ARMA-X Analysis

Contents

Data

Load Base Data

```r
# 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"))
```

```r
#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

```r
#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')))
```

```r
#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')))
```

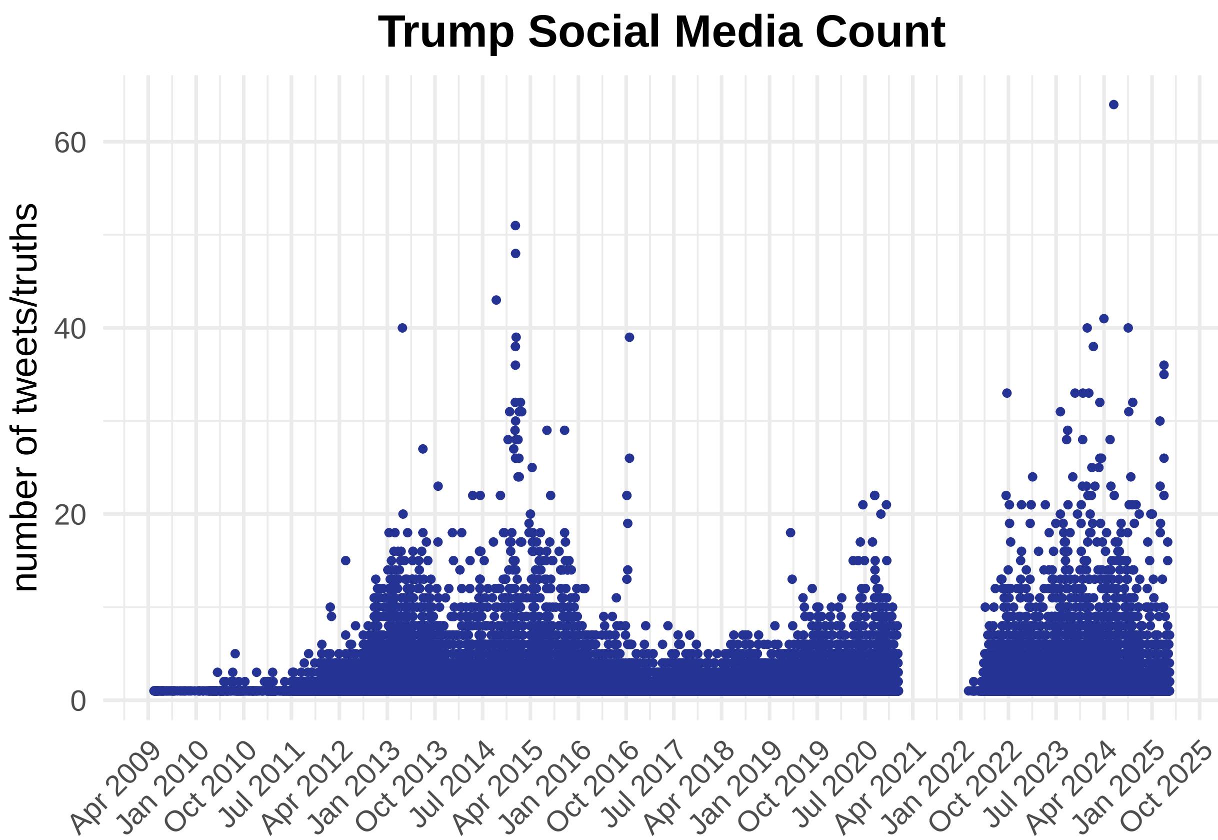
Number of Posts

```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')))

#plot
ggplot(tweetcount_alltime, aes(x = timestamp, y = N)) +
    geom_point(color = "#253494", size = 1) +
    scale_x_datetime(date_labels = "%b %Y", date_breaks = "9 month") +
    labs(title = "Trump Social Media Count",
         x = NULL,
         y = "number of tweets/truths") +
    theme_minimal(base_size = 14) +
    theme(axis.text.x = element_text(angle = 45, hjust = 1),
          plot.title = element_text(face = "bold", hjust = 0.5))
```

```
## Warning: Removed 1172 rows containing missing values or values outside the scale range
## (`geom_point()`).
```



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

```r
#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

```r
#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

```r
#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

```r
#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

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

#rename volatility columns
names(armax_data)[2] <- "SPY_vol"
```

```r
names(armax_data)[3] <- "VGK_vol"
names(armax_data)[4] <- "ASHR_vol"

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

S&P500 ARMA-X Models

Find Number of Lags

```r
lag_selector(y=armax_data$SPY_vol, xreg=armax_data$N,
             nb.lags=5, type="latex")
```

Table 1:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
N_lag_0	−0.0005	−0.0005***
	(0.0004)	(0.0002)
N_lag_1	−0.0001	−0.0001
	(0.0004)	(0.0002)
N_lag_2	0.0004	0.0004
	(0.0004)	(0.0003)
N_lag_3	0.0002	0.0002
	(0.0004)	(0.0001)
N_lag_4	0.0004	0.0004
	(0.0004)	(0.0003)
N_lag_5	−0.0002	−0.0002
	(0.0004)	(0.0002)
Constant	0.022***	0.022***
	(0.001)	(0.001)
Observations	19,840	19,840
Note:	*p<0.1; **p<0.05; ***p<0.01	

```r
lag_selector(y=armax_data$SPY_vol, xreg=armax_data$dummy,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$SPY_vol, xreg=armax_data$total_tariff,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$SPY_vol, xreg=armax_data$total_trade,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$SPY_vol, xreg=armax_data$prop_positive,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$SPY_vol, xreg=armax_data$prop_negative,
             nb.lags=5, type="latex")
```

Table 2:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
dummy_lag_0	−0.001	−0.001
	(0.001)	(0.002)
dummy_lag_1	−0.001	−0.001
	(0.001)	(0.001)
dummy_lag_2	0.004**	0.004**
	(0.001)	(0.002)
dummy_lag_3	0.003*	0.003**
	(0.001)	(0.001)
dummy_lag_4	0.003*	0.003
	(0.001)	(0.002)
dummy_lag_5	−0.001	−0.001
	(0.001)	(0.001)
Constant	0.020***	0.020***
	(0.001)	(0.001)
Observations	19,840	19,840
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 3:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
total_tariff_lag_0	0.036**	0.036
	(0.016)	(0.022)
total_tariff_lag_1	0.051***	0.051
	(0.016)	(0.038)
total_tariff_lag_2	0.045***	0.045
	(0.016)	(0.029)
total_tariff_lag_3	0.065***	0.065**
	(0.016)	(0.029)
total_tariff_lag_4	0.066***	0.066**
	(0.016)	(0.031)
total_tariff_lag_5	0.085***	0.085*
	(0.016)	(0.045)
Constant	0.021***	0.021***
	(0.001)	(0.001)
Observations	19,840	19,840
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 4:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
total_trade_lag_0	−0.003	−0.003
	(0.008)	(0.004)
total_trade_lag_1	0.002	0.002
	(0.008)	(0.008)
total_trade_lag_2	−0.001	−0.001
	(0.008)	(0.005)
total_trade_lag_3	0.001	0.001
	(0.008)	(0.006)
total_trade_lag_4	−0.001	−0.001
	(0.008)	(0.006)
total_trade_lag_5	−0.002	−0.002
	(0.008)	(0.005)
Constant	0.022^{***}	0.022^{***}
	(0.001)	(0.001)
Observations	19,840	19,840
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 5:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
prop_positive_lag_0	0.0004	0.0004
	(0.002)	(0.004)
prop_positive_lag_1	−0.0004	−0.0004
	(0.002)	(0.001)
prop_positive_lag_2	0.008^{***}	0.008^{*}
	(0.002)	(0.004)
prop_positive_lag_3	0.002	0.002
	(0.002)	(0.002)
prop_positive_lag_4	0.005^{**}	0.005
	(0.002)	(0.004)
prop_positive_lag_5	−0.001	−0.001
	(0.002)	(0.001)
Constant	0.020^{***}	0.020^{***}
	(0.001)	(0.001)
Observations	19,840	19,840
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 6:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
prop_negative_lag_0	−0.002	−0.002
	(0.003)	(0.002)
prop_negative_lag_1	−0.002	−0.002
	(0.003)	(0.002)
prop_negative_lag_2	0.001	0.001
	(0.003)	(0.001)
prop_negative_lag_3	0.007^{**}	0.007
	(0.003)	(0.006)
prop_negative_lag_4	0.002	0.002
	(0.003)	(0.002)
prop_negative_lag_5	−0.002	−0.002
	(0.003)	(0.002)
Constant	0.021^{***}	0.021^{***}
	(0.001)	(0.001)
Observations	19,840	19,840
Note:	*p<0.1; **p<0.05; ***p<0.01	

Tweet Count on Volatility by hour

```
armax(armax_data$SPY_vol,xreg=armax_data$N,nb.lags=0,latex=T)
```

Tweet Dummy on Volatility by hour

```
armax(armax_data$SPY_vol,xreg=armax_data$dummy,nb.lags=3,latex=T)
```

Tariff Mention on Volatility by hour

```
armax(armax_data$SPY_vol,xreg=armax_data$total_tariff,nb.lags=5,latex=T)
```

Positive Vibe on Volatility by hour

```
armax(armax_data$SPY_vol,xreg=armax_data$prop_positive,nb.lags=2,latex=T)
```

	Model 1
ar1	0.3478^{***}
	(0.0071)
ar2	0.0345^{***}
	(0.0076)
ar3	0.0825^{***}
	(0.0101)
ar4	0.1541^{***}
	(0.0106)
ar5	0.1050^{***}
	(0.0095)
intercept	0.0222^{***}
	(0.0020)
N_lag_0	-0.0005
	(0.0003)
AIC	-44843.0497
AICc	-44843.0424
BIC	-44779.8840
Log Likelihood	22429.5248
Num. obs.	19845

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 7: ARMAX Model Results

	Model 1
ar1	0.3476^{***}
	(0.0071)
ar2	0.0344^{***}
	(0.0076)
ar3	0.0835^{***}
	(0.0101)
ar4	0.1542^{***}
	(0.0106)
ar5	0.1045^{***}
	(0.0095)
intercept	0.0209^{***}
	(0.0022)
dummy_lag_0	-0.0016
	(0.0012)
dummy_lag_1	-0.0010
	(0.0012)
dummy_lag_2	0.0038^{**}
	(0.0012)
dummy_lag_3	0.0022
	(0.0012)
AIC	-44839.4930
AICc	-44839.4797
BIC	-44752.6419
Log Likelihood	22430.7465
Num. obs.	19842

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 8: ARMAX Model Results

	Model 1
ar1	0.3471^{***}
	(0.0071)
ar2	0.0359^{***}
	(0.0076)
ar3	0.0822^{***}
	(0.0102)
ar4	0.1564^{***}
	(0.0109)
ar5	0.1083^{***}
	(0.0098)
intercept	0.0222^{***}
	(0.0021)
total_tariff_lag_0	-0.0422^{**}
	(0.0142)
total_tariff_lag_1	-0.0288
	(0.0147)
total_tariff_lag_2	-0.0480^{***}
	(0.0145)
total_tariff_lag_3	-0.0319^{*}
	(0.0146)
total_tariff_lag_4	-0.0383^{*}
	(0.0149)
total_tariff_lag_5	-0.0153
	(0.0144)
AIC	-44836.1606
AICc	-44836.1423
BIC	-44733.5197
Log Likelihood	22431.0803
Num. obs.	19840

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 9: ARMAX Model Results

	Model 1
ar1	0.3481^{***}
	(0.0071)
ar2	0.0338^{***}
	(0.0076)
ar3	0.0835^{***}
	(0.0101)
ar4	0.1539^{***}
	(0.0106)
ar5	0.1048^{***}
	(0.0095)
intercept	0.0212^{***}
	(0.0021)
prop_positive_lag_0	-0.0018
	(0.0018)
prop_positive_lag_1	-0.0013
	(0.0018)
prop_positive_lag_2	0.0074^{***}
	(0.0018)
AIC	-44849.0130
AICc	-44849.0019
BIC	-44770.0570
Log Likelihood	22434.5065
Num. obs.	19843

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 10: ARMAX Model Results

European Market ARMA-X Models

Find Number of Lags

```r
lag_selector(y=armax_data$VGK_vol, xreg=armax_data$N,
             nb.lags=5, type="latex")
```

Table 11:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
N_lag_0	−0.00001**	−0.00001***
	(0.00001)	(0.00000)
N_lag_1	−0.00000	−0.00000
	(0.00001)	(0.00000)
N_lag_2	0.00000	0.00000
	(0.00001)	(0.00000)
N_lag_3	0.00000	0.00000
	(0.00001)	(0.00000)
N_lag_4	0.00000	0.00000
	(0.00001)	(0.00000)
N_lag_5	−0.00000	−0.00000
	(0.00001)	(0.00000)
Constant	0.0004***	0.0004***
	(0.00002)	(0.00002)
Observations	19,799	19,799
Note:	*p<0.1; **p<0.05; ***p<0.01	

```r
lag_selector(y=armax_data$VGK_vol, xreg=armax_data$dummy,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$VGK_vol, xreg=armax_data$total_tariff,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$VGK_vol, xreg=armax_data$total_trade,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$VGK_vol, xreg=armax_data$prop_positive,
             nb.lags=5, type="latex")
```

```r
lag_selector(y=armax_data$VGK_vol, xreg=armax_data$prop_negative,
             nb.lags=5, type="latex")
```

Table 12:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
dummy_lag_0	-0.0001^{*}	-0.0001^{*}
	(0.00003)	(0.00003)
dummy_lag_1	-0.00001	-0.00001
	(0.00003)	(0.00002)
dummy_lag_2	0.00002	0.00002
	(0.00003)	(0.00003)
dummy_lag_3	0.0001^{**}	0.0001^{**}
	(0.00003)	(0.00003)
dummy_lag_4	0.00001	0.00001
	(0.00003)	(0.00002)
dummy_lag_5	-0.00002	-0.00002
	(0.00003)	(0.00003)
Constant	0.0004^{***}	0.0004^{***}
	(0.00002)	(0.00002)
Observations	19,799	19,799
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 13:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
total_tariff_lag_0	0.0001	0.0001
	(0.0003)	(0.0002)
total_tariff_lag_1	0.0003	0.0003
	(0.0003)	(0.0003)
total_tariff_lag_2	0.0002	0.0002
	(0.0003)	(0.0002)
total_tariff_lag_3	0.0003	0.0003
	(0.0003)	(0.0002)
total_tariff_lag_4	0.0004	0.0004^{*}
	(0.0003)	(0.0002)
total_tariff_lag_5	0.0004	0.0004^{*}
	(0.0003)	(0.0002)
Constant	0.0004^{***}	0.0004^{***}
	(0.00001)	(0.00002)
Observations	19,799	19,799
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 14:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
total_trade_lag_0	−0.0001	−0.0001
	(0.0002)	(0.00004)
total_trade_lag_1	−0.00004	−0.00004
	(0.0002)	(0.0001)
total_trade_lag_2	−0.00000	−0.00000
	(0.0002)	(0.0001)
total_trade_lag_3	−0.00004	−0.00004
	(0.0002)	(0.00004)
total_trade_lag_4	−0.00003	−0.00003
	(0.0002)	(0.00004)
total_trade_lag_5	−0.00000	−0.00000
	(0.0002)	(0.0001)
Constant	0.0004***	0.0004***
	(0.00001)	(0.00002)
Observations	19,799	19,799
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 15:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
prop_positive_lag_0	−0.00002	−0.00002
	(0.00004)	(0.0001)
prop_positive_lag_1	−0.00001	−0.00001
	(0.00004)	(0.00003)
prop_positive_lag_2	0.00003	0.00003
	(0.00004)	(0.00005)
prop_positive_lag_3	0.0001	0.0001
	(0.00004)	(0.00004)
prop_positive_lag_4	0.00004	0.00004
	(0.00004)	(0.00004)
prop_positive_lag_5	−0.0001	−0.0001*
	(0.00004)	(0.00003)
Constant	0.0004***	0.0004***
	(0.00002)	(0.00002)
Observations	19,799	19,799
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 16:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
prop_negative_lag_0	-0.0001^{**}	-0.0001^{***}
	(0.0001)	(0.00003)
prop_negative_lag_1	-0.0001	-0.0001
	(0.0001)	(0.00004)
prop_negative_lag_2	-0.00000	-0.00000
	(0.0001)	(0.00005)
prop_negative_lag_3	0.0001^{*}	0.0001
	(0.0001)	(0.0001)
prop_negative_lag_4	-0.00002	-0.00002
	(0.0001)	(0.00003)
prop_negative_lag_5	0.00004	0.00004
	(0.0001)	(0.0001)
Constant	0.0004^{***}	0.0004^{***}
	(0.00002)	(0.00002)
Observations	19,799	19,799
Note:	*p<0.1; **p<0.05; ***p<0.01	

Tweet Count on Volatility by hour

```
armax(armax_data$VGK_vol,xreg=armax_data$N,nb.lags=0,latex=T)
```

Tweet Dummy on Volatility by hour

```
armax(armax_data$VGK_vol,xreg=armax_data$dummy,nb.lags=3,latex=T)
```

Tariff Mention on Volatility by hour

```
armax(armax_data$VGK_vol,xreg=armax_data$total_tariff,nb.lags=5,latex=T)
```

Negative Vibe on Volatility by hour

```
armax(armax_data$VGK_vol,xreg=armax_data$prop_negative,nb.lags=0,latex=T)
```

	Model 1
ar1	1.3706^{***}
	(0.0103)
ar2	-0.4744^{***}
	(0.0146)
ar3	0.0946^{***}
	(0.0084)
ma1	-0.9571^{***}
	(0.0049)
intercept	0.0004^{***}
	(0.0001)
N_lag_0	-0.0000
	(0.0000)
AIC	-199309.4472
AICc	-199309.4416
BIC	-199254.1918
Log Likelihood	99661.7236
Num. obs.	19804

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 17: ARMAX Model Results

	Model 1
ar1	1.3711^{***}
	(0.0103)
ar2	-0.4741^{***}
	(0.0146)
ar3	0.0941^{***}
	(0.0084)
ma1	-0.9580^{***}
	(0.0048)
intercept	0.0004^{***}
	(0.0001)
dummy_lag_0	-0.0000
	(0.0000)
dummy_lag_1	-0.0000
	(0.0000)
dummy_lag_2	0.0000
	(0.0000)
dummy_lag_3	0.0001^{*}
	(0.0000)
AIC	-199276.6568
AICc	-199276.6457
BIC	-199197.7219
Log Likelihood	99648.3284
Num. obs.	19801

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 18: ARMAX Model Results

	Model 1
ar1	0.9891^{***}
	(0.0023)
ma1	-0.5735^{***}
	(0.0095)
ma2	-0.3191^{***}
	(0.0104)
ma3	-0.0526^{***}
	(0.0091)
intercept	0.0004^{***}
	(0.0001)
total_tariff_lag_0	-0.0003
	(0.0003)
total_tariff_lag_1	-0.0002
	(0.0003)
total_tariff_lag_2	-0.0002
	(0.0003)
total_tariff_lag_3	-0.0002
	(0.0003)
total_tariff_lag_4	-0.0001
	(0.0003)
total_tariff_lag_5	-0.0000
	(0.0003)
AIC	-199243.6740
AICc	-199243.6582
BIC	-199148.9534
Log Likelihood	99633.8370
Num. obs.	19799

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 19: ARMAX Model Results

	Model 1
ar1	0.9886^{***}
	(0.0024)
ma1	-0.5728^{***}
	(0.0096)
ma2	-0.3192^{***}
	(0.0103)
ma3	-0.0524^{***}
	(0.0091)
intercept	0.0004^{***}
	(0.0001)
prop_negative_lag_0	-0.0001
	(0.0000)
AIC	-199309.9660
AICc	-199309.9603
BIC	-199254.7105
Log Likelihood	99661.9830
Num. obs.	19804

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 20: ARMAX Model Results

Chinese Market ARMA-X Models

Find Number of Lags

```
lag_selector(y=armax_data$ASHR_vol, xreg=armax_data$N,
             nb.lags=5, type="latex")
```

Table 21:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
N_lag_0	−0.00001***	−0.00001***
	(0.00000)	(0.00000)
N_lag_1	0.00000	0.00000
	(0.00000)	(0.00000)
N_lag_2	0.00000	0.00000
	(0.00000)	(0.00000)
N_lag_3	0.00000**	0.00000***
	(0.00000)	(0.00000)
N_lag_4	0.00000*	0.00000*
	(0.00000)	(0.00000)
N_lag_5	−0.00000	−0.00000**
	(0.00000)	(0.00000)
Constant	0.0002***	0.0002***
	(0.00000)	(0.00001)
Observations	19,782	19,782
Note:	*p<0.1; **p<0.05; ***p<0.01	

```
lag_selector(y=armax_data$ASHR_vol, xreg=armax_data$dummy,
             nb.lags=5, type="latex")
```

```
lag_selector(y=armax_data$ASHR_vol, xreg=armax_data$total_tariff,
             nb.lags=5, type="latex")
```

```
lag_selector(y=armax_data$ASHR_vol, xreg=armax_data$total_trade,
             nb.lags=5, type="latex")
```

```
lag_selector(y=armax_data$ASHR_vol, xreg=armax_data$prop_positive,
             nb.lags=5, type="latex")
```

```
lag_selector(y=armax_data$ASHR_vol, xreg=armax_data$prop_negative,
             nb.lags=5, type="latex")
```

Table 22:

	Dependent variable:	
	y__aligned	
	(no HAC)	(HAC)
	(1)	(2)
dummy__lag__0	-0.00004^{***}	-0.00004^{***}
	(0.00001)	(0.00001)
dummy__lag__1	0.00003^{***}	0.00003^{***}
	(0.00001)	(0.00001)
dummy__lag__2	0.00002^{**}	0.00002^{***}
	(0.00001)	(0.00001)
dummy__lag__3	0.00004^{***}	0.00004^{***}
	(0.00001)	(0.00001)
dummy__lag__4	0.00001	0.00001
	(0.00001)	(0.00001)
dummy__lag__5	-0.00001^{*}	-0.00001^{**}
	(0.00001)	(0.00001)
Constant	0.0002^{***}	0.0002^{***}
	(0.00001)	(0.00001)
Observations	19,782	19,782
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 23:

	Dependent variable:	
	y__aligned	
	(no HAC)	(HAC)
	(1)	(2)
total__tariff__lag__0	-0.0001	-0.0001^{***}
	(0.0001)	(0.00002)
total__tariff__lag__1	-0.00004	-0.00004
	(0.0001)	(0.00003)
total__tariff__lag__2	-0.0001	-0.0001^{***}
	(0.0001)	(0.00001)
total__tariff__lag__3	-0.0001	-0.0001^{***}
	(0.0001)	(0.00001)
total__tariff__lag__4	-0.0001	-0.0001^{**}
	(0.0001)	(0.00002)
total__tariff__lag__5	-0.00005	-0.00005^{*}
	(0.0001)	(0.00003)
Constant	0.0002^{***}	0.0002^{***}
	(0.00000)	(0.00001)
Observations	19,782	19,782
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 24:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
total_trade_lag_0	−0.00001	−0.00001
	(0.00004)	(0.00002)
total_trade_lag_1	−0.00003	−0.00003
	(0.00004)	(0.00002)
total_trade_lag_2	0.0003***	0.0003
	(0.00004)	(0.0003)
total_trade_lag_3	0.0001*	0.0001
	(0.00004)	(0.00005)
total_trade_lag_4	0.0001***	0.0001
	(0.00004)	(0.0001)
total_trade_lag_5	0.00003	0.00003
	(0.00004)	(0.00003)
Constant	0.0002***	0.0002***
	(0.00000)	(0.00001)
Observations	19,782	19,782
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 25:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
prop_positive_lag_0	−0.00003***	−0.00003**
	(0.00001)	(0.00001)
prop_positive_lag_1	0.00004***	0.00004***
	(0.00001)	(0.00001)
prop_positive_lag_2	0.00003***	0.00003***
	(0.00001)	(0.00001)
prop_positive_lag_3	0.0001***	0.0001***
	(0.00001)	(0.00001)
prop_positive_lag_4	0.00001	0.00001
	(0.00001)	(0.00001)
prop_positive_lag_5	−0.00000	−0.00000
	(0.00001)	(0.00001)
Constant	0.0001***	0.0001***
	(0.00000)	(0.00001)
Observations	19,782	19,782
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 26:

	Dependent variable:	
	y_aligned	
	(no HAC)	(HAC)
	(1)	(2)
prop_negative_lag_0	−0.0001***	−0.0001***
	(0.00001)	(0.00001)
prop_negative_lag_1	−0.00001	−0.00001
	(0.00001)	(0.00001)
prop_negative_lag_2	−0.00000	−0.00000
	(0.00001)	(0.00001)
prop_negative_lag_3	0.00002	0.00002
	(0.00001)	(0.00001)
prop_negative_lag_4	−0.00001	−0.00001
	(0.00001)	(0.00001)
prop_negative_lag_5	−0.00005***	−0.00005***
	(0.00001)	(0.00001)
Constant	0.0002***	0.0002***
	(0.00000)	(0.00001)
Observations	19,782	19,782
Note:	*p<0.1; **p<0.05; ***p<0.01	

Tweet Count on Volatility by hour

```
armax(armax_data$ASHR_vol,xreg=armax_data$N,nb.lags=5,latex=T)
```

Tweet Dummy on Volatility by hour

```
armax(armax_data$ASHR_vol,xreg=armax_data$dummy,nb.lags=5,latex=T)
```

Tariff Mention on Volatility by hour

```
armax(armax_data$ASHR_vol,xreg=armax_data$total_tariff,nb.lags=5,latex=T)
```

Positive Vibe on Volatility by hour

```
armax(armax_data$ASHR_vol,xreg=armax_data$prop_positive,nb.lags=3,latex=T)
```

	Model 1
ar1	0.9869^{***}
	(0.0021)
ma1	-0.8890^{***}
	(0.0071)
N_lag_0	-0.0000
	(0.0000)
N_lag_1	0.0000
	(0.0000)
N_lag_2	0.0000
	(0.0000)
N_lag_3	0.0000
	(0.0000)
N_lag_4	0.0000
	(0.0000)
N_lag_5	-0.0000
	(0.0000)
AIC	-252815.6654
AICc	-252815.6563
BIC	-252744.6326
Log Likelihood	126416.8327
Num. obs.	19782

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 27: ARMAX Model Results

Negative Vibe on Volatility by hour

```
armax(armax_data$ASHR_vol,xreg=armax_data$prop_negative,nb.lags=5,latex=T)
```

	Model 1
ar1	0.9900^{***}
	(0.0015)
ma1	-0.7428^{***}
	(0.0072)
ma2	-0.1820^{***}
	(0.0072)
intercept	0.0001^{***}
	(0.0000)
dummy_lag_0	-0.0000^{***}
	(0.0000)
dummy_lag_1	0.0000^{**}
	(0.0000)
dummy_lag_2	0.0000
	(0.0000)
dummy_lag_3	0.0000^{***}
	(0.0000)
dummy_lag_4	0.0000
	(0.0000)
dummy_lag_5	-0.0000
	(0.0000)
AIC	-253562.5355
AICc	-253562.5222
BIC	-253475.7177
Log Likelihood	126792.2678
Num. obs.	19782

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 28: ARMAX Model Results

	Model 1
ar1	0.9730^{***}
	(0.0035)
ma1	-0.8650^{***}
	(0.0091)
intercept	0.0002^{***}
	(0.0000)
total_tariff_lag_0	-0.0001
	(0.0001)
total_tariff_lag_1	-0.0000
	(0.0001)
total_tariff_lag_2	-0.0001
	(0.0001)
total_tariff_lag_3	-0.0001
	(0.0001)
total_tariff_lag_4	-0.0000
	(0.0001)
total_tariff_lag_5	-0.0000
	(0.0001)
AIC	-252847.8136
AICc	-252847.8025
BIC	-252768.8884
Log Likelihood	126433.9068
Num. obs.	19782

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 29: ARMAX Model Results

	Model 1
ar1	0.0685
	(0.0562)
ar2	0.9124^{***}
	(0.0557)
ma1	0.1792^{**}
	(0.0568)
ma2	-0.8724^{***}
	(0.0413)
ma3	-0.1626^{***}
	(0.0133)
intercept	0.0002^{***}
	(0.0000)
prop_positive_lag_0	-0.0000^{***}
	(0.0000)
prop_positive_lag_1	0.0000^{*}
	(0.0000)
prop_positive_lag_2	0.0000^{*}
	(0.0000)
prop_positive_lag_3	0.0000^{***}
	(0.0000)
AIC	-253551.1009
AICc	-253551.0875
BIC	-253464.2820
Log Likelihood	126786.5504
Num. obs.	19784

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 30: ARMAX Model Results

	Model 1
ar1	0.9730^{***}
	(0.0035)
ma1	-0.8645^{***}
	(0.0091)
intercept	0.0002^{***}
	(0.0000)
prop_negative_lag_0	-0.0001^{***}
	(0.0000)
prop_negative_lag_1	0.0000
	(0.0000)
prop_negative_lag_2	0.0000
	(0.0000)
prop_negative_lag_3	0.0000^{**}
	(0.0000)
prop_negative_lag_4	0.0000
	(0.0000)
prop_negative_lag_5	-0.0000
	(0.0000)
AIC	-252890.7623
AICc	-252890.7511
BIC	-252811.8370
Log Likelihood	126455.3811
Num. obs.	19782

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 31: ARMAX Model Results