ARMA-X Figures

Contents

Full Timeframe (Jan 2024 to May 2025)

```
#load final dataset
source(here("helperfunctions/full_data.R"))

#backup
backup = data

#select timeframe
data = filter(data,between(timestamp, as.Date('2014-01-01'), as.Date('2025-05-07')))
```

SPY Models

We choose the specification in the armax_models file. In this file, we will just run said specifications to produce nice tables and graphs to include in our final paper.

```
models <- list()

# ARMA-X(3,3,1) with Tweet Dummy as Exogenous
models[["Model 1"]] <- armax(data$SPY_vol, xreg = data$dummy, latex = F,
                             nb.lags = 1, p = 3, q = 3)

# ARMA-X(3,3,1) with Tweet Count as Exogenous
models[["Model 2"]] <- armax(data$SPY_vol, xreg = data$N, latex = F,
                             nb.lags = 1, p = 3, q = 3)

# ARMA-X(3,2,3) with Tariff Mentions as Exogenous
models[["Model 3"]] <- armax(data$SPY_vol, xreg = data$tariff, latex = F,
                             nb.lags = 3, p = 3, q = 2)

# ARMA-X(3,2,1) with Trade Mentions as Exogenous
models[["Model 4"]] <- armax(data$SPY_vol, xreg = data$trade, latex = F,
                             nb.lags = 1, p = 3, q = 2)

# ARMA-X(3,2,0) with China Mentions as Exogenous
models[["Model 5"]] <- armax(data$SPY_vol, xreg = data$china, latex = F,
                             nb.lags = 0, p = 3, q = 2)
```

SPY Table

```
names = list( "ar1" = "AR(1)",
              "ar2" = "AR(2)",
              "ar3" = "AR(3)",
              "ma1" = "MA(1)",
              "ma2" = "MA(2)",
              "ma3" = "MA(3)",
              "(Intercept)" = "Constant",
              "dummy_lag_0" = "$TweetDummy_{t}$",
              "dummy_lag_1" = "$TweetDummy_{t-1}$",
```

```
              "N_lag_0" = "$TweetCount_{t}$",
              "N_lag_1" = "$TweetCount_{t-1}$",
              "tariff_lag_0" = "$Tariff_{t}$",
              "tariff_lag_1" = "$Tariff_{t-1}$",
              "tariff_lag_2" = "$Tariff_{t-2}$",
              "tariff_lag_3" = "$Tariff_{t-3}$",
              "trade_lag_0" = "$Trade_{t}$",
              "trade_lag_1" = "$Trade_{t-1}$",
              "china_lag_0" = "$China_{t}$")

texreg(models,
          custom.model.names = names(models),
          custom.coef.map = names,
          caption = "ARMAX Models of Average Hourly Volatility",
          caption.above = TRUE,
          label = "tab:armax",
          digits = 4)
```

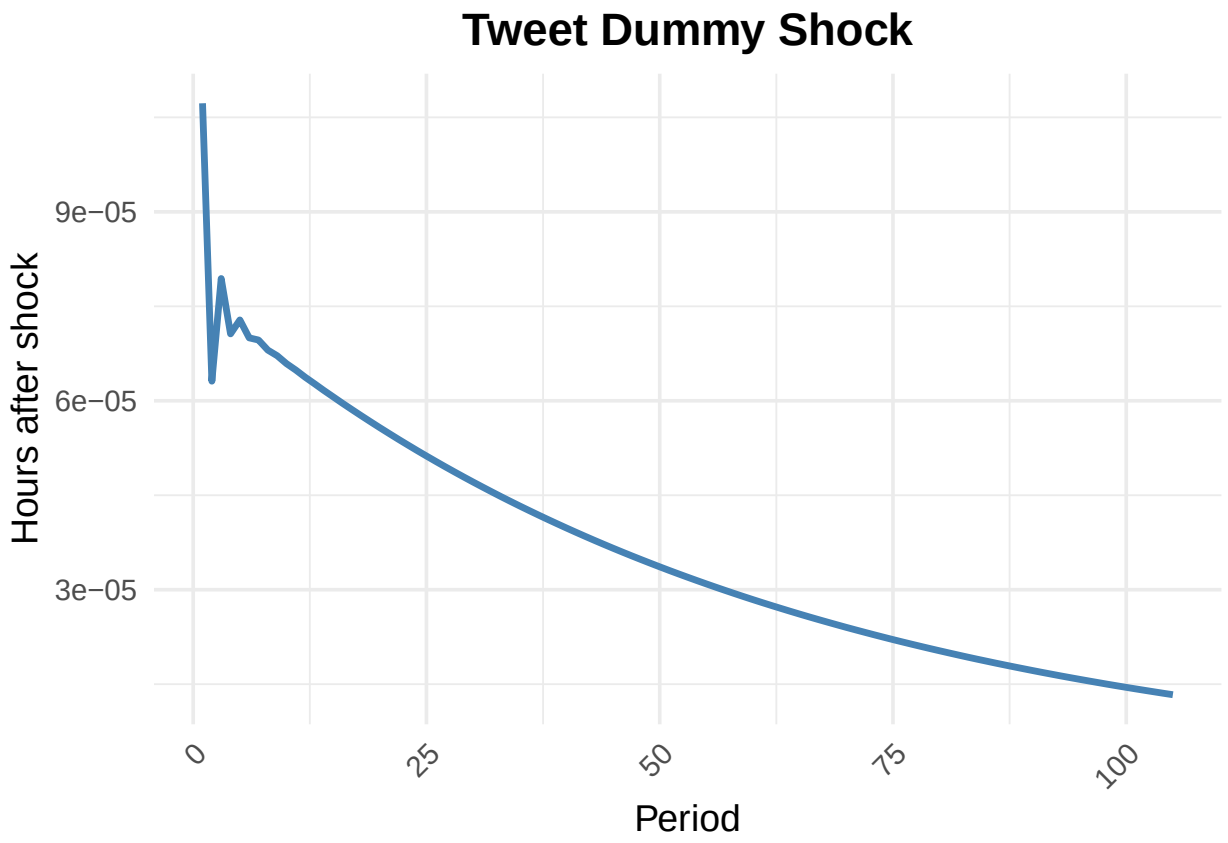
SPY IRFs

```
#we want to plot the IRFs of these models
nb.periods = 7 * 15

irf.plot(models[["Model 1"]],nb.periods,title="Tweet Dummy Shock")
```

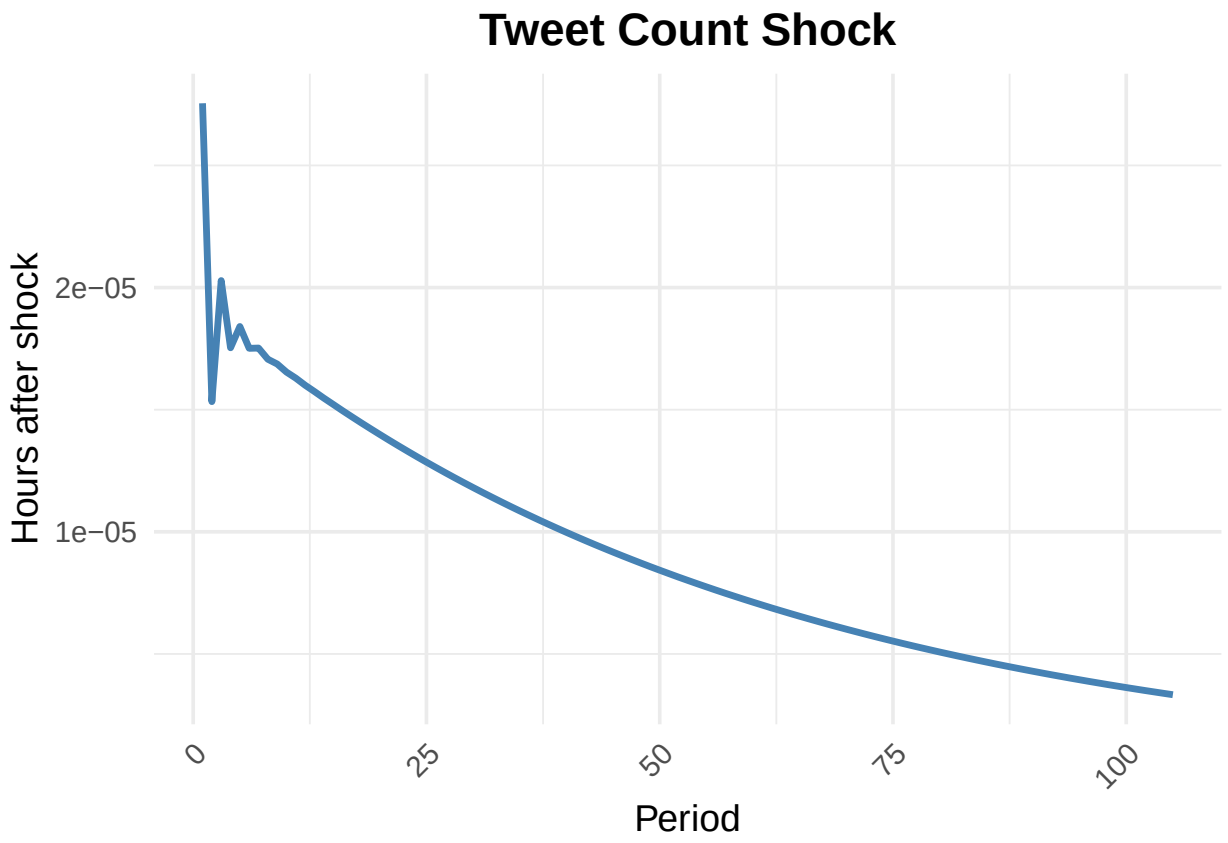
Table 1: ARMAX Models of Average Hourly Volatility

	Model 1	Model 2	Model 3	Model 4	Model 5
AR(1)	0.0300	0.0278	0.2200^{***}	2.1903^{***}	0.2209^{***}
	(0.0510)	(0.0510)	(0.0084)	(0.0096)	(0.0084)
AR(2)	0.7229^{***}	0.7210^{***}	0.9388^{***}	-1.4727^{***}	0.9382^{***}
	(0.0397)	(0.0399)	(0.0037)	(0.0173)	(0.0037)
AR(3)	0.2110^{***}	0.2148^{***}	-0.1837^{***}	0.2784^{***}	-0.1837^{***}
	(0.0287)	(0.0284)	(0.0079)	(0.0082)	(0.0079)
MA(1)	0.2751^{***}	0.2779^{***}	0.0870^{***}	-1.8955^{***}	0.0878^{***}
	(0.0496)	(0.0496)	(0.0042)	(0.0062)	(0.0042)
MA(2)	-0.6445^{***}	-0.6430^{***}	-0.8960^{***}	0.9165^{***}	-0.8950^{***}
	(0.0284)	(0.0285)	(0.0042)	(0.0063)	(0.0042)
MA(3)	-0.3527^{***}	-0.3563^{***}			
	(0.0256)	(0.0253)			
$TweetDummy_t$	0.0014^{***}				
	(0.0002)				
$TweetDummy_{t-1}$	0.0008^{***}				
	(0.0002)				
$TweetCount_t$		0.0004^{***}			
		(0.0001)			
$TweetCount_{t-1}$		0.0002^{**}			
		(0.0001)			
$Tariff_t$			0.0035^{*}		
			(0.0014)		
$Tariff_{t-1}$			0.0191^{***}		
			(0.0015)		
$Tariff_{t-2}$			0.0103^{***}		
			(0.0015)		
$Tariff_{t-3}$			-0.0045^{**}		
			(0.0014)		
$Trade_t$				0.0032	
				(0.0018)	
$Trade_{t-1}$				0.0016	
				(0.0018)	
$China_t$					0.0026^{*}
					(0.0012)
AIC	−45761.2161	−45737.6695	−46020.9547	−45816.1540	−45840.5349
AICc	−45761.2051	−45737.6585	−46020.9415	−45816.1449	−45840.5277
BIC	−45682.1963	−45658.6497	−45934.0340	−45745.0361	−45777.3186
Log Likelihood	22890.6081	22878.8348	23021.4774	22917.0770	22928.2675
Num. obs.	19970	19970	19968	19970	19971

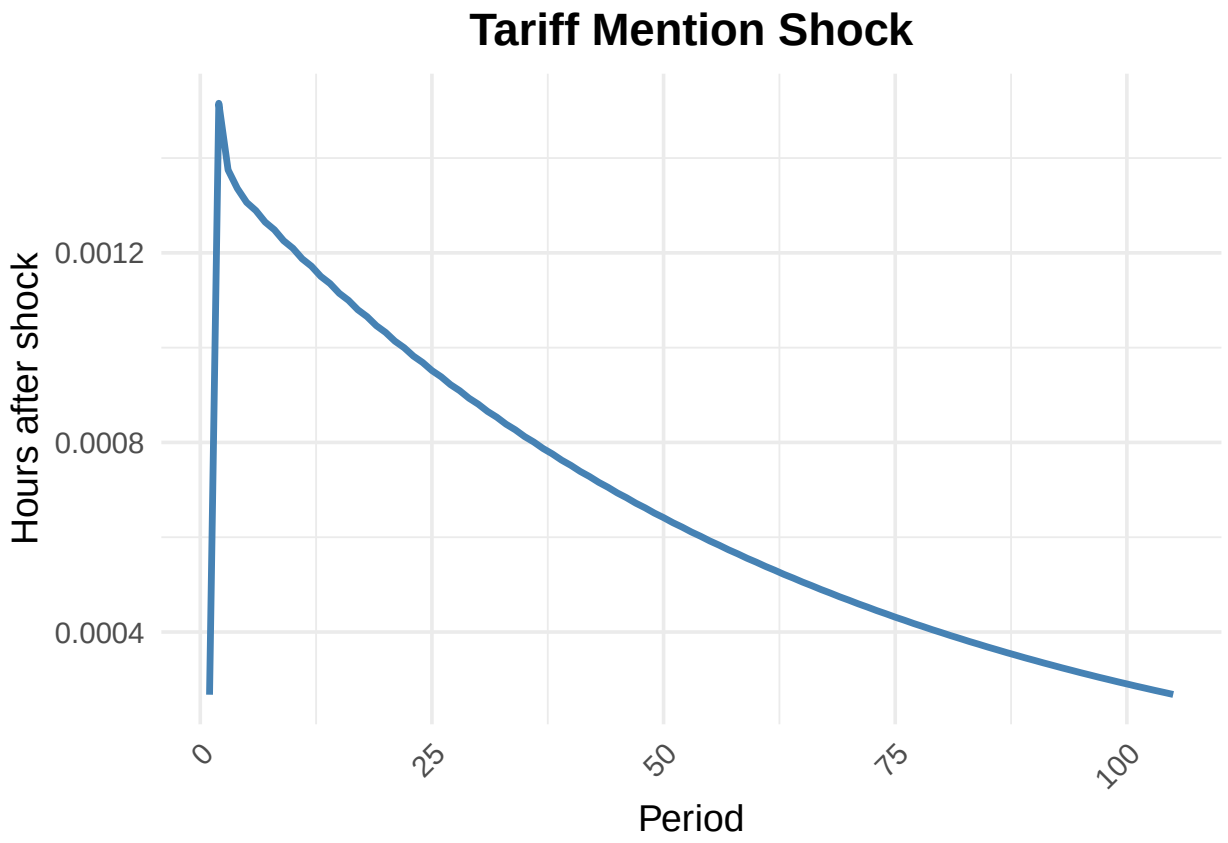
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$



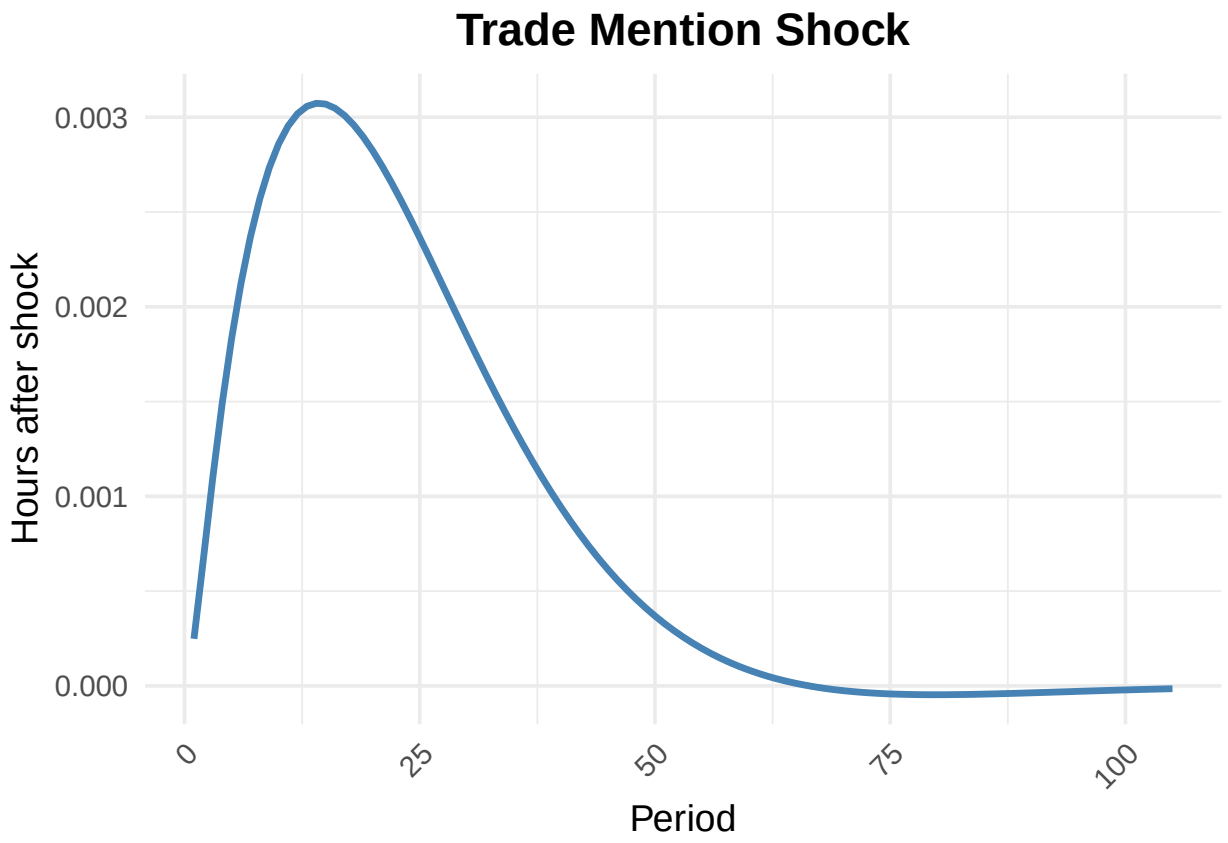

```
irf.plot(models[["Model 2"]],nb.periods,title="Tweet Count Shock")
```



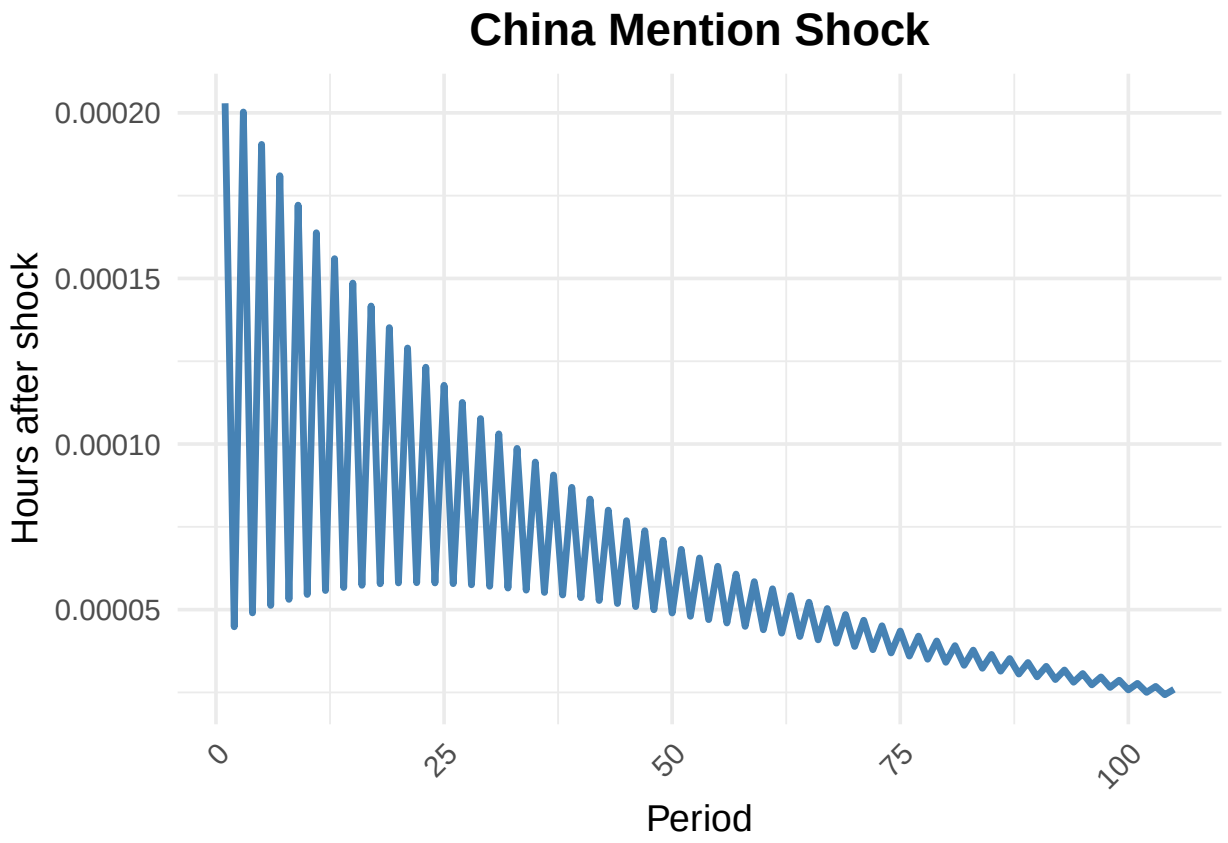

```
irf.plot(models[["Model 3"]],nb.periods,title="Tariff Mention Shock")
```




```
irf.plot(models[["Model 4"]],nb.periods,title="Trade Mention Shock")
```




```
irf.plot(models[["Model 5"]],nb.periods,title="China Mention Shock")
```



SPY Residuals

```
res1 = checkresiduals(models[["Model 1"]], plot = FALSE)
res2 = checkresiduals(models[["Model 2"]], plot = FALSE)
res3 = checkresiduals(models[["Model 3"]], plot = FALSE)
res4 = checkresiduals(models[["Model 4"]], plot = FALSE)
res5 = checkresiduals(models[["Model 5"]], plot = FALSE)
```

First Term

```
#load final dataset
data = backup

#first term
data = filter(data,between(timestamp, as.Date('2017-01-20'), as.Date('2021-01-20')))
```

SPY Models

```
models <- list()

# ARMA-X(3,3,0) with Tariff Mentions as Exogenous
models[["First Term (1)"]] <- armax(data$SPY_vol, xreg = data$tariff, latex = F,
                            nb.lags = 0, p = 3, q = 3)

# ARMA-X(3,3,0) with Trade Mentions as Exogenous
models[["First Term (2)"]] <- armax(data$SPY_vol, xreg = data$trade, latex = F,
                            nb.lags = 0, p = 3, q = 3)

# ARMA-X(3,3,0) with Trade Mentions as Exogenous
models[["First Term (3)"]] <- armax(data$SPY_vol, xreg = data$china, latex = F,
                            nb.lags = 0, p = 3, q = 3)
```

SPY Residuals

```
res = checkresiduals(models[["First Term (1)"]], plot = FALSE)
res = checkresiduals(models[["First Term (2)"]], plot = FALSE)
res = checkresiduals(models[["First Term (3)"]], plot = FALSE)
```

Second Term

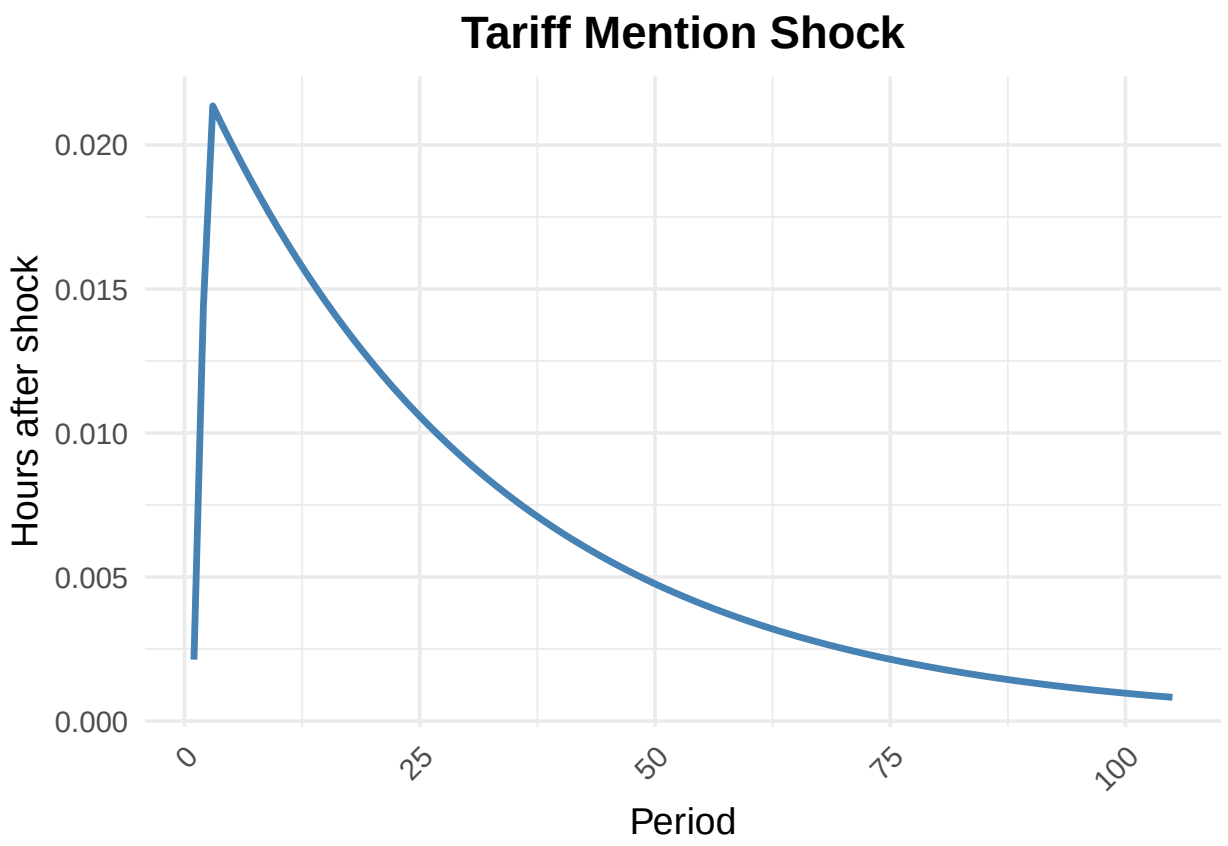
```
#load final dataset
data = backup

#second term
data = filter(data,between(timestamp, as.Date('2025-01-20'), as.Date('2025-05-07')))
```

SPY Models

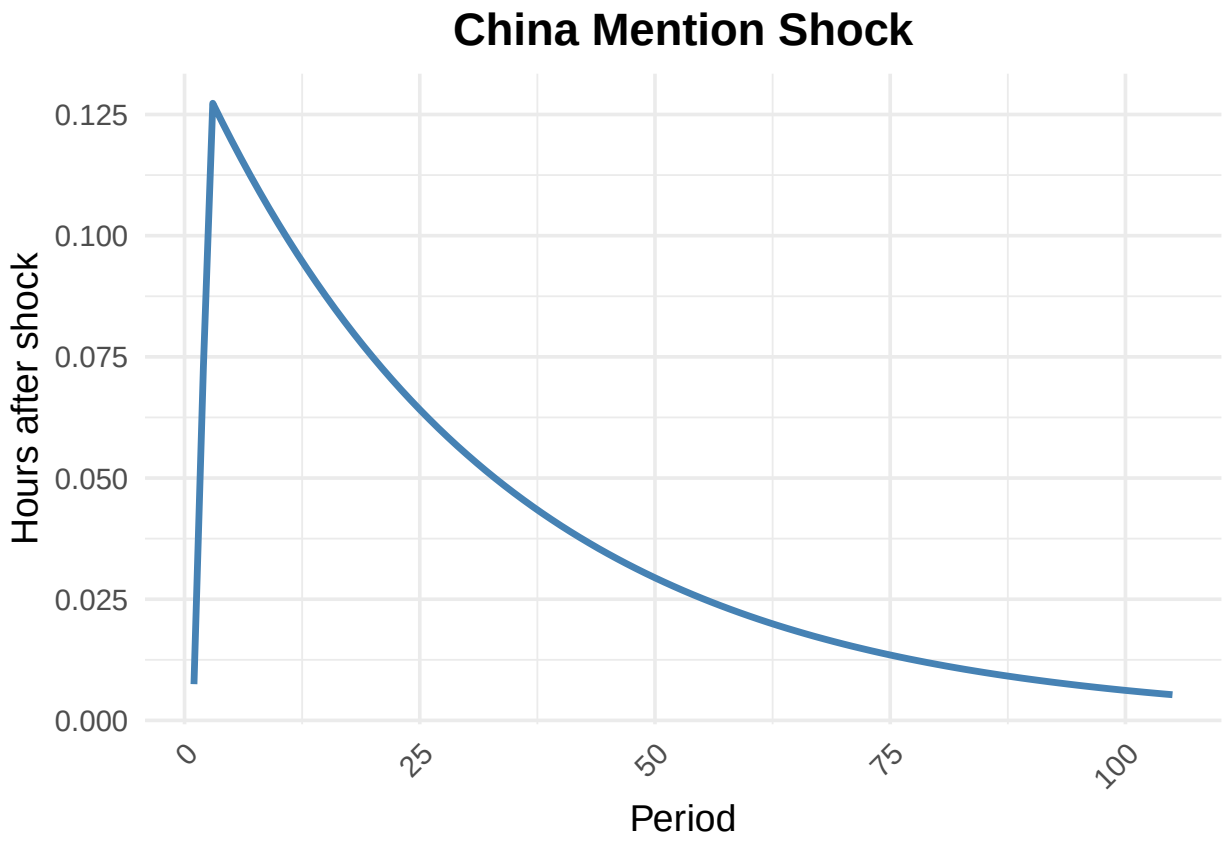
```
# ARMA-X(3,2,3) with Tariff Mentions as Exogenous
models[["Second Term (1)"]] <- armax(data$SPY_vol, xreg = data$tariff, latex = F,
                            nb.lags = 2, p = 1, q = 2)

# ARMA-X(3,2,1) with Trade Mentions as Exogenous
models[["Second Term (2)"]] <- armax(data$SPY_vol, xreg = data$trade, latex = F,
                            nb.lags = 0, p = 1, q = 2)

# ARMA-X(3,2,0) with China Mentions as Exogenous
models[["Second Term (3)"]] <- armax(data$SPY_vol, xreg = data$china, latex = F,
                            nb.lags = 2, p = 1, q = 2)
```

SPY IRFs

```
#we want to plot the IRFs of these models
nb.periods = 7 * 15

irf.plot(models[["Second Term (1)"]],nb.periods,title="Tariff Mention Shock")
```




```
irf.plot(models[["Second Term (3)"]],nb.periods,title="China Mention Shock")
```



SPY Residuals

```
res = checkresiduals(models[["Second Term (1)"]], plot = FALSE)
res = checkresiduals(models[["Second Term (2)"]], plot = FALSE)
res = checkresiduals(models[["Second Term (3)"]], plot = FALSE)
```

SPY Table (both terms)

```
xnames = list("ar1" = "AR(1)",
              "ar2" = "AR(2)",
              "ar3" = "AR(3)",
              "ma1" = "MA(1)",
              "ma2" = "MA(2)",
              "ma3" = "MA(3)",
              "(Intercept)" = "Constant",
              "tariff_lag_0" = "$Tariff_{t}$",
              "tariff_lag_1" = "$Tariff_{t-1}$",
              "tariff_lag_2" = "$Tariff_{t-2}$",
              "trade_lag_0" = "$Trade_{t}$",
              "china_lag_0" = "$China_{t}$",
              "china_lag_1" = "$China_{t-1}$",
              "china_lag_2" = "$China_{t-2}$")
```

Table 2: Split-Term ARMAX Models of Average Hourly Volatility

	First Term (1)	First Term (2)	First Term (3)	Second Term (1)	Second Term (2)	Second Term (
AR(1)	0.2953***	0.2943***	0.2927***	0.9686***	0.9683***	0.9693***
	(0.0225)	(0.0224)	(0.0224)	(0.0163)	(0.0163)	(0.0161)
AR(2)	0.1434***	0.1439***	0.1438***			
	(0.0220)	(0.0220)	(0.0219)			
AR(3)	0.5456***	0.5462***	0.5480***			
	(0.0223)	(0.0222)	(0.0222)			
MA(1)	0.1854***	0.1863***	0.1866***	−0.6965***	−0.6905***	−0.7207***
	(0.0180)	(0.0179)	(0.0179)	(0.0469)	(0.0469)	(0.0467)
MA(2)	−0.1707***	−0.1706***	−0.1695***	−0.1732***	−0.1755***	−0.1609***
	(0.0169)	(0.0169)	(0.0168)	(0.0437)	(0.0438)	(0.0434)
MA(3)	−0.6557***	−0.6564***	−0.6575***			
	(0.0162)	(0.0161)	(0.0161)			
$Tariff_t$	0.0011			0.0048		
	(0.0010)			(0.0099)		
$Tariff_{t-1}$				0.0278**		
				(0.0102)		
$Tariff_{t-2}$				0.0168		
				(0.0099)		
$Trade_t$		0.0023**			−0.0074	
		(0.0009)			(0.0297)	
$China_t$			0.0018**			0.0173
			(0.0006)			(0.0319)
$China_{t-1}$						0.1515***
						(0.0324)
$China_{t-2}$						0.1309***
						(0.0319)
AIC	−28604.6559	−28610.2269	−28613.1693	633.4836	638.2093	610.2140
AICc	−28604.6303	−28610.2013	−28613.1437	633.7676	638.3737	610.4980
BIC	−28542.9191	−28548.4901	−28551.4325	667.4525	663.7092	644.1829
Log Likelihood	14311.3279	14314.1134	14315.5847	−308.7418	−313.1047	−297.1070
Num. obs.	7042	7042	7042	516	518	516

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

```
texreg(models,
       custom.model.names = names(models),
       custom.coef.map = xnames,
       caption = "Split-Term ARMAX Models of Average Hourly Volatility",
       caption.above = TRUE,
       label = "tab:armax_term",
       digits = 4)
```