ARMA-X Analysis Tutorial

Contents

Data

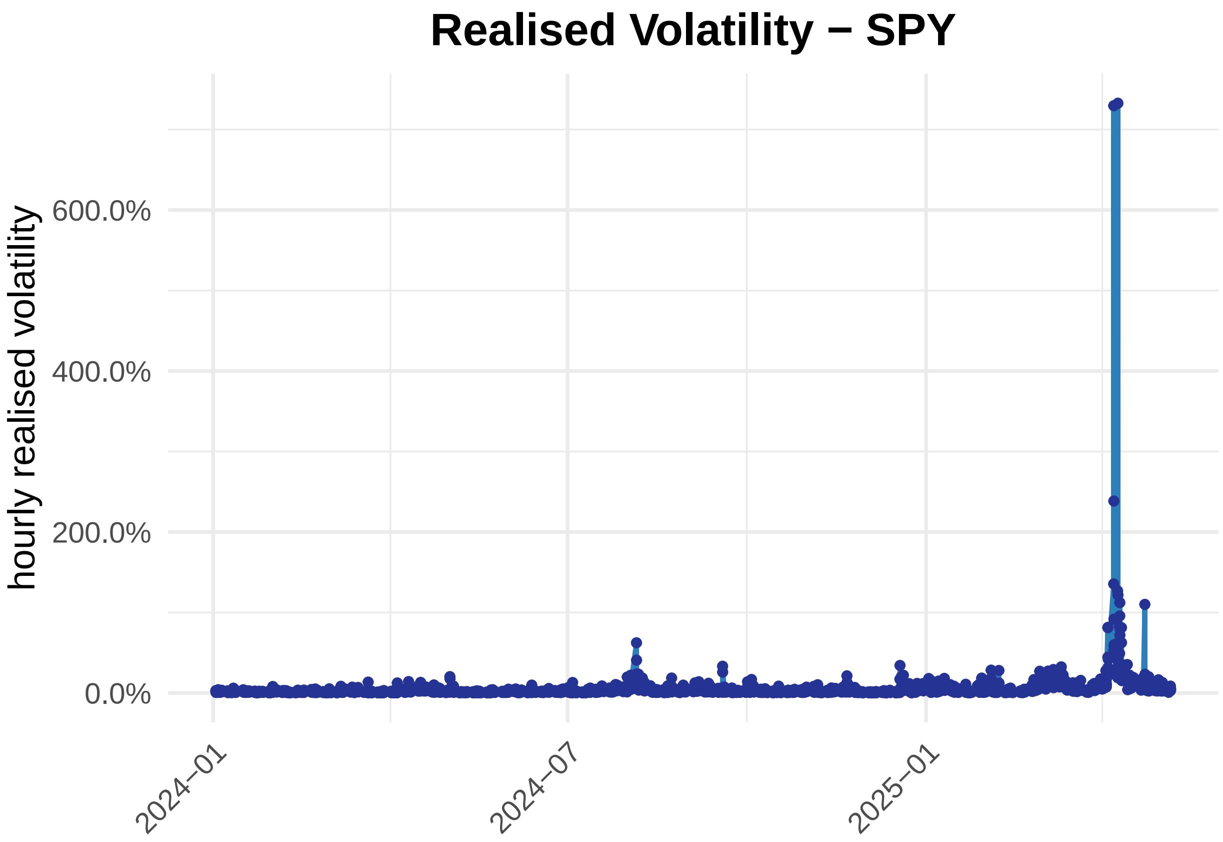
Load Base Data

```
# 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('2024-01-01'),
                          as.Date('2025-05-07')))

#plot
hvol_plotter(SPY_volatility,breaks="3 month",
             title="Realised Volatility - SPY")
```

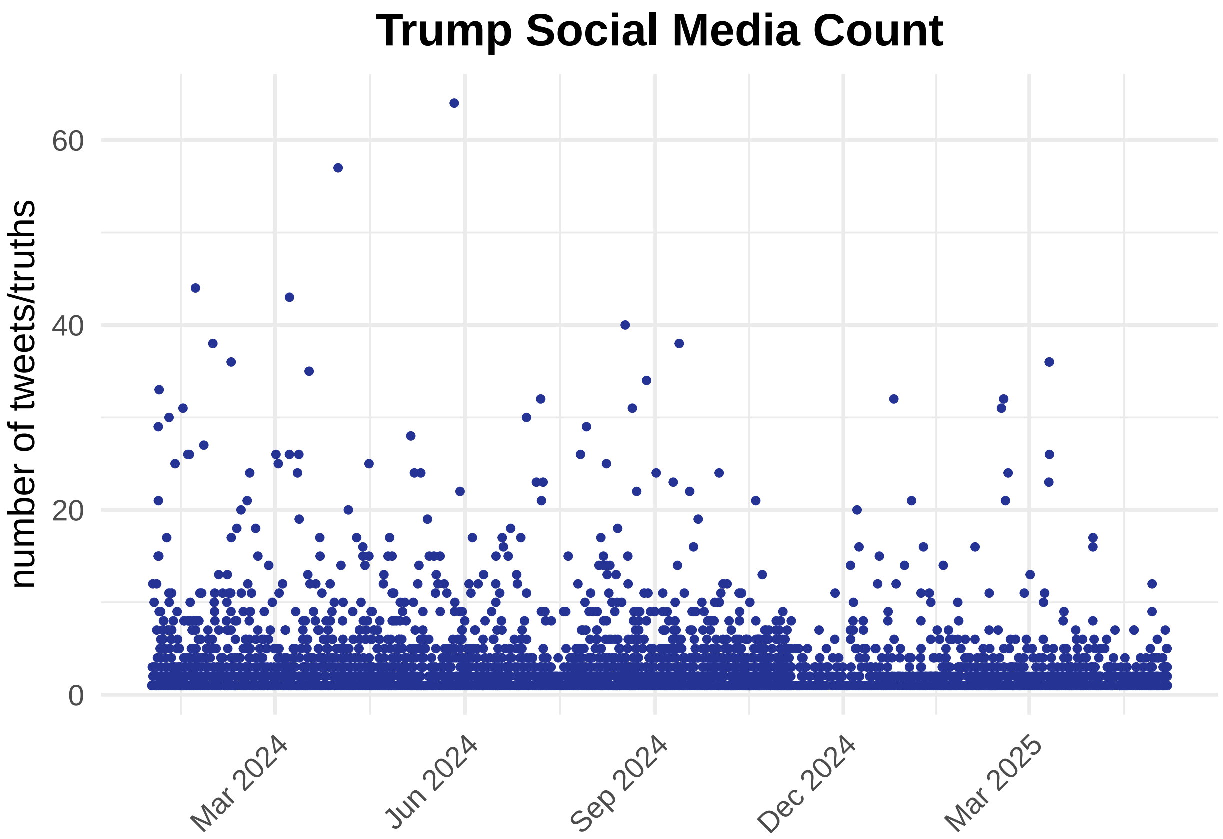


```
#find hourly volatility
#NOTE: this ignores tweets made outside trading hours!!
VGK_volatility_alltime = dplyr::select(VGK,timestamp,r_vol_h)

#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('2024-01-01'),
                          as.Date('2025-05-07')))
```

```
#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('2024-01-01'),
                          as.Date('2025-05-07')))
```

Number of Posts

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

#select time period
tweetcount = filter(tweetcount_alltime,
                  between(timestamp,
                          as.Date('2024-01-01'),
                          as.Date('2025-05-07')))

#plot
ggplot(tweetcount, aes(x = timestamp, y = N)) +
    geom_point(color = "#253494", size = 1) +
    scale_x_datetime(date_labels = "%b %Y", date_breaks = "3 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))
```



Dummy for Social Media Post

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

#select time period
tweetdummy = filter(tweetdummy_alltime,
                    between(timestamp,
                            as.Date('2024-01-01'),
                            as.Date('2025-05-07')))
```

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('2024-01-01'),
                            as.Date('2025-05-07')))
```

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('2024-01-01'),
                          as.Date('2025-05-07')))
```

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('2024-01-01'),
                          as.Date('2025-05-07')))
```

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('2024-01-01'),
                          as.Date('2025-05-07')))
```

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"
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 Tariff Models

Finding Model

```r
#auto.armax selects the lowest AIC value given r (exogenous variable lags)
res1 = auto.armax(armax_data$SPY_vol,xreg=armax_data$total_tariff,nb.lags=7,
                latex=T,max.p = 7, max.q = 7, max.d=0)
```

```
##
## \begin{table}
## \begin{center}
## \begin{tabular}{l c}
## \hline
##  & Model 1 \\
## \hline
## ar1                   & $0.9758^{***}$  \\
##                       & $(0.0063)$      \\
## ma1                   & $-0.6906^{***}$ \\
##                       & $(0.0217)$      \\
## ma2                   & $-0.1800^{***}$ \\
##                       & $(0.0214)$      \\
## intercept             & $0.0543^{*}$    \\
##                       & $(0.0228)$      \\
## total\_tariff\_lag\_0 & $-0.0066$       \\
##                       & $(0.0113)$      \\
## total\_tariff\_lag\_1 & $-0.0131$       \\
##                       & $(0.0116)$      \\
## total\_tariff\_lag\_2 & $0.0359^{**}$   \\
##                       & $(0.0117)$      \\
## total\_tariff\_lag\_3 & $-0.0049$       \\
##                       & $(0.0117)$      \\
## total\_tariff\_lag\_4 & $0.0044$        \\
##                       & $(0.0117)$      \\
## total\_tariff\_lag\_5 & $0.0037$        \\
##                       & $(0.0116)$      \\
## total\_tariff\_lag\_6 & $-0.0188$       \\
##                       & $(0.0115)$      \\
## total\_tariff\_lag\_7 & $-0.0141$       \\
##                       & $(0.0112)$      \\
## \hline
## AIC                   & $-674.3212$     \\
## AICc                  & $-674.1655$     \\
## BIC                   & $-599.4019$     \\
## Log Likelihood        & $350.1606$      \\
## Num. obs.             & $2352$          \\
## \hline
## \multicolumn{2}{l}{\scriptsize{$^{***}p<0.001$; $^{**}p<0.01$; $^{*}p<0.05$}}
## \end{tabular}
## \caption{ARMAX Model Results}
## \label{tab:armax}
## \end{center}
## \end{table}
```

```r
#armax enables a custom armax specification with p,q,r
res2 = armax(armax_data$SPY_vol, xreg=armax_data$total_tariff, nb.lags=2,
                   p=5, q=0, d=0, latex=T)
```

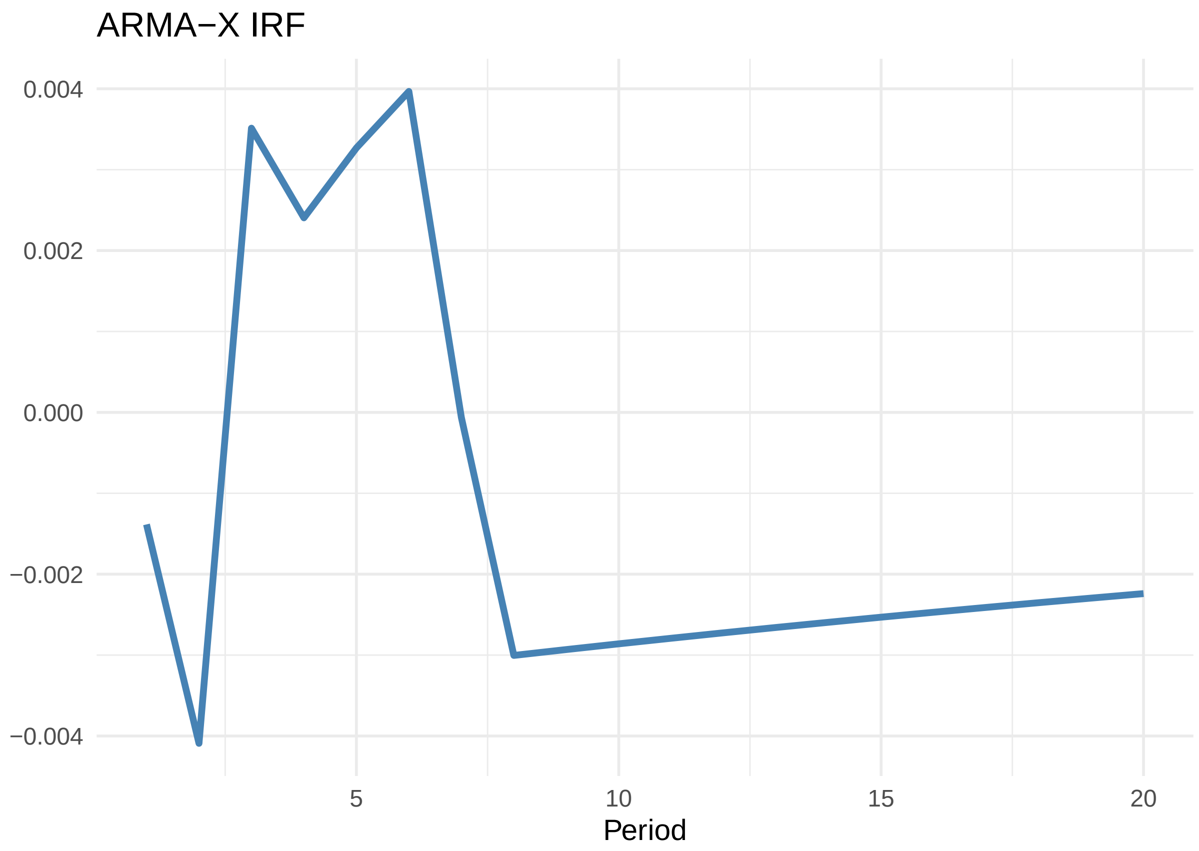
```
##
## \begin{table}
## \begin{center}
## \begin{tabular}{l c}
## \hline
##  & Model 1 \\
## \hline
## ar1                   & $0.3224^{***}$ \\
##                       & $(0.0206)$     \\
## ar2                   & $0.0329$       \\
##                       & $(0.0219)$     \\
## ar3                   & $0.1113^{***}$ \\
##                       & $(0.0224)$     \\
## ar4                   & $0.0896^{***}$ \\
##                       & $(0.0223)$     \\
## ar5                   & $0.0460^{*}$   \\
##                       & $(0.0208)$     \\
## intercept             & $0.0539^{***}$ \\
##                       & $(0.0110)$     \\
## total\_tariff\_lag\_0 & $-0.0128$      \\
##                       & $(0.0115)$     \\
## total\_tariff\_lag\_1 & $-0.0250^{*}$  \\
##                       & $(0.0122)$     \\
## total\_tariff\_lag\_2 & $0.0312^{**}$  \\
##                       & $(0.0114)$     \\
## \hline
## AIC                   & $-597.9298$    \\
## AICc                  & $-597.8360$    \\
## BIC                   & $-540.2783$    \\
## Log Likelihood        & $308.9649$     \\
## Num. obs.             & $2357$         \\
## \hline
## \multicolumn{2}{l}{\scriptsize{$^{***}p<0.001$; $^{**}p<0.01$; $^{*}p<0.05$}}
## \end{tabular}
## \caption{ARMAX Model Results}
## \label{tab:armax}
## \end{center}
## \end{table}
```

```r
#auto.armax.r selects the lowest AIC checking all 3 p,q,r values
res3 = auto.armax.r(armax_data$SPY_vol, x=armax_data$total_tariff,
                max_p = 7, max_q = 7, max_r = 3, criterion = "AIC", latex=T)
```

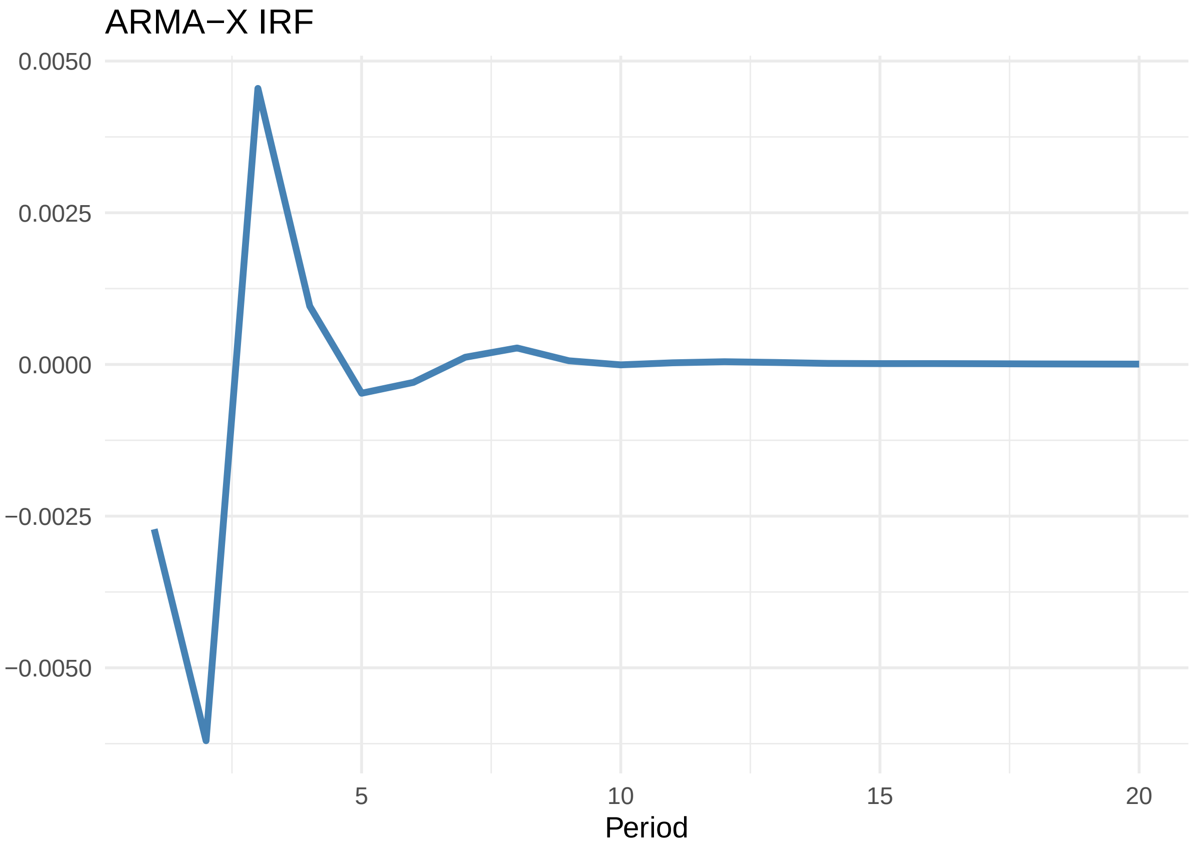
```
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use `linewidth` instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
## Warning in sqrt(diag(model$var.coef)): NaNs produced

##
## \begin{table}
## \begin{center}
## \begin{tabular}{l c}
## \hline
##  & Model 1 \\
## \hline
## ar1                   & $1.0801$        \\
##                       & $$              \\
## ar2                   & $-0.4288$       \\
##                       & $$              \\
## ar3                   & $0.4976^{***}$  \\
##                       & $(0.0488)$      \\
## ar4                   & $-0.3019^{***}$ \\
##                       & $(0.0281)$      \\
## ar5                   & $0.7924^{***}$  \\
##                       & $(0.0293)$      \\
## ar6                   & $-0.6814^{***}$ \\
##                       & $(0.0150)$      \\
## ma1                   & $-0.7735^{***}$ \\
##                       & $(0.0094)$      \\
## ma2                   & $0.1292^{***}$  \\
##                       & $(0.0303)$      \\
## ma3                   & $-0.3723^{***}$ \\
##                       & $(0.0240)$      \\
## ma4                   & $0.2371^{***}$  \\
##                       & $(0.0211)$      \\
## ma5                   & $-0.9602^{***}$ \\
##                       & $(0.0095)$      \\
## ma6                   & $0.6554$        \\
##                       & $$              \\
## ma7                   & $0.2287^{***}$  \\
##                       & $(0.0181)$      \\
## intercept             & $0.0507^{***}$  \\
##                       & $(0.0138)$      \\
## total\_tariff\_lag\_0 & $0.0030$        \\
##                       & $(0.0086)$      \\
## total\_tariff\_lag\_1 & $-0.0101$       \\
##                       & $(0.0094)$      \\
## total\_tariff\_lag\_2 & $0.0112$        \\
##                       & $(0.0088)$      \\
## \hline
## AIC                   & $-940.4859$     \\
## AICc                  & $-940.1933$     \\
## BIC                   & $-836.7133$     \\
## Log Likelihood        & $488.2429$      \\
## Num. obs.             & $2357$          \\
## \hline
## \multicolumn{2}{l}{\scriptsize{$^{***}p<0.001$; $^{**}p<0.01$; $^{*}p<0.05$}}
## \end{tabular}
## \caption{ARMAX selected by AIC}
## \label{tab:armax_select}
## \end{center}
## \end{table}
```

Plotting IRFs

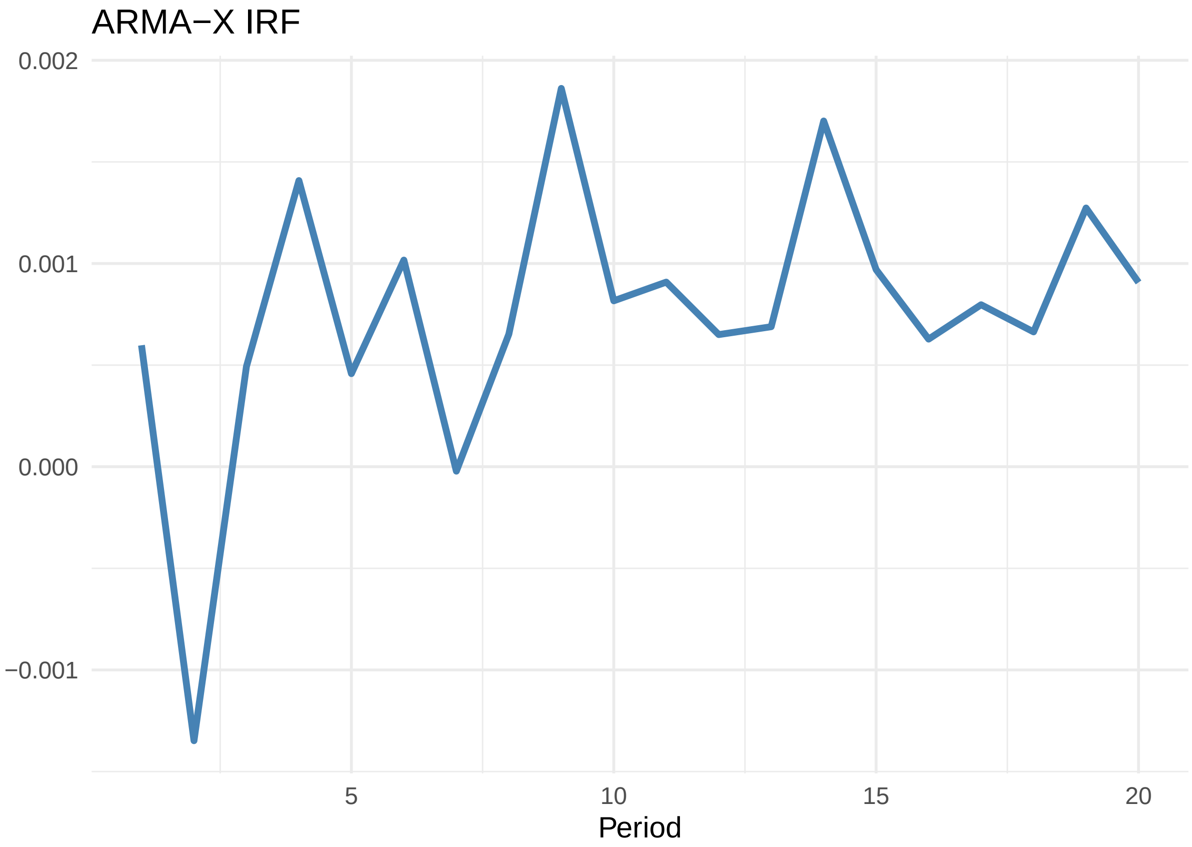
```
nb.periods = 20

irf.plot(res1,nb.periods)
```



```
irf.plot(res2,nb.periods)
```



```
irf.plot(res3$model,nb.periods)
```


ARMA−X IRF
0.002
0.001
0.000
−0.001
5
10
15
20
Period