ARMA-X Analysis Tutorial

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")
```

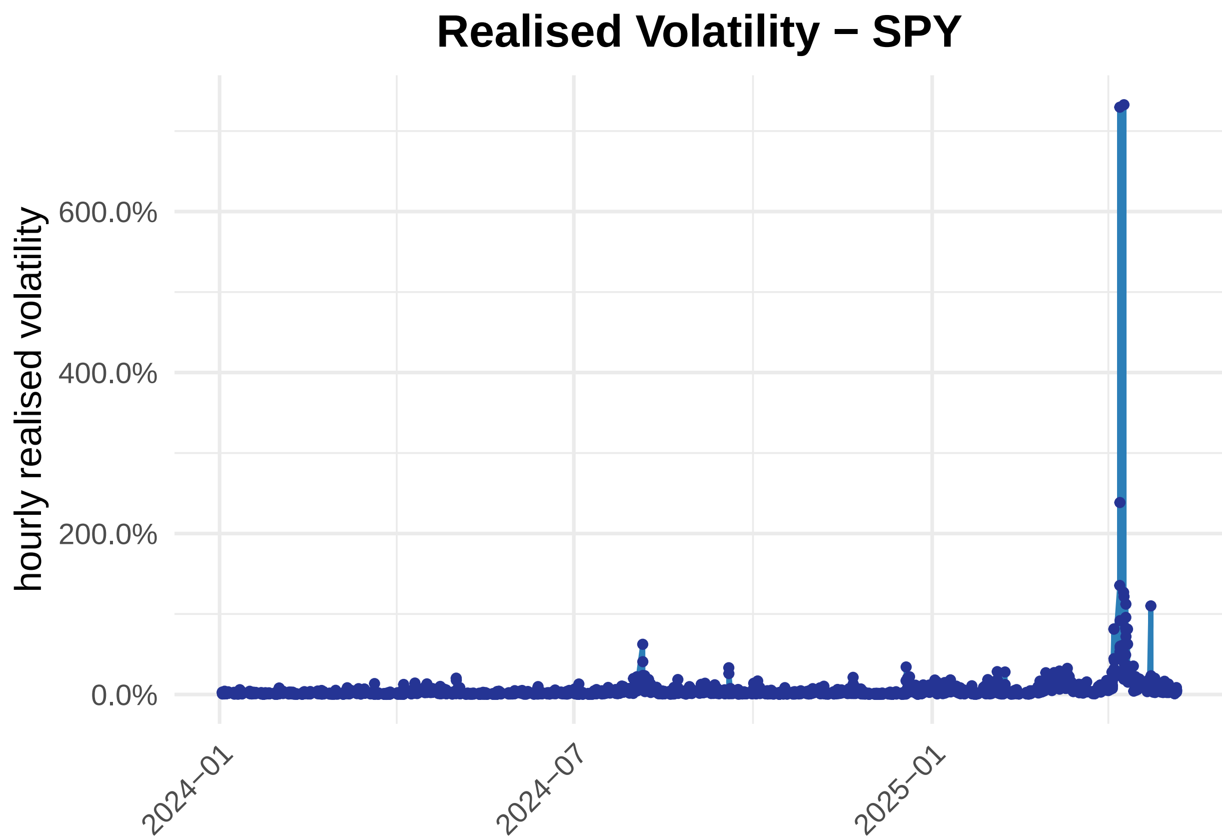
Volatility

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

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




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

```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,
```

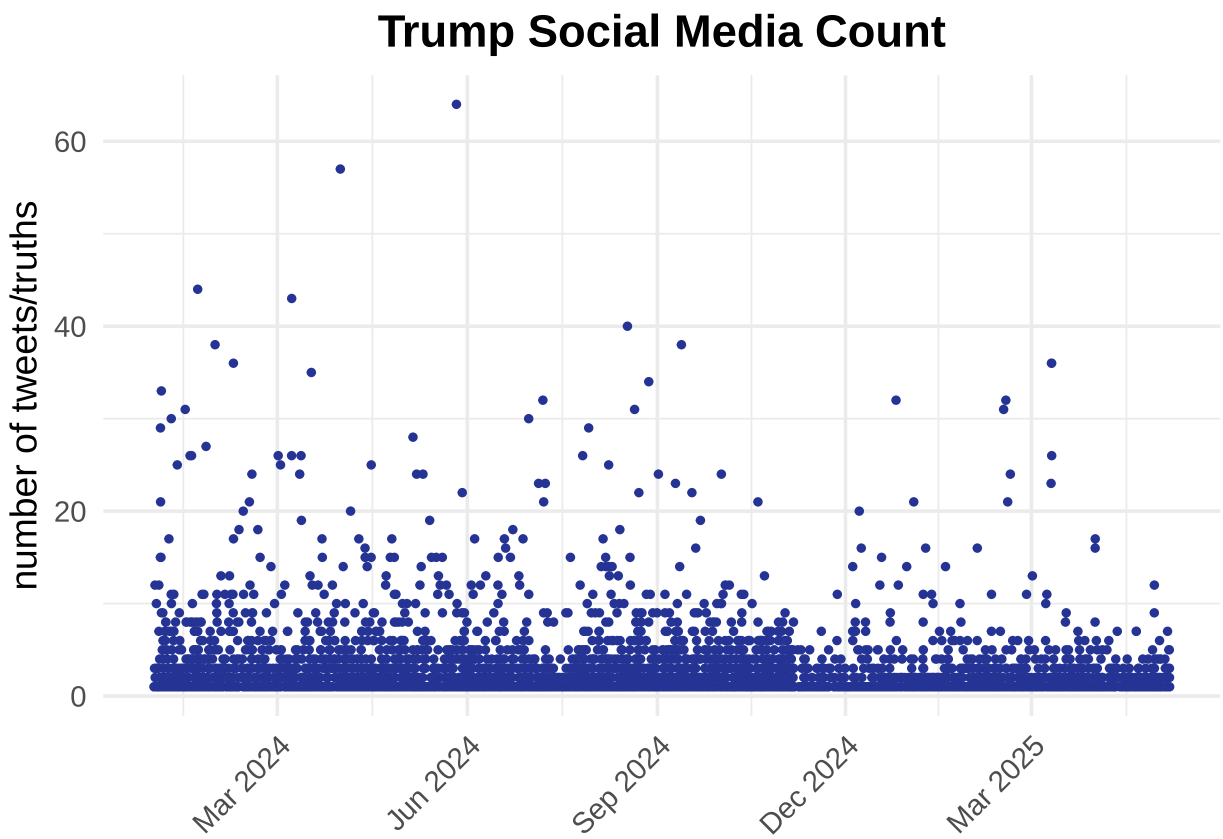
```r
                  between(timestamp,
                          as.Date('2024-01-01'),
                          as.Date('2025-05-07')))
```

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('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"
```

```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 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)
```

```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)
```

```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)
```

Plotting IRFs

```r
nb.periods = 20

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

	Model 1
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)
AIC	-674.3212
AICc	-674.1655
BIC	-599.4019
Log Likelihood	350.1606
Num. obs.	2352

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

Table 1: ARMAX Model Results

	Model 1
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)
AIC	-597.9298
AICc	-597.8360
BIC	-540.2783
Log Likelihood	308.9649
Num. obs.	2357

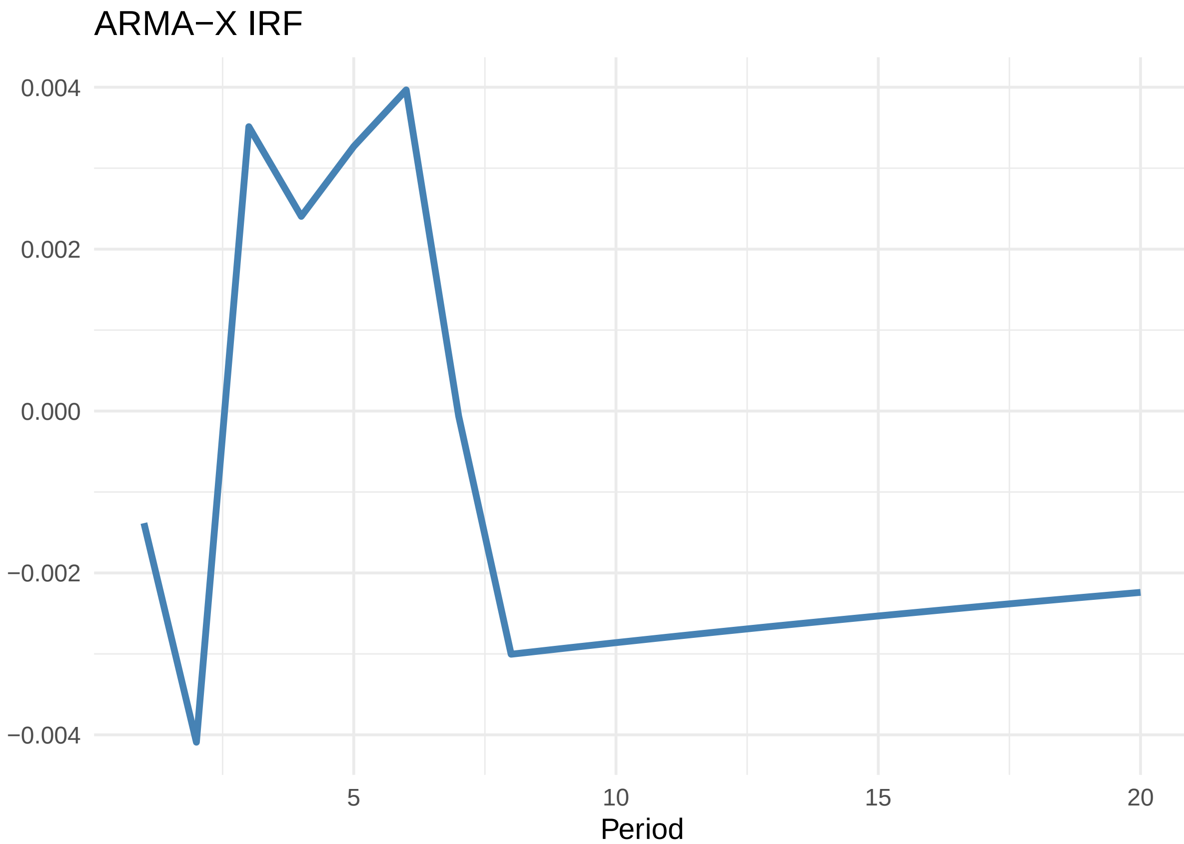
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 2: ARMAX Model Results

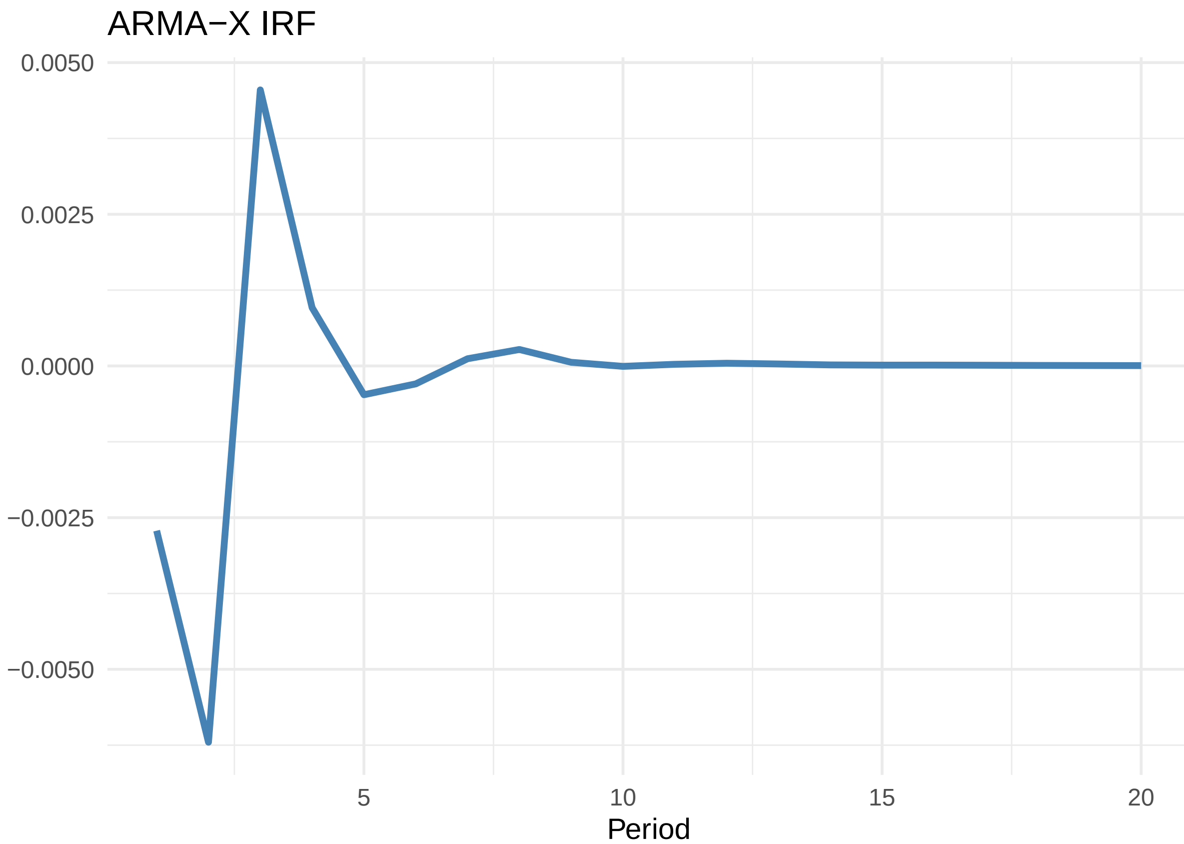
	Model 1
ar1	1.0801
ar2	-0.4288
ar3	0.4976^{***}
	(0.0488)
ar4	-0.3019^{***}
	(0.0281)
ar5	0.7924^{***}
	(0.0293)
ar6	-0.6814^{***}
	(0.0150)
ma1	-0.7735^{***}
	(0.0094)
ma2	0.1292^{***}
	(0.0303)
ma3	-0.3723^{***}
	(0.0240)
ma4	0.2371^{***}
	(0.0211)
ma5	-0.9602^{***}
	(0.0095)
ma6	0.6554
ma7	0.2287^{***}
	(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)
AIC	-940.4859
AICc	-940.1933
BIC	-836.7133
Log Likelihood	488.2429
Num. obs.	2357

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

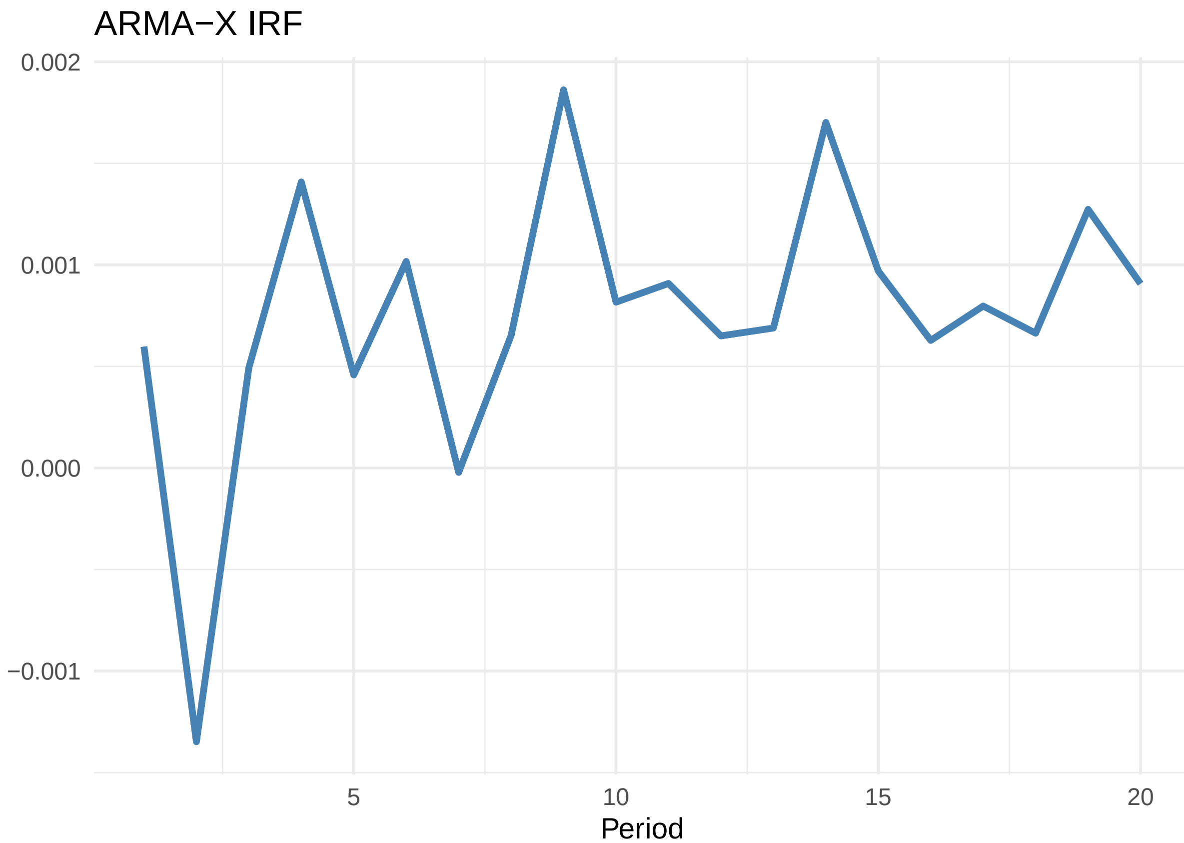
Table 3: ARMAX selected by AIC




```r
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