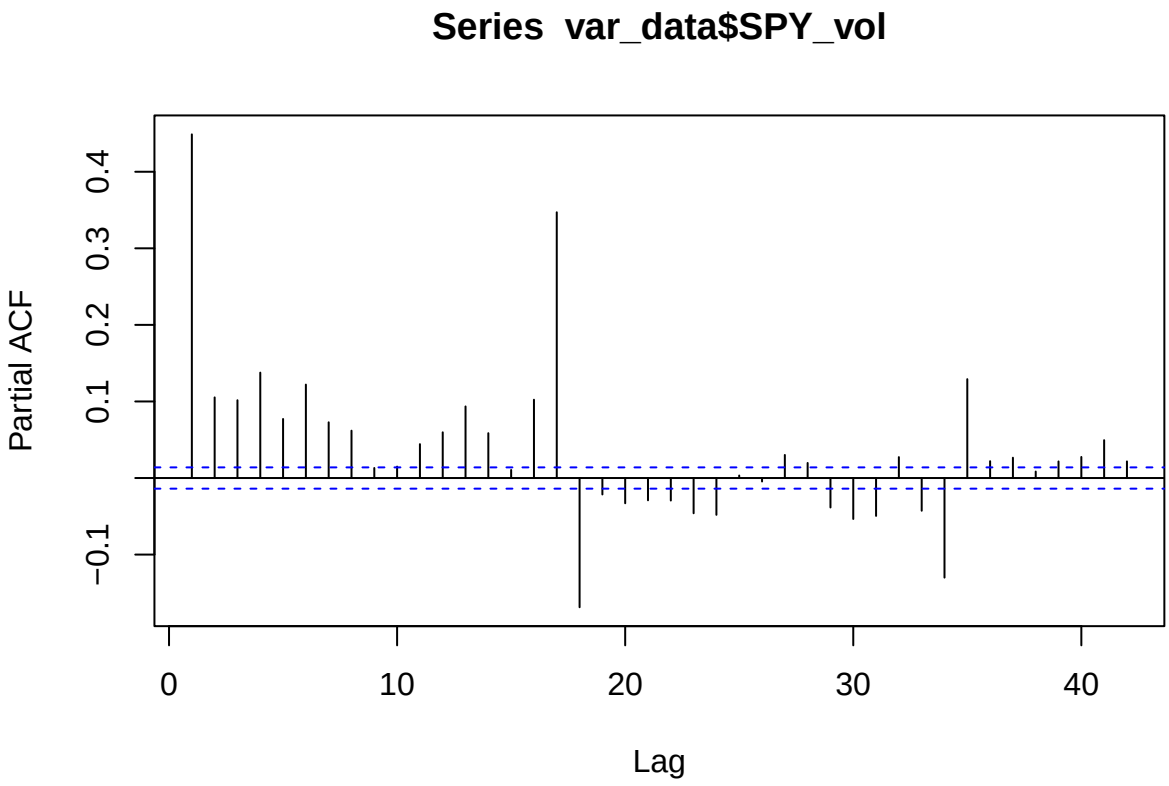
Tests

Following: https://github.com/ritvikmath/Time-Series-Analysis/blob/master/VAR%20Model.ipynb

```
acf(var_data$SPY_vol)
```




```
pacf(var_data$SPY_vol)
```




```r
#Correlation between "heater" and lagged "ice cream"

for (lag in 1:13) {

  volatility_series <- var_data$SPY_vol[(lag+1):nrow(var_data)]
  lagged_tweet_series <- var_data$total_tariff[1:(nrow(var_data)-lag)]

  # Print lag value
  cat('Lag:', lag, '\n')

  # Calculate Pearson correlation
  correlation <- cor.test(volatility_series, lagged_tweet_series, method="pearson")
  cat("Correlation coefficient:", correlation$estimate, "\n")
  cat("P-value:", correlation$p.value, "\n")

  # Separator line
  cat('------\n')
}
```

```
## Lag: 1
## Correlation coefficient: 0.02172497
## P-value: 0.002209397
## ------
## Lag: 2
## Correlation coefficient: 0.01929839
## P-value: 0.006556817
```

```
## ------
## Lag: 3
## Correlation coefficient: 0.02785951
## P-value: 8.67837e-05
## ------
## Lag: 4
## Correlation coefficient: 0.02832837
## P-value: 6.584245e-05
## ------
## Lag: 5
## Correlation coefficient: 0.036346
## P-value: 3.041321e-07
## ------
## Lag: 6
## Correlation coefficient: 0.02049096
## P-value: 0.003898092
## ------
## Lag: 7
## Correlation coefficient: 0.01738812
## P-value: 0.01432125
## ------
## Lag: 8
## Correlation coefficient: 0.01581177
## P-value: 0.02594795
## ------
## Lag: 9
## Correlation coefficient: 0.1321634
## P-value: 5.455897e-78
## ------
## Lag: 10
## Correlation coefficient: 0.04215385
## P-value: 2.866286e-09
## ------
## Lag: 11
## Correlation coefficient: 0.04823505
## P-value: 1.07098e-11
## ------
## Lag: 12
## Correlation coefficient: 0.01741241
## P-value: 0.01419798
## ------
## Lag: 13
## Correlation coefficient: 0.01609355
## P-value: 0.02342715
## ------
```

```
#data
variables <- c("SPY_vol", "total_tariff")

ts_data <- xts(var_data[, variables],
               order.by = var_data$timestamp)
```

```r
#adf test
# ADF stationary test for each column
adf_test_results <- apply(ts_data, 2, function(x) adf.test(x)$p.value) #2 means columns
```

```
## Warning in adf.test(x): p-value smaller than printed p-value
```

```r
# print p values (p<0.05 means stationary, p>0.05 means explosive)
adf_test_results
```

```
##      SPY_vol total_tariff
##    0.9833197    0.0100000
```

```r
#lags
# Determine optimal lag length using AIC
lag_selection <- VARselect(ts_data, lag.max = 55, type = "const")

# View the lag length selection
lag_selection$selection
```

```
## AIC(n)  HQ(n)  SC(n) FPE(n)
##     53     47     47     53
```

```r
#fit
# Fit the VAR model with the chosen lag length
var_model <- VAR(ts_data, p = lag_selection$selection["AIC(n)"], type = "const")

# Check the summary of the model
summary(var_model)
```

```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: SPY_vol, total_tariff
## Deterministic variables: const
## Sample size: 19792
## Log Likelihood: 64628.868
## Roots of the characteristic polynomial:
## 1.011 1.011 1.009 1.009 1.006 1.006 0.9951 0.9951 0.9923 0.9896 0.9896 0.9852 0.9852 0.9828 0.9828 0
## Call:
## VAR(y = ts_data, p = lag_selection$selection["AIC(n)"], type = "const")
##
##
## Estimation results for equation SPY_vol:
## ========================================
## SPY_vol = SPY_vol.l1 + total_tariff.l1 + SPY_vol.l2 + total_tariff.l2 + SPY_vol.l3 + total_tariff.l3
##
##                    Estimate Std. Error t value Pr(>|t|)
## SPY_vol.l1        0.4029657  0.0071270  56.541  < 2e-16 ***
## total_tariff.l1   0.0044758  0.0111196   0.403 0.687307
## SPY_vol.l2       -0.0468603  0.0077593  -6.039 1.58e-09 ***
## total_tariff.l2  -0.0047389  0.0111197  -0.426 0.669988
```

```
## SPY_vol.l3        0.0695965  0.0086607   8.036 9.81e-16 ***
## total_tariff.l3  -0.0108372  0.0111206  -0.975 0.329813
## SPY_vol.l4        0.0438535  0.0088306   4.966 6.89e-07 ***
## total_tariff.l4  -0.0058432  0.0111195  -0.525 0.599247
## SPY_vol.l5        0.0125214  0.0088295   1.418 0.156166
## total_tariff.l5  -0.0026000  0.0111195  -0.234 0.815126
## SPY_vol.l6        0.1157566  0.0088437  13.089  < 2e-16 ***
## total_tariff.l6  -0.0141008  0.0111208  -1.268 0.204825
## SPY_vol.l7       -0.0083874  0.0087975  -0.953 0.340405
## total_tariff.l7  -0.0211804  0.0111209  -1.905 0.056852 .
## SPY_vol.l8        0.0638476  0.0087891   7.264 3.89e-13 ***
## total_tariff.l8   0.0152849  0.0111208   1.374 0.169318
## SPY_vol.l9       -0.0613206  0.0088860  -6.901 5.33e-12 ***
## total_tariff.l9   0.0781593  0.0111258   7.025 2.21e-12 ***
## SPY_vol.l10       0.0147307  0.0089074   1.654 0.098194 .
## total_tariff.l10 -0.0185605  0.0111413  -1.666 0.095745 .
## SPY_vol.l11      -0.0539690  0.0089064  -6.060 1.39e-09 ***
## total_tariff.l11  0.0229345  0.0111435   2.058 0.039594 *
## SPY_vol.l12       0.0587522  0.0089347   6.576 4.96e-11 ***
## total_tariff.l12 -0.0173852  0.0111876  -1.554 0.120207
## SPY_vol.l13       0.0621052  0.0089569   6.934 4.22e-12 ***
## total_tariff.l13  0.0050035  0.0111882   0.447 0.654725
## SPY_vol.l14       0.0207169  0.0090250   2.295 0.021715 *
## total_tariff.l14 -0.0082270  0.0111885  -0.735 0.462162
## SPY_vol.l15      -0.0136240  0.0089286  -1.526 0.127054
## total_tariff.l15  0.0665781  0.0111886   5.951 2.72e-09 ***
## SPY_vol.l16      -0.1187535  0.0089441 -13.277  < 2e-16 ***
## total_tariff.l16  0.0054375  0.0111987   0.486 0.627292
## SPY_vol.l17       0.8242653  0.0090079  91.504  < 2e-16 ***
## total_tariff.l17  0.2277308  0.0111974  20.338  < 2e-16 ***
## SPY_vol.l18      -0.4474117  0.0107753 -41.522  < 2e-16 ***
## total_tariff.l18 -0.0141682  0.0113484  -1.248 0.211873
## SPY_vol.l19       0.0784935  0.0112320   6.988 2.87e-12 ***
## total_tariff.l19 -0.0110562  0.0113489  -0.974 0.329965
## SPY_vol.l20      -0.0103286  0.0165882  -0.623 0.533524
## total_tariff.l20  0.0058384  0.0113713   0.513 0.607653
## SPY_vol.l21       0.0925247  0.0168340   5.496 3.93e-08 ***
## total_tariff.l21 -0.0160638  0.0113733  -1.412 0.157846
## SPY_vol.l22      -0.0285369  0.0168554  -1.693 0.090463 .
## total_tariff.l22 -0.0096735  0.0113739  -0.851 0.395057
## SPY_vol.l23      -0.0011902  0.0168446  -0.071 0.943670
## total_tariff.l23 -0.0284967  0.0113802  -2.504 0.012286 *
## SPY_vol.l24      -0.1456959  0.0169014  -8.620  < 2e-16 ***
## total_tariff.l24 -0.0091315  0.0113815  -0.802 0.422384
## SPY_vol.l25       0.1608299  0.0169068   9.513  < 2e-16 ***
## total_tariff.l25 -0.0296465  0.0113843  -2.604 0.009217 **
## SPY_vol.l26      -0.0914580  0.0169243  -5.404 6.59e-08 ***
## total_tariff.l26 -0.0067423  0.0113867  -0.592 0.553778
## SPY_vol.l27       0.0016216  0.0170554   0.095 0.924255
## total_tariff.l27  0.0138162  0.0113868   1.213 0.225008
## SPY_vol.l28       0.1292058  0.0171012   7.555 4.36e-14 ***
## total_tariff.l28 -0.0061603  0.0113870  -0.541 0.588521
## SPY_vol.l29      -0.0920397  0.0171304  -5.373 7.84e-08 ***
## total_tariff.l29  0.0069019  0.0113884   0.606 0.544489
```

```
## SPY_vol.l30       0.0591633  0.0171509   3.450 0.000563 ***
## total_tariff.l30 -0.0101181  0.0113887  -0.888 0.374320
## SPY_vol.l31      -0.1178345  0.0171546  -6.869 6.66e-12 ***
## total_tariff.l31 -0.0019124  0.0113951  -0.168 0.866718
## SPY_vol.l32       0.0307949  0.0171476   1.796 0.072530 .
## total_tariff.l32  0.0140541  0.0113950   1.233 0.217459
## SPY_vol.l33      -0.0325417  0.0169834  -1.916 0.055367 .
## total_tariff.l33  0.0154964  0.0113952   1.360 0.173874
## SPY_vol.l34       0.0159556  0.0170262   0.937 0.348708
## total_tariff.l34  0.0554849  0.0113954   4.869 1.13e-06 ***
## SPY_vol.l35       0.0985510  0.0170260   5.788 7.22e-09 ***
## total_tariff.l35 -0.0209856  0.0114022  -1.840 0.065713 .
## SPY_vol.l36      -0.0276377  0.0170331  -1.623 0.104693
## total_tariff.l36  0.0032000  0.0114032   0.281 0.779004
## SPY_vol.l37       0.0241785  0.0170395   1.419 0.155924
## total_tariff.l37  0.0041716  0.0114502   0.364 0.715621
## SPY_vol.l38      -0.1976257  0.0170393 -11.598  < 2e-16 ***
## total_tariff.l38  0.0310785  0.0114492   2.714 0.006644 **
## SPY_vol.l39       0.0674862  0.0170987   3.947 7.95e-05 ***
## total_tariff.l39  0.2471205  0.0114513  21.580  < 2e-16 ***
## SPY_vol.l40      -0.0378744  0.0170487  -2.222 0.026326 *
## total_tariff.l40 -0.0192476  0.0115850  -1.661 0.096645 .
## SPY_vol.l41      -0.0217985  0.0171371  -1.272 0.203385
## total_tariff.l41  0.0072193  0.0115869   0.623 0.533253
## SPY_vol.l42       0.0816700  0.0171405   4.765 1.90e-06 ***
## total_tariff.l42  0.0025367  0.0116221   0.218 0.827226
## SPY_vol.l43       0.0023184  0.0171413   0.135 0.892413
## total_tariff.l43  0.0008803  0.0116228   0.076 0.939625
## SPY_vol.l44      -0.0125033  0.0171417  -0.729 0.465762
## total_tariff.l44 -0.0013680  0.0116223  -0.118 0.906302
## SPY_vol.l45      -0.0383364  0.0171530  -2.235 0.025431 *
## total_tariff.l45 -0.0220076  0.0116225  -1.894 0.058301 .
## SPY_vol.l46       0.0027048  0.0171609   0.158 0.874762
## total_tariff.l46  0.0261358  0.0116208   2.249 0.024520 *
## SPY_vol.l47       0.0161689  0.0170438   0.949 0.342801
## total_tariff.l47  0.2150016  0.0116219  18.500  < 2e-16 ***
## SPY_vol.l48       0.0278653  0.0169935   1.640 0.101071
## total_tariff.l48 -0.0175236  0.0117227  -1.495 0.134972
## SPY_vol.l49       0.0715337  0.0170010   4.208 2.59e-05 ***
## total_tariff.l49 -0.0088177  0.0117247  -0.752 0.452027
## SPY_vol.l50      -0.0091148  0.0169368  -0.538 0.590471
## total_tariff.l50  0.0162108  0.0117420   1.381 0.167425
## SPY_vol.l51      -0.0432057  0.0169398  -2.551 0.010763 *
## total_tariff.l51  0.0051383  0.0117444   0.438 0.661744
## SPY_vol.l52      -0.0461411  0.0169432  -2.723 0.006469 **
## total_tariff.l52  0.0039263  0.0117449   0.334 0.738158
## SPY_vol.l53       0.0010663  0.0155729   0.068 0.945409
## total_tariff.l53 -0.0500905  0.0117460  -4.264 2.01e-05 ***
## const             0.0007962  0.0004965   1.604 0.108826
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.05917 on 19685 degrees of freedom
```

```
## Multiple R-Squared: 0.5752,  Adjusted R-squared: 0.5729
## F-statistic: 251.5 on 106 and 19685 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation total_tariff:
## ============================================
## total_tariff = SPY_vol.l1 + total_tariff.l1 + SPY_vol.l2 + total_tariff.l2 + SPY_vol.l3 + total_tari
##
##                    Estimate Std. Error t value Pr(>|t|)
## SPY_vol.l1       -1.302e-02  4.576e-03  -2.844 0.004456 **
## total_tariff.l1  -1.437e-03  7.139e-03  -0.201 0.840475
## SPY_vol.l2        7.987e-02  4.982e-03  16.032  < 2e-16 ***
## total_tariff.l2  -3.036e-03  7.140e-03  -0.425 0.670639
## SPY_vol.l3       -1.791e-02  5.561e-03  -3.221 0.001278 **
## total_tariff.l3  -4.570e-04  7.140e-03  -0.064 0.948971
## SPY_vol.l4       -1.193e-04  5.670e-03  -0.021 0.983210
## total_tariff.l4  -1.565e-03  7.139e-03  -0.219 0.826499
## SPY_vol.l5       -5.147e-03  5.669e-03  -0.908 0.363913
## total_tariff.l5  -3.158e-03  7.139e-03  -0.442 0.658247
## SPY_vol.l6       -6.731e-03  5.678e-03  -1.185 0.235853
## total_tariff.l6   5.258e-03  7.140e-03   0.736 0.461480
## SPY_vol.l7       -9.830e-03  5.649e-03  -1.740 0.081834 .
## total_tariff.l7  -6.898e-04  7.140e-03  -0.097 0.923034
## SPY_vol.l8        1.068e-01  5.643e-03  18.922  < 2e-16 ***
## total_tariff.l8   3.171e-02  7.140e-03   4.441 8.98e-06 ***
## SPY_vol.l9       -3.693e-02  5.705e-03  -6.473 9.84e-11 ***
## total_tariff.l9   3.145e-03  7.143e-03   0.440 0.659760
## SPY_vol.l10       1.055e-02  5.719e-03   1.844 0.065175 .
## total_tariff.l10 -1.256e-03  7.153e-03  -0.176 0.860606
## SPY_vol.l11      -1.439e-02  5.718e-03  -2.516 0.011886 *
## total_tariff.l11 -1.133e-02  7.155e-03  -1.583 0.113356
## SPY_vol.l12       5.997e-03  5.737e-03   1.045 0.295876
## total_tariff.l12 -1.972e-03  7.183e-03  -0.275 0.783649
## SPY_vol.l13      -7.054e-03  5.751e-03  -1.227 0.219996
## total_tariff.l13 -5.168e-03  7.184e-03  -0.719 0.471880
## SPY_vol.l14       5.831e-03  5.795e-03   1.006 0.314280
## total_tariff.l14 -2.225e-03  7.184e-03  -0.310 0.756764
## SPY_vol.l15      -9.863e-03  5.733e-03  -1.720 0.085362 .
## total_tariff.l15 -6.617e-04  7.184e-03  -0.092 0.926609
## SPY_vol.l16      -3.281e-03  5.743e-03  -0.571 0.567822
## total_tariff.l16 -1.554e-03  7.190e-03  -0.216 0.828875
## SPY_vol.l17      -7.279e-03  5.784e-03  -1.258 0.208239
## total_tariff.l17 -8.951e-03  7.189e-03  -1.245 0.213138
## SPY_vol.l18       2.403e-02  6.918e-03   3.474 0.000515 ***
## total_tariff.l18 -7.957e-04  7.286e-03  -0.109 0.913043
## SPY_vol.l19      -7.502e-02  7.212e-03 -10.402  < 2e-16 ***
## total_tariff.l19  1.264e-02  7.287e-03   1.735 0.082704 .
## SPY_vol.l20       2.684e-02  1.065e-02   2.520 0.011750 *
## total_tariff.l20 -2.097e-03  7.301e-03  -0.287 0.773900
## SPY_vol.l21      -2.141e-02  1.081e-02  -1.981 0.047635 *
## total_tariff.l21 -1.708e-03  7.302e-03  -0.234 0.815025
## SPY_vol.l22      -1.614e-02  1.082e-02  -1.492 0.135842
## total_tariff.l22  3.398e-02  7.303e-03   4.653 3.29e-06 ***
## SPY_vol.l23       4.103e-03  1.082e-02   0.379 0.704439
```

```
## total_tariff.l23  5.226e-04  7.307e-03   0.072 0.942980
## SPY_vol.l24      -1.034e-02  1.085e-02  -0.953 0.340746
## total_tariff.l24 -5.428e-04  7.308e-03  -0.074 0.940786
## SPY_vol.l25       2.718e-02  1.086e-02   2.504 0.012279 *
## total_tariff.l25  9.871e-03  7.309e-03   1.350 0.176882
## SPY_vol.l26       3.762e-03  1.087e-02   0.346 0.729223
## total_tariff.l26  2.280e-04  7.311e-03   0.031 0.975117
## SPY_vol.l27      -2.151e-02  1.095e-02  -1.964 0.049504 *
## total_tariff.l27 -4.102e-03  7.311e-03  -0.561 0.574773
## SPY_vol.l28       7.618e-03  1.098e-02   0.694 0.487789
## total_tariff.l28 -6.429e-04  7.311e-03  -0.088 0.929936
## SPY_vol.l29      -1.785e-02  1.100e-02  -1.623 0.104616
## total_tariff.l29 -2.677e-03  7.312e-03  -0.366 0.714323
## SPY_vol.l30       6.299e-03  1.101e-02   0.572 0.567307
## total_tariff.l30  3.478e-02  7.312e-03   4.756 1.99e-06 ***
## SPY_vol.l31       1.643e-02  1.101e-02   1.492 0.135692
## total_tariff.l31 -2.178e-03  7.316e-03  -0.298 0.765941
## SPY_vol.l32      -8.450e-03  1.101e-02  -0.767 0.442821
## total_tariff.l32  1.800e-03  7.316e-03   0.246 0.805668
## SPY_vol.l33       1.461e-02  1.090e-02   1.340 0.180292
## total_tariff.l33 -1.769e-03  7.316e-03  -0.242 0.808963
## SPY_vol.l34       3.707e-03  1.093e-02   0.339 0.734570
## total_tariff.l34 -1.758e-03  7.317e-03  -0.240 0.810159
## SPY_vol.l35       1.021e-03  1.093e-02   0.093 0.925570
## total_tariff.l35 -2.826e-03  7.321e-03  -0.386 0.699446
## SPY_vol.l36       1.549e-02  1.094e-02   1.416 0.156673
## total_tariff.l36  3.182e-02  7.322e-03   4.347 1.39e-05 ***
## SPY_vol.l37      -1.537e-02  1.094e-02  -1.405 0.159953
## total_tariff.l37 -2.205e-05  7.352e-03  -0.003 0.997606
## SPY_vol.l38       6.482e-04  1.094e-02   0.059 0.952752
## total_tariff.l38 -2.373e-03  7.351e-03  -0.323 0.746805
## SPY_vol.l39       2.266e-03  1.098e-02   0.206 0.836468
## total_tariff.l39 -2.283e-03  7.352e-03  -0.310 0.756200
## SPY_vol.l40       7.531e-03  1.095e-02   0.688 0.491481
## total_tariff.l40 -8.533e-04  7.438e-03  -0.115 0.908670
## SPY_vol.l41       1.579e-02  1.100e-02   1.435 0.151355
## total_tariff.l41  1.281e-02  7.439e-03   1.722 0.085054 .
## SPY_vol.l42      -1.329e-02  1.101e-02  -1.208 0.227058
## total_tariff.l42 -3.205e-03  7.462e-03  -0.430 0.667518
## SPY_vol.l43      -6.047e-03  1.101e-02  -0.549 0.582706
## total_tariff.l43 -6.058e-04  7.463e-03  -0.081 0.935301
## SPY_vol.l44      -2.124e-02  1.101e-02  -1.930 0.053595 .
## total_tariff.l44 -4.124e-03  7.462e-03  -0.553 0.580550
## SPY_vol.l45       3.319e-02  1.101e-02   3.014 0.002584 **
## total_tariff.l45 -9.134e-04  7.462e-03  -0.122 0.902586
## SPY_vol.l46      -2.111e-02  1.102e-02  -1.916 0.055392 .
## total_tariff.l46 -8.413e-04  7.461e-03  -0.113 0.910224
## SPY_vol.l47       1.867e-02  1.094e-02   1.706 0.088037 .
## total_tariff.l47  7.672e-03  7.462e-03   1.028 0.303921
## SPY_vol.l48      -1.613e-03  1.091e-02  -0.148 0.882491
## total_tariff.l48  5.635e-04  7.527e-03   0.075 0.940321
## SPY_vol.l49       1.472e-03  1.092e-02   0.135 0.892741
## total_tariff.l49  1.240e-02  7.528e-03   1.647 0.099584 .
## SPY_vol.l50      -2.550e-02  1.087e-02  -2.345 0.019030 *
```

```
## total_tariff.l50 -1.107e-03  7.539e-03  -0.147 0.883264
## SPY_vol.l51      -6.175e-03  1.088e-02  -0.568 0.570230
## total_tariff.l51 -1.781e-03  7.541e-03  -0.236 0.813240
## SPY_vol.l52       1.454e-02  1.088e-02   1.336 0.181415
## total_tariff.l52 -1.839e-03  7.541e-03  -0.244 0.807334
## SPY_vol.l53      -1.503e-02  9.999e-03  -1.503 0.132806
## total_tariff.l53 -2.652e-03  7.542e-03  -0.352 0.725072
## const             3.730e-04  3.188e-04   1.170 0.242050
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.03799 on 19685 degrees of freedom
## Multiple R-Squared: 0.05212, Adjusted R-squared: 0.04702
## F-statistic: 10.21 on 106 and 19685 DF,  p-value: < 2.2e-16
##
##
##
## Covariance matrix of residuals:
##                 SPY_vol total_tariff
## SPY_vol       3.501e-03   -4.118e-05
## total_tariff -4.118e-05    1.443e-03
##
## Correlation matrix of residuals:
##               SPY_vol total_tariff
## SPY_vol       1.00000     -0.01832
## total_tariff -0.01832      1.00000
```

Find Number of Lags

Tweet Count on Volatility by hour

Tweet Dummy on Volatility by hour

Tariff Mention on Volatility by hour

Positive Vibe on Volatility by hour

European Market VAR Models

Find Number of Lags

Tweet Count on Volatility by hour

Tweet Dummy on Volatility by hour

Tariff Mention on Volatility by hour

Negative Vibe on Volatility by hour

Chinese Market VAR Models

Find Number of Lags

Tweet Count on Volatility by hour

Tweet Dummy on Volatility by hour

Tariff Mention on Volatility by hour

Positive Vibe on Volatility by hour

Negative Vibe on Volatility by hour