ARMA-X Model

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	Model 1
ar1	0.0300
	(0.0510)
ar2	0.7229***
	(0.0397)
ar3	0.2110***
	(0.0287)
ma1	0.2751***
	(0.0496)
ma2	−0.6445***
	(0.0284)
ma3	−0.3527***
	(0.0256)
intercept	0.0202***
	(0.0042)
dummy_lag_0	0.0014***
	(0.0002)
dummy_lag_1	0.0008***
	(0.0002)
AIC	−45761.2161
AICc	−45761.2051
BIC	−45682.1963
Log Likelihood	22890.6081
Num. obs.	19970

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

Table 1: ARMAX selected by AIC

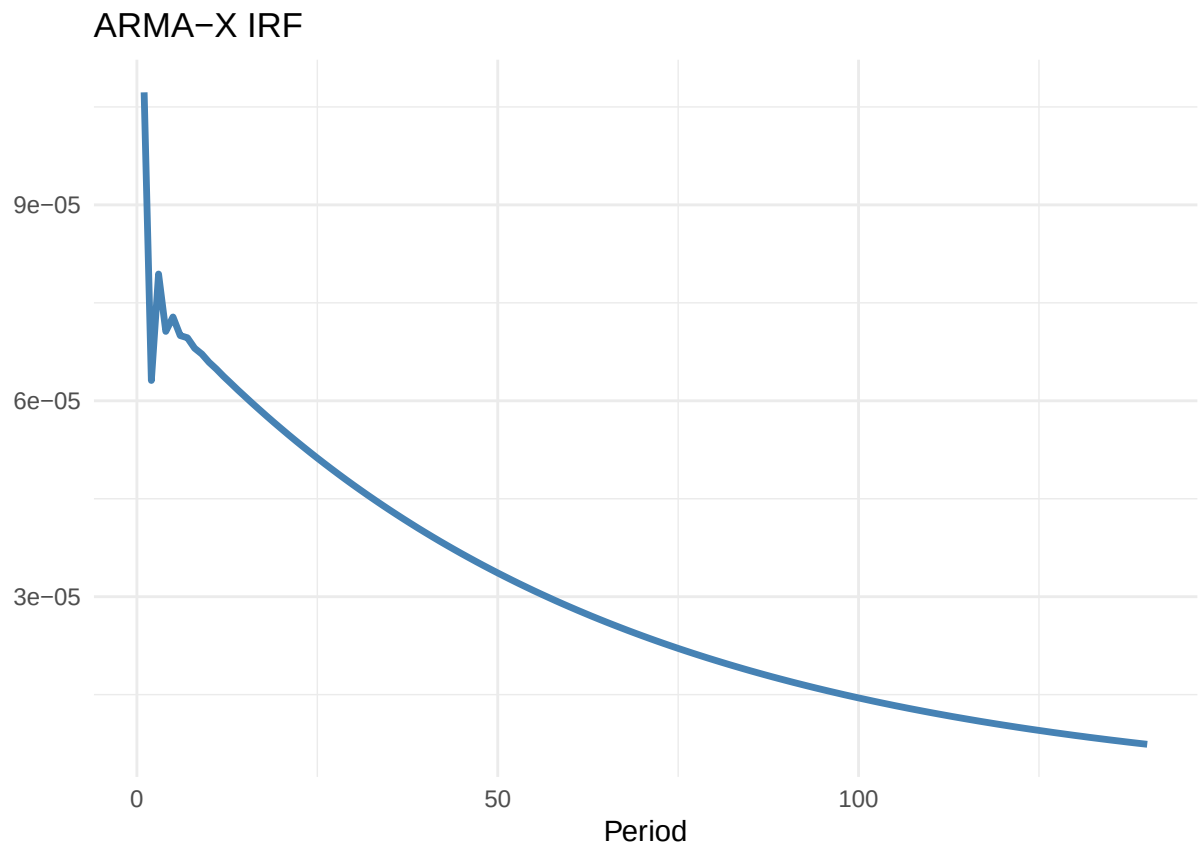
S&P500 Univariate ARMA-X Models

Here we try various specifications with multiple variables to see what comes out.

Tweet Dummy as Exogenous

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

```
#we want to plot the IRFs of these models
nb.periods = 7 * 20

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



Tweet Count as Exogenous

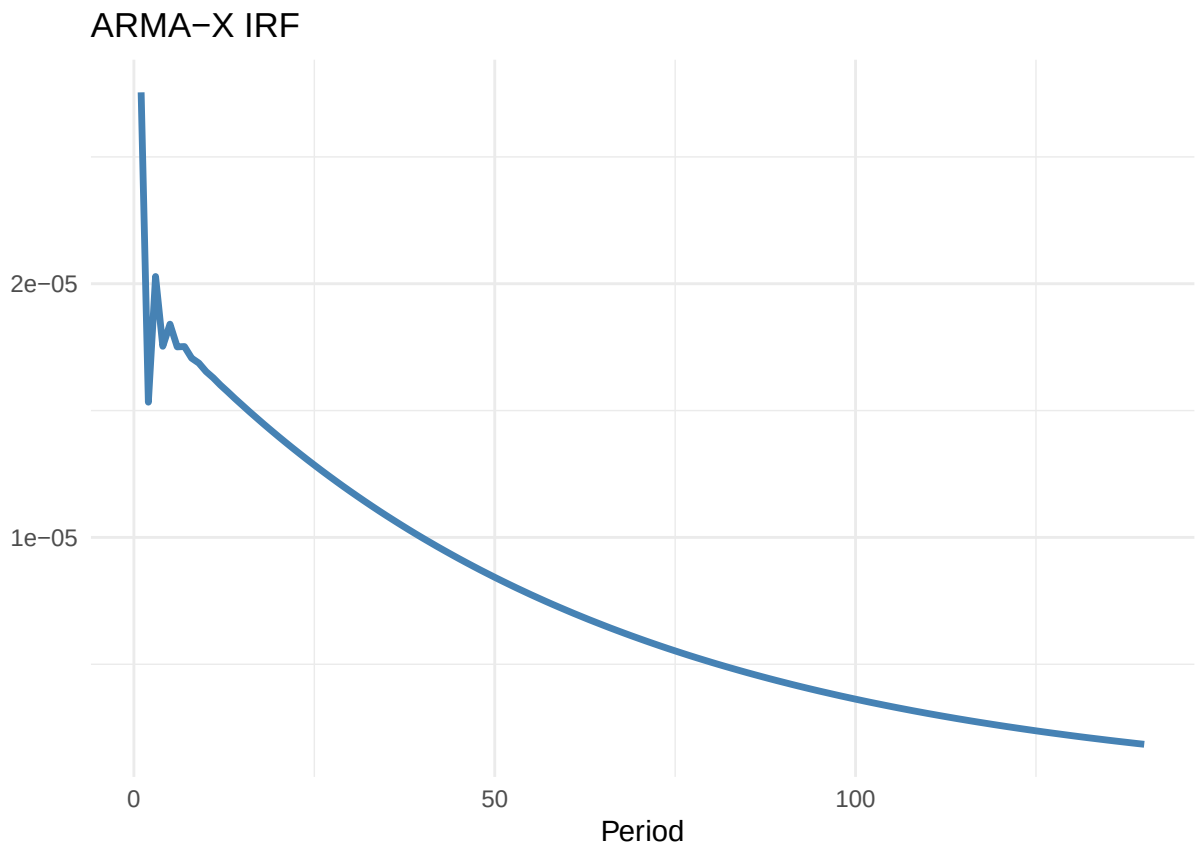
```
#auto.armax.r selects the lowest AIC checking all 3 p,q,r values
res = auto.armax.r(data$SPY_vol, x=data$N,
                max_p = 3, max_q = 3, max_r = 3, criterion = "AIC", latex=T)
```

```
#we want to plot the IRFs of these models
nb.periods = 7 * 20

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

	Model 1
ar1	0.0278
	(0.0510)
ar2	0.7210^{***}
	(0.0399)
ar3	0.2148^{***}
	(0.0284)
ma1	0.2779^{***}
	(0.0496)
ma2	-0.6430^{***}
	(0.0285)
ma3	-0.3563^{***}
	(0.0253)
intercept	0.0211^{***}
	(0.0042)
N_lag_0	0.0004^{***}
	(0.0001)
N_lag_1	0.0002^{**}
	(0.0001)
AIC	−45737.6695
AICc	−45737.6585
BIC	−45658.6497
Log Likelihood	22878.8348
Num. obs.	19970

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

Table 2: ARMAX selected by AIC



Tariff as Exogenous

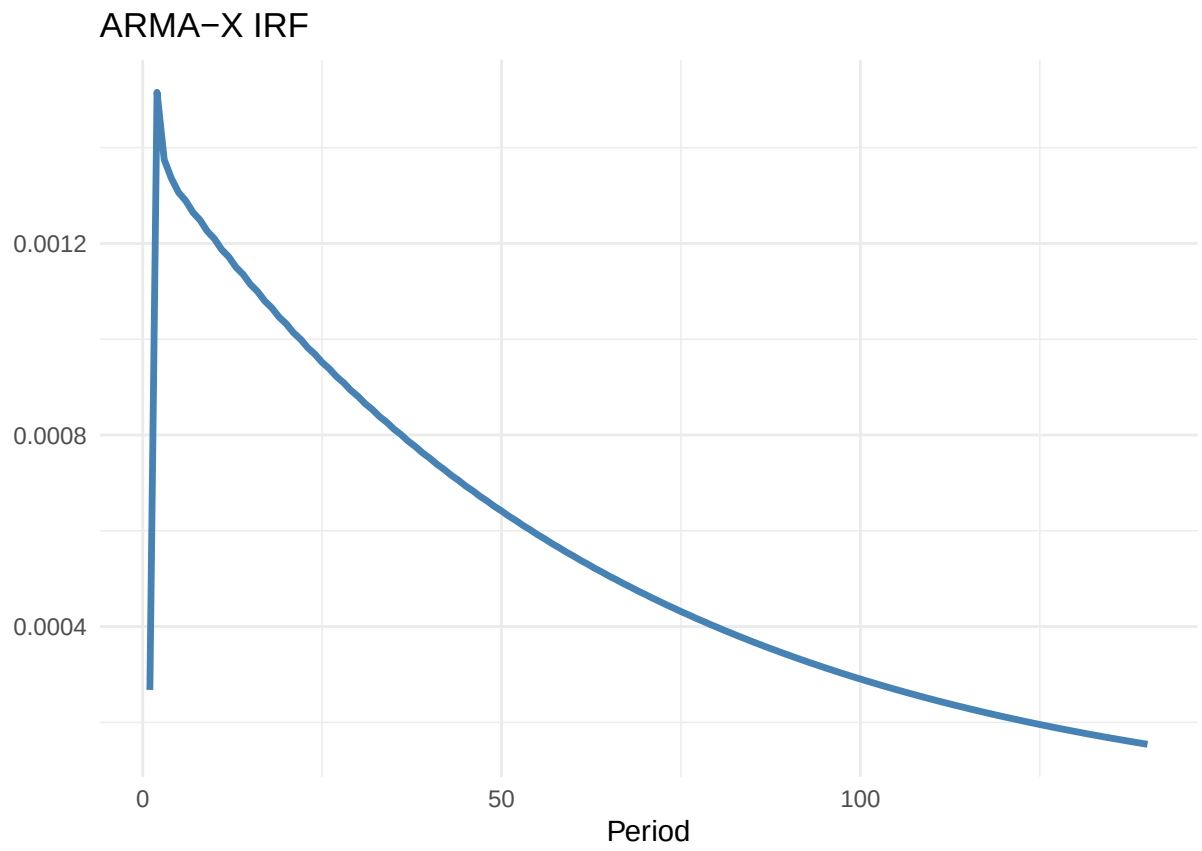
```
#auto.armax.r selects the lowest AIC checking all 3 p,q,r values
res = auto.armax.r(data$SPY_vol, x=data$tariff,
                max_p = 3, max_q = 3, max_r = 3, criterion = "AIC", latex=T)
```

```
#we want to plot the IRFs of these models
nb.periods = 7 * 20

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

	Model 1
ar1	0.2200^{***}
	(0.0084)
ar2	0.9388^{***}
	(0.0037)
ar3	-0.1837^{***}
	(0.0079)
ma1	0.0870^{***}
	(0.0042)
ma2	-0.8960^{***}
	(0.0042)
intercept	0.0219^{***}
	(0.0042)
tariff_lag_0	0.0035^{*}
	(0.0014)
tariff_lag_1	0.0191^{***}
	(0.0015)
tariff_lag_2	0.0103^{***}
	(0.0015)
tariff_lag_3	-0.0045^{**}
	(0.0014)
AIC	−46020.9547
AICc	−46020.9415
BIC	−45934.0340
Log Likelihood	23021.4774
Num. obs.	19968

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

Table 3: ARMAX selected by AIC



Trade Mention as Exogenous

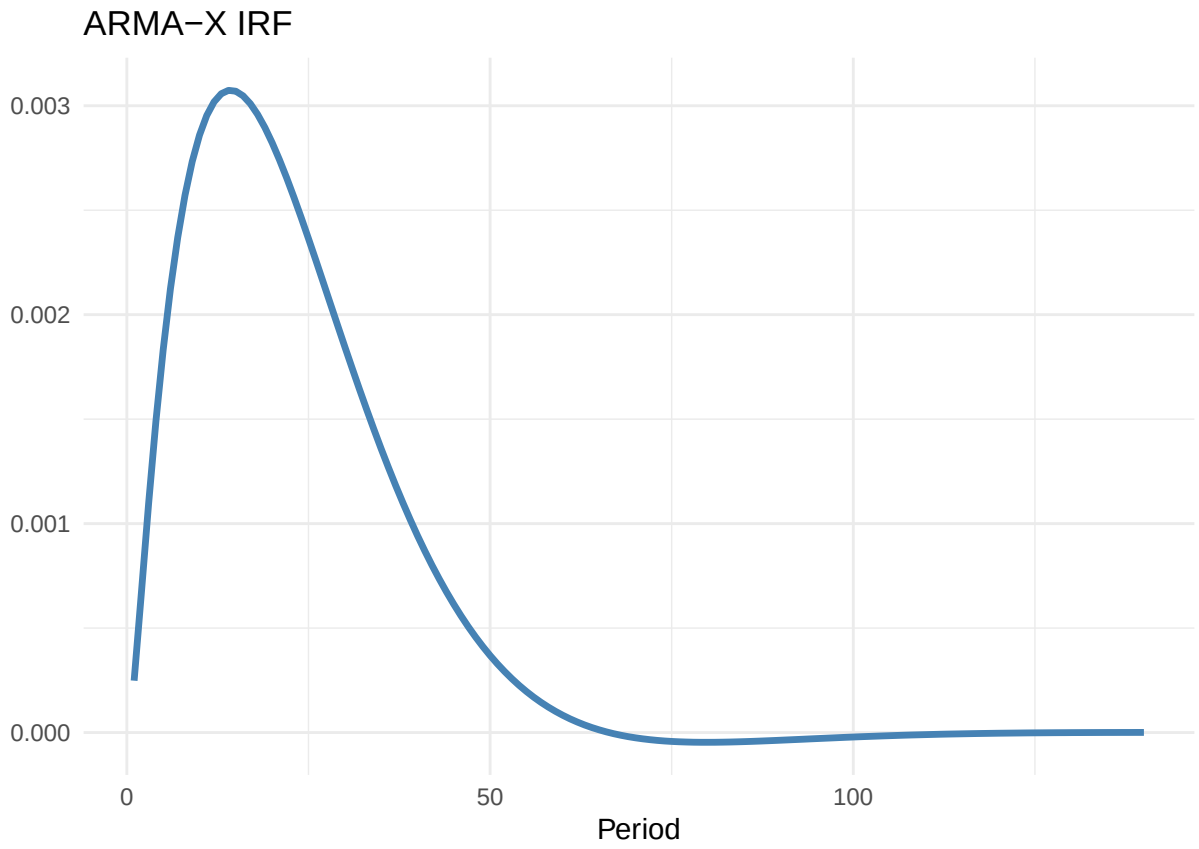
```
#auto.armax.r selects the lowest AIC checking all 3 p,q,r values
res = auto.armax.r(data$SPY_vol, x=data$trade,
                max_p = 3, max_q = 3, max_r = 3, criterion = "AIC", latex=T)
```

```
#we want to plot the IRFs of these models
nb.periods = 7 * 20

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

	Model 1
ar1	2.1903***
	(0.0096)
ar2	−1.4727***
	(0.0173)
ar3	0.2784***
	(0.0082)
ma1	−1.8955***
	(0.0062)
ma2	0.9165***
	(0.0063)
intercept	0.0225***
	(0.0028)
trade_lag_0	0.0032
	(0.0018)
trade_lag_1	0.0016
	(0.0018)
AIC	−45816.1540
AICc	−45816.1449
BIC	−45745.0361
Log Likelihood	22917.0770
Num. obs.	19970

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

Table 4: ARMAX selected by AIC



	Model 1
ar1	0.2209***
	(0.0084)
ar2	0.9382***
	(0.0037)
ar3	−0.1837***
	(0.0079)
ma1	0.0878***
	(0.0042)
ma2	−0.8950***
	(0.0042)
intercept	0.0225***
	(0.0042)
china_lag_0	0.0026*
	(0.0012)
AIC	−45840.5349
AICc	−45840.5277
BIC	−45777.3186
Log Likelihood	22928.2675
Num. obs.	19971

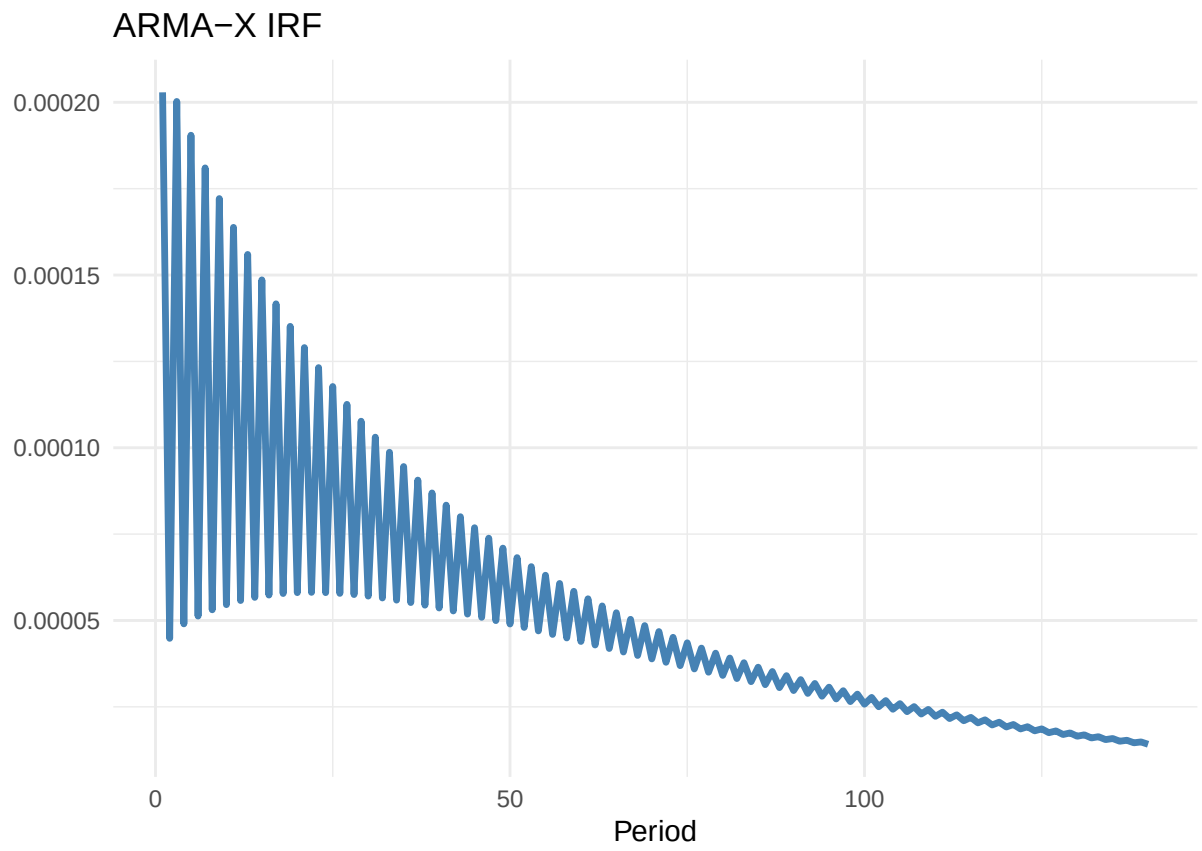
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

Table 5: ARMAX selected by AIC

China Mention as Exogenous

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

```
#we want to plot the IRFs of these models
nb.periods = 7 * 20

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



Positive Vibe as Exogenous

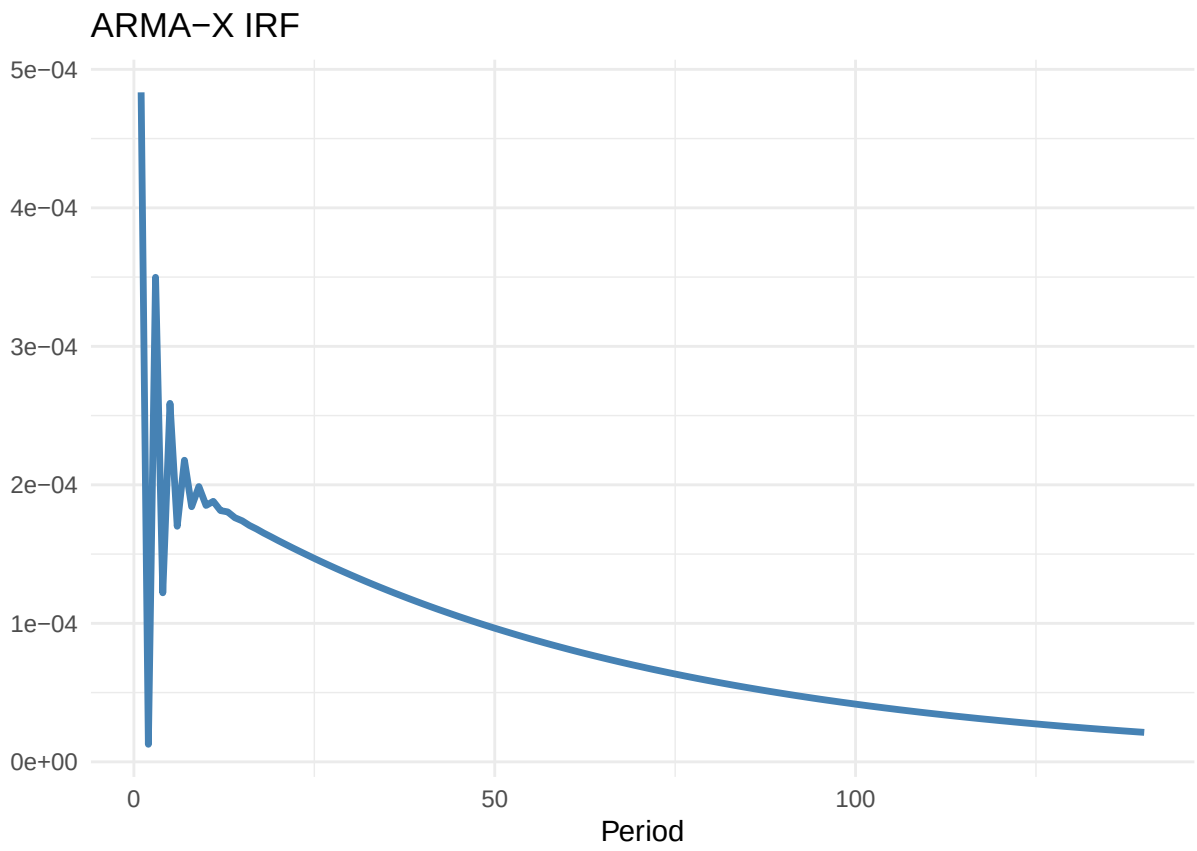
```
#auto.armax.r selects the lowest AIC checking all 3 p,q,r values
res = auto.armax.r(data$SPY_vol, x=data$prop_positive,
                max_p = 3, max_q = 3, max_r = 3, criterion = "AIC", latex=T)
```

```
#we want to plot the IRFs of these models
nb.periods = 7 * 20

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

	Model 1
ar1	0.0262
	(0.0503)
ar2	0.7230***
	(0.0390)
ar3	0.2146***
	(0.0283)
ma1	0.2800***
	(0.0489)
ma2	−0.6451***
	(0.0277)
ma3	−0.3571***
	(0.0252)
intercept	0.0212***
	(0.0042)
prop_positive_lag_0	0.0063***
	(0.0016)
AIC	−45722.7625
AICc	−45722.7534
BIC	−45651.6441
Log Likelihood	22870.3812
Num. obs.	19971

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

Table 6: ARMAX selected by AIC



	Model 1
ar1	0.0237
	(0.0495)
ar2	0.7250***
	(0.0379)
ar3	0.2150***
	(0.0283)
ma1	0.2824***
	(0.0481)
ma2	−0.6460***
	(0.0270)
ma3	−0.3581***
	(0.0251)
intercept	0.0216***
	(0.0042)
prop_negative_lag_0	0.0070**
	(0.0022)
AIC	−45716.8054
AICc	−45716.7964
BIC	−45645.6871
Log Likelihood	22867.4027
Num. obs.	19971

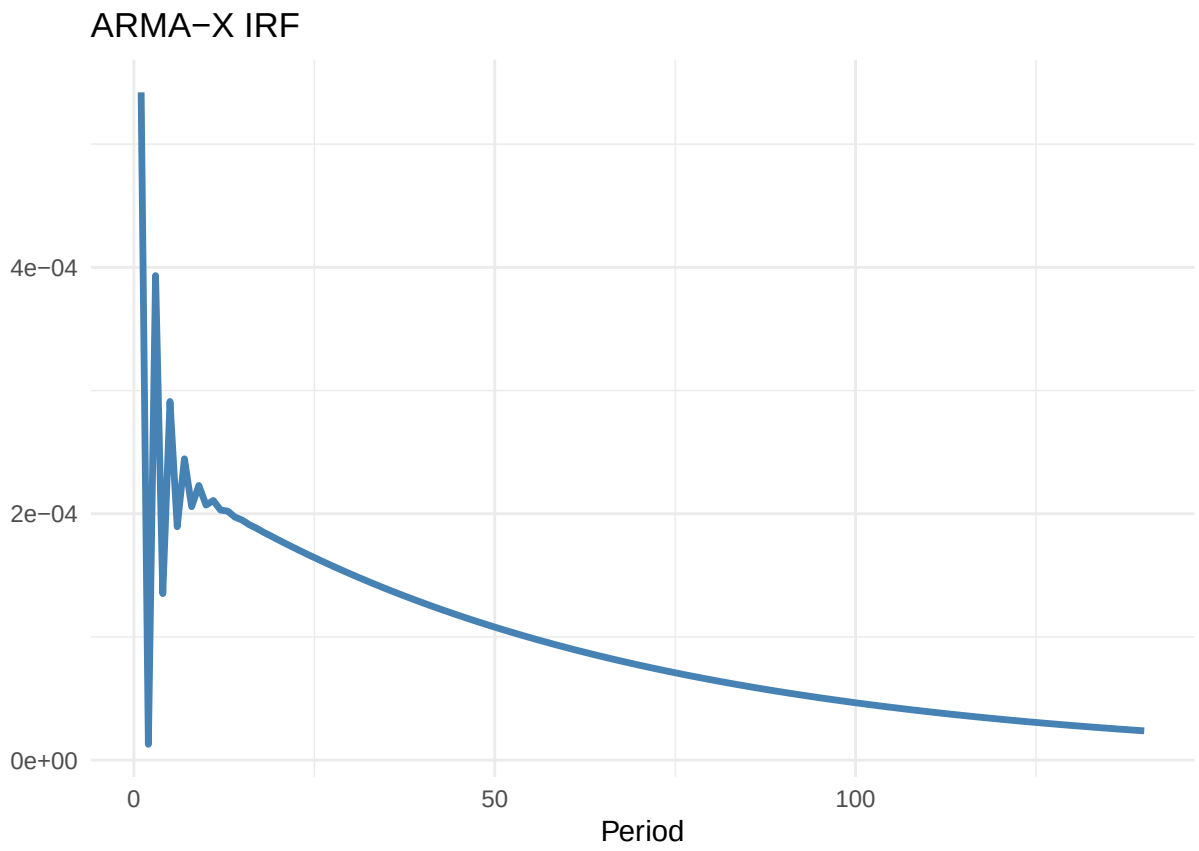
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

Table 7: ARMAX selected by AIC

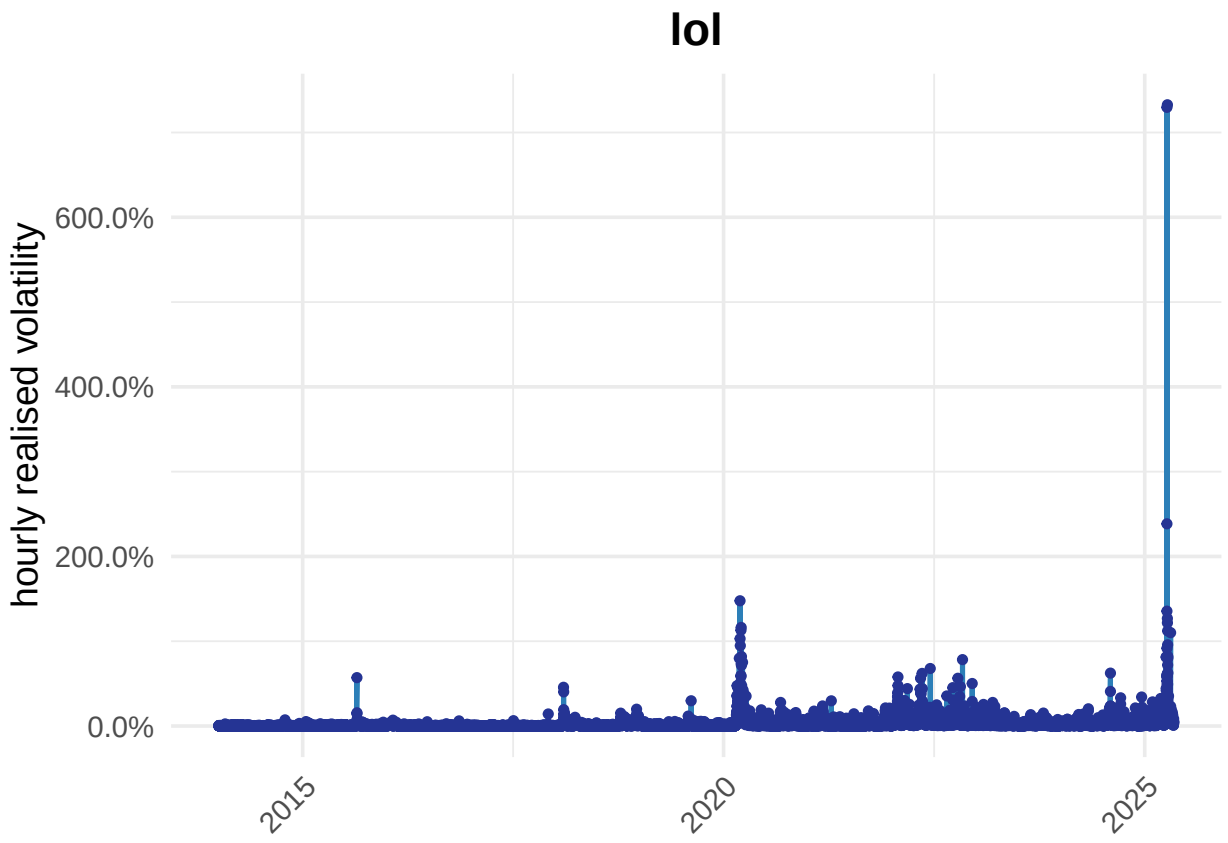
Negative Vibe as Exogenous

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

```
#we want to plot the IRFs of these models
nb.periods = 7 * 20

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




```
r_vol_h = data$SPY_vol

data$r_vol_h = r_vol_h

hvol_plotter(data, breaks="6 month", title="lol")
```


lol
hourly realised volatility
600.0%
400.0%
200.0%
0.0%
2015
2020
2025