Part 7 Appendix

7.1 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')))

#for interpretation
mean1 = mean(data$SPY_vol)
```

7.1.1 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. This is also why there are specification differences in the separate timeframes. We always use the best fit we found earlier.

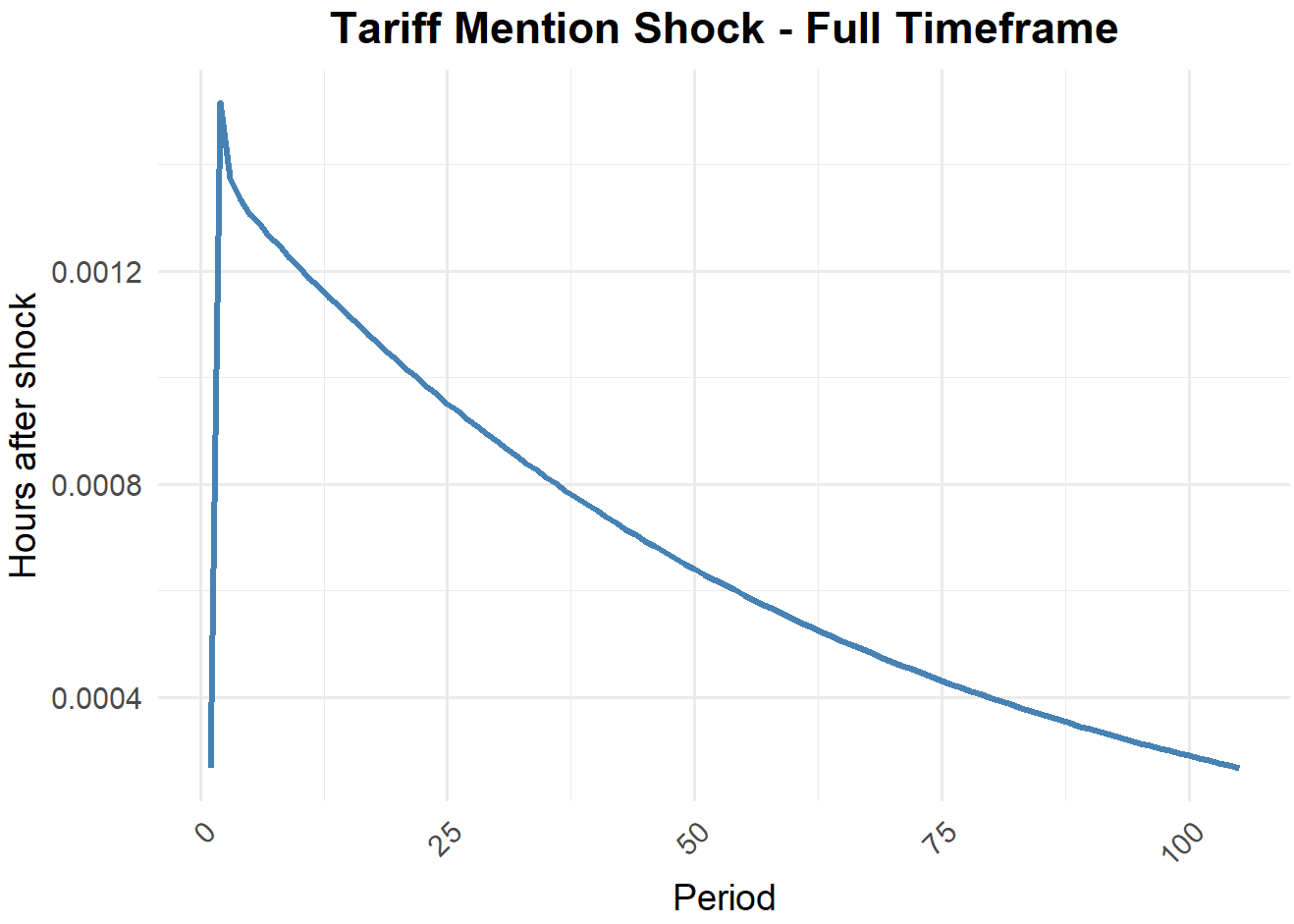
```r
models <- list()

# 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)
```

7.1.2 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" = "$China_{t}$")

table1 = 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)
table1
```

7.1.3 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")
#irf.plot(models[["Model 2"]],nb.periods,title="Tweet Count Shock")
plot1 = irf.plot(models[["Model 3"]],nb.periods,
                 title="Tariff Mention Shock - Full Timeframe")
plot1
```




```
#irf.plot(models[["Model 4"]],nb.periods,title="Trade Mention Shock")
#irf.plot(models[["Model 5"]],nb.periods,title="China Mention Shock")

ggsave("armax_plot1.png",plot=plot1,bg="white")
```

7.1.4 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)
```

```
resnames = c("Twitter Dummy", "Twitter Count", "Tariff", "Trade", "China")

#extract p-values directly from checkresiduals results
pvals <- data.frame(Model = resnames,
                    `Ljung-Box p-value` = c(
                      res1$p.value,
                      res2$p.value,
                      res3$p.value,
                      res4$p.value,
                      res5$p.value))

#table
knitr::kable(pvals, digits = 100, caption = "Full Timeframe Ljung-Box Test p-values")
```

(#tab:SPYresiduals table)Full Timeframe Ljung-Box Test p-values

Model	Ljung.Box.p.value
Twitter Dummy	0
Twitter Count	0
Tariff	0
Trade	0
China	0

7.2 First Term

```
#load final dataset
data = backup

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

#for interpretation
mean2 = mean(data$SPY_vol)
```

7.2.1 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)
```

7.2.2 SPY Residuals

```
res6 = checkresiduals(models[["First Term (1)"]], plot = FALSE)
res7 = checkresiduals(models[["First Term (2)"]], plot = FALSE)
res8 = checkresiduals(models[["First Term (3)"]], plot = FALSE)

pvals_new1 <- data.frame(
  Model = c("First Term Tariffs", "First Term Trade", "First Term China"),
  `Ljung-Box p-value` = c(
    res6$p.value,
    res7$p.value,
    res8$p.value))
```

7.3 Second Term

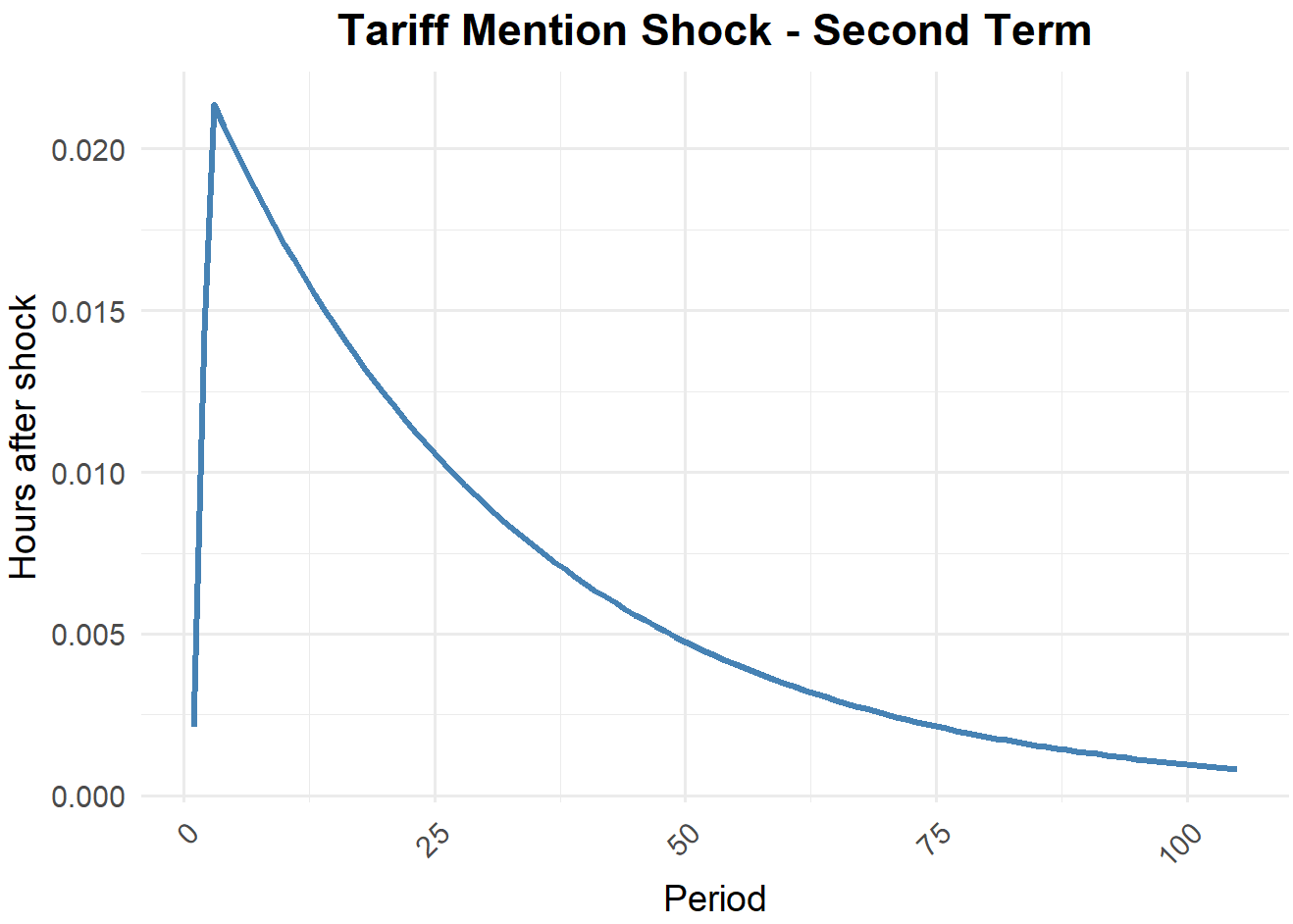
```
#load final dataset
data = backup

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

#for interpretation
mean3 = mean(data$SPY_vol)
```

7.3.1 SPY Models

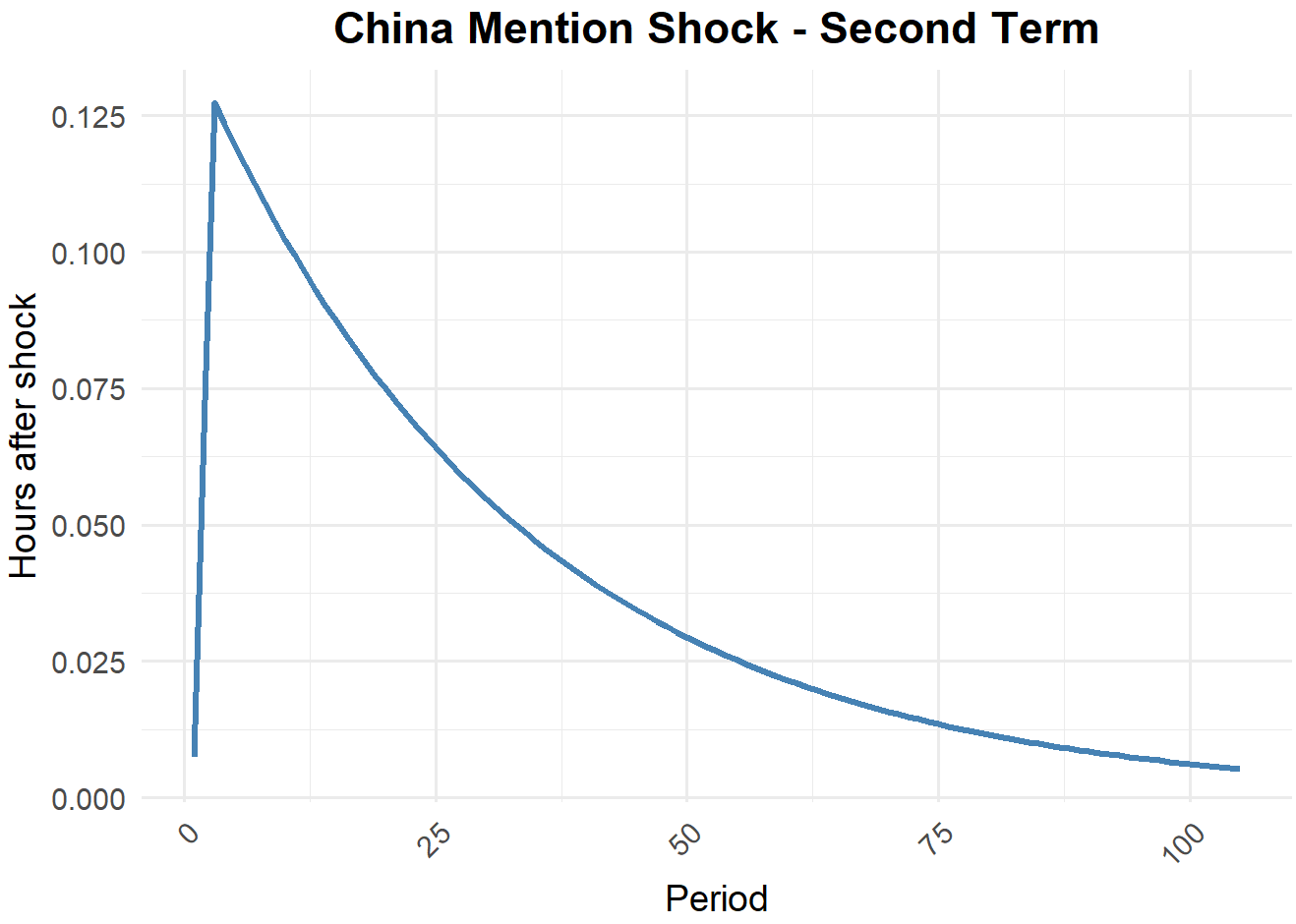
```
# ARMA-X(3,2,3) with Tariff Mentions as Exogenous
models[["Second Term (1)"]] <- armax(data$SPY_vol, xreg = data$tariff, latex = F,
                             nb.lags = 2, p = 1, q = 2)

# 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)
```

7.3.2 SPY IRFs

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

plot2 = irf.plot(models[["Second Term (1)"]],nb.periods,
                 title="Tariff Mention Shock - Second Term")
plot2
```




```
ggsave("armax_plot2.png",plot=plot2,bg="white")


plot3 = irf.plot(models[["Second Term (3)"]],nb.periods,
                 title="China Mention Shock - Second Term")
plot3
```



7.3.3 SPY Residuals

```
res9 = checkresiduals(models[["Second Term (1)"]], plot = FALSE)
res10 = checkresiduals(models[["Second Term (2)"]], plot = FALSE)
res11 = checkresiduals(models[["Second Term (3)"]], plot = FALSE)

pvals_new2 <- data.frame(
  Model = c("Second Term Tariffs", "Second Term Trade", "Second Term China"),
  `Ljung-Box p-value` = c(
    res9$p.value,
    res10$p.value,
    res11$p.value))

#combine with other term
pvals_combined <- rbind(pvals_new1, pvals_new2)
```

7.3.4 SPY Table (both terms)

```
library(texreg)

# Change model names (not sure if needed anymore)
#model_names <- c(
# "First Term (1)", "First Term (2)", "First Term (3)",
# "Second Term (1)", "Second Term (2)", "Second Term (3)"
#)
#names(models) <- model_names

# HTML coefficients names adjusted (is this correct?)
xnames_ordered <- c(
  "AR(1)", "AR(2)", "AR(3)",
  "MA(1)", "MA(2)", "MA(3)",
  "Constant",
  "Tariff<sub>t</sub>", "Tariff<sub>t-1</sub>", "Tariff<sub>t-2</sub>",
  "Trade<sub>t</sub>",
  "China<sub>t</sub>", "China<sub>t-1</sub>", "China<sub>t-2</sub>"
)

# Render as html -> need to render file to have it nice
htmlreg(
  models,
  custom.coef.names = xnames_ordered,
  custom.model.names = model_names,
  caption = "Split-Term ARMAX Models of Average Hourly Volatility",
  stars = c(0.001, 0.01, 0.05),
  doctype = FALSE
)
```

	First Term (1)	First Term (2)	First Term (3)	Second Term (1)	Second Term (2)	Second Term (3)
AR(1)	0.30***	0.29***	0.29***	0.97***	0.97***	0.97***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
AR(2)	0.14***	0.14***	0.14***			
	(0.02)	(0.02)	(0.02)			
AR(3)	0.55***	0.55***	0.55***			
	(0.02)	(0.02)	(0.02)			
MA(1)	0.19***	0.19***	0.19***	-0.70***	-0.69***	-0.72***
	(0.02)	(0.02)	(0.02)	(0.05)	(0.05)	(0.05)
MA(2)	-0.17***	-0.17***	-0.17***	-0.17***	-0.18***	-0.16***
	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)
MA(3)	-0.66***	-0.66***	-0.66***			
	(0.02)	(0.02)	(0.02)			
Constant	0.02*	0.02*	0.02*	0.12	0.14	0.10
	(0.01)	(0.01)	(0.01)	(0.08)	(0.08)	(0.07)
$Tariff_t$	0.00			0.00		
	(0.00)			(0.01)		
$Tariff_{t-1}$		0.00**			-0.01	
		(0.00)			(0.03)	
$Tariff_{t-2}$			0.00**			0.02
			(0.00)			(0.03)
$Trade_t$				0.03**		

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

	First Term (1)	First Term (2)	First Term (3)	Second Term (1)	Second Term (2)	Second Term (3)
				(0.01)		
$China_t$				0.02		
				(0.01)		
$China_{t-1}$						0.15***
						(0.03)
$China_{t-2}$						0.13***
						(0.03)
AIC	-28604.66	-28610.23	-28613.17	633.48	638.21	610.21
AICc	-28604.63	-28610.20	-28613.14	633.77	638.37	610.50
BIC	-28542.92	-28548.49	-28551.43	667.45	663.71	644.18
Log Likelihood	14311.33	14314.11	14315.58	-308.74	-313.10	-297.11
Num. obs.	7042	7042	7042	516	518	516

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

Split-Term ARMAX Models of Average Hourly Volatility

7.4 Descriptive Stats

```
means <- data.frame(
  Model = c("Full Time Mean", "First Term Mean", "Second Term Mean"),
  `SPY Volatility Mean` = c(
    mean1,
    mean2,
    mean3))

table4 = knitr::kable(means, digits = 6, format="latex",
             caption = "Summary Statistics of SPY Volatility")

table4
```