

# Final\_VAR

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## Dummy

```
y = cbind(Vdata$dummy, Vdata$SPY_vol)
colnames(y)[1:2] <- c("dummy", "vol")
est.VAR <- VAR(y,p=6)

#extract results
mod_vol = est.VAR$varresult$vol
f = formula(mod_vol)
d = model.frame(mod_vol)
lm_clean = lm(f, data= d)

#apply Newey-West
nw_vcov = NeweyWest(lm_clean, lag=6)
nw_se = sqrt(diag(nw_vcov))

#t-stats
coef = coef(lm_clean)
t_stat = coef/nw_se

#recalculate p-values
robust = 2*(1-pt(abs(t_stat), df = df.residual(lm_clean)))

#Recreate a Robust Omega Matrix
U = residuals(est.VAR)
T = nrow(U)
L = 6 #number of lag
Omega = matrix(0, ncol(U), ncol(U))
for(l in 0:L) {
  weight = 1 - l/(L+1)
  Gamma_l_ = t(U[(l+1):T, , drop=FALSE]) %*% U[1:(T-l), , drop=FALSE] /T
  if (l == 0){
    Omega = Omega + Gamma_l_
  } else {
    Omega = Omega + weight*(Gamma_l_ + t(Gamma_l_))
  }
}

#make the B matrix
loss <- function(param){
  #Define the restriction
  B <- matrix(c(param[1], param[2], 0, param[3]), ncol = 2)

  #Make BB' approximatively equal to omega
  X <- Omega - B %*% t(B)

  #loss function
  loss <- sum(X^2)
  return(loss)
}

res.opt <- optim(c(1, 0, 1), loss, method = "BFGS")
```

```
B.hat <- matrix(c(res.opt$par[1], res.opt$par[2], 0, res.opt$par[3]), ncol = 2)
```

```
nb.sim = 7*7
```

```
#get back the coefficient of est.VAR
```

```
phi <- Acoef(est.VAR)
```

```
PHI = make.PHI(phi)
```

```
#take the constant
```

```
constant <- sapply(est.VAR$varresult, function(eq) coef(eq)["const"])
```

```
c=as.matrix(constant)
```

```
#Simulate the IRF
```

```
p <- length(phi)
```

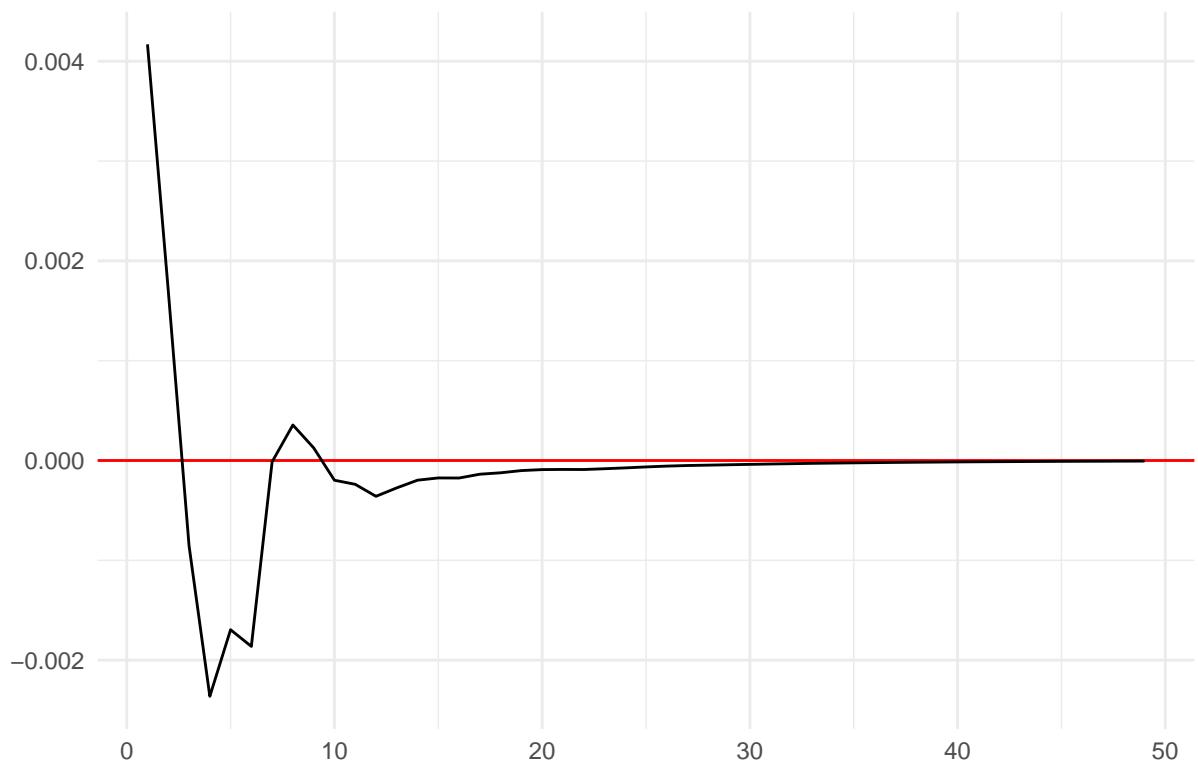
```
n <- dim(phi)[1])[1]
```

```
Y <- simul.VAR(c=c, Phi = phi, B = B.hat, nb.sim, y0.star=rep(0, n*p),  
               indic.IRF = 1, u.shock = c(1,0))
```

```
Yd = data.frame(  
  period = 1:nrow(Y),  
  response = Y[,2])
```

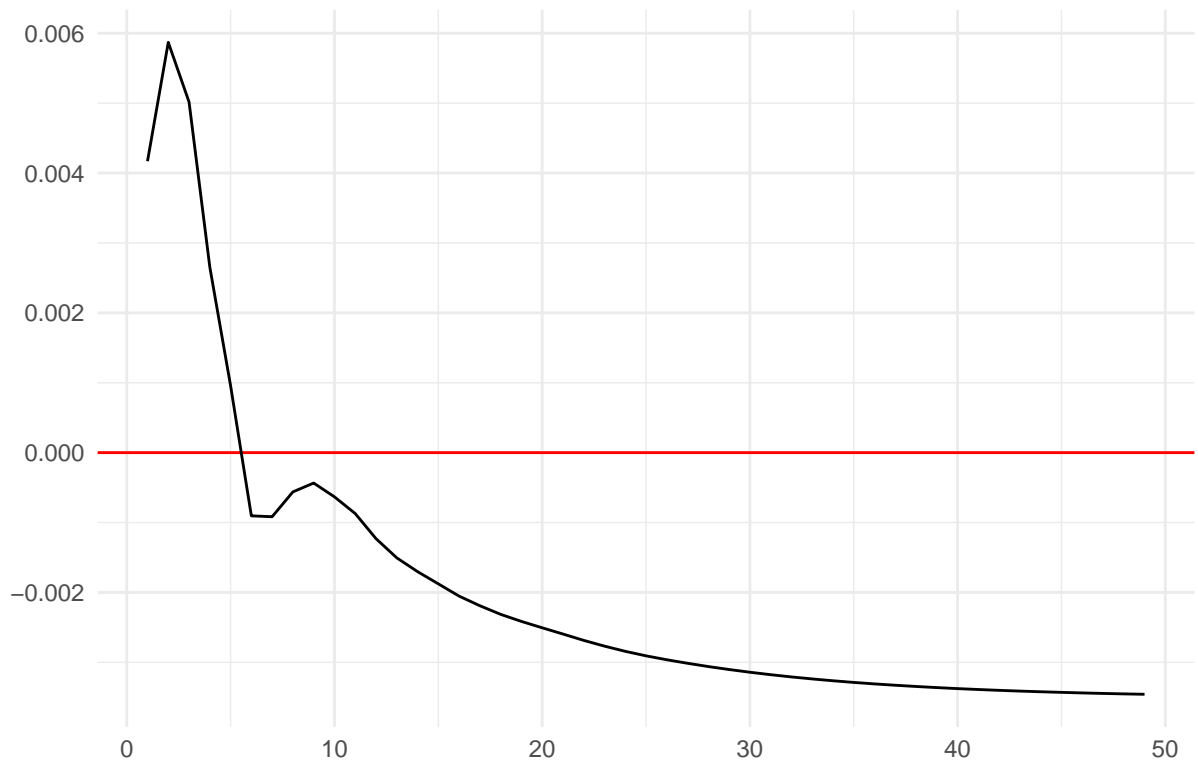
```
ggplot(Yd, aes(x=period, y=response)) +  
  geom_hline(yintercept = 0, color="red") +  
  geom_line() +  
  theme_light() +  
  ggtitle("S&P IRF of Dummy on Volatility")+  
  ylab("")+  
  xlab("") +  
  theme_minimal()
```

S&P IRF of Dummy on Volatility



```
ggplot(Yd,aes(x=period, y=cumsum(response))) +  
  geom_hline(yintercept = 0, color="red") +  
  geom_line() +  
  theme_light() +  
  ggtitle("S&P Cumulaltive IRF of Dummy on Volatility") +  
  ylab("")+  
  xlab("") +  
  theme_minimal()
```

### S&P Cumulative IRF of Dummy on Volatility



N

```

y2 = cbind(Vdata$N, Vdata$SPY_vol)
colnames(y2)[1:2] <- c("N", "vol")
est.VAR2 <- VAR(y2,p=6)

#extract results
mod_vol2 = est.VAR2$varresult$vol
f2 = formula(mod_vol2)
d2 = model.frame(mod_vol2)
lm_clean2 = lm(f2, data= d2)

#apply Newey-West
nw_vcov2 = NeweyWest(lm_clean2, lag=6)
nw_se2 = sqrt(diag(nw_vcov2))

#t-stats
coef2 = coef(lm_clean2)
t_stat2 = coef2/nw_se2

#recalculate p-values
robust2 = 2*(1-pt(abs(t_stat2), df = df.residual(lm_clean2)))

```

## Tariff

```
y3 = cbind(Vdata$tariff, Vdata$SPY_vol)
colnames(y3)[1:2] <- c("tariff", "vol")
est.VAR3 <- VAR(y3,p=6)

#extract results
mod_vol3 = est.VAR3$varresult$vol
f3 = formula(mod_vol3)
d3 = model.frame(mod_vol3)
lm_clean3 = lm(f3, data= d3)

#apply Newey-West
nw_vcov3 = NeweyWest(lm_clean3, lag=6)
nw_se3 = sqrt(diag(nw_vcov3))

#t-stats
coef3 = coef(lm_clean3)
t_stat3 = coef3/nw_se3

#recalculate p-values
robust3 = 2*(1-pt(abs(t_stat3), df = df.residual(lm_clean3)))

#Recreate a Robust Omega Matrix
U3 = residuals(est.VAR3)
T3 = nrow(U3)
Omega3 = matrix(0, ncol(U3), ncol(U3))
for(l in 0:L) {
  weight = 1 - l/(L+1)
  Gamma_l_3 = t(U3[(l+1):T3, , drop=FALSE]) %*% U3[1:(T3-l), , drop=FALSE] /T3
  if (l == 0){
    Omega3 = Omega3 + Gamma_l_3
  } else {
    Omega3 = Omega3 + weight*(Gamma_l_3 + t(Gamma_l_3))
  }
}

#make the B matrix
loss3 <- function(param3){
  #Define the restriction
  B3 <- matrix(c(param3[1], param3[2], 0, param3[3]), ncol = 2)

  #Make BB' approximatively equal to omega
  X3 <- Omega3 - B3 %*% t(B3)

  #loss function
  loss3 <- sum(X3^2)
  return(loss3)
}

res.opt3 <- optim(c(1, 0, 1), loss3, method = "BFGS")
B.hat3 <- matrix(c(res.opt3$par[1], res.opt3$par[2], 0, res.opt3$par[3]), ncol = 2)
```

```

#get back the coefficient of est.VAR
phi3 <- Acoef(est.VAR3)
PHI3 = make.PHI(phi3)

#take the constant
constant3 <- sapply(est.VAR3$varresult, function(eq) coef(eq)["const"])
c3=as.matrix(constant3)

#Simulate the IRF
p3 <- length(phi3)
n3 <- dim(phi3)[[1]][1]

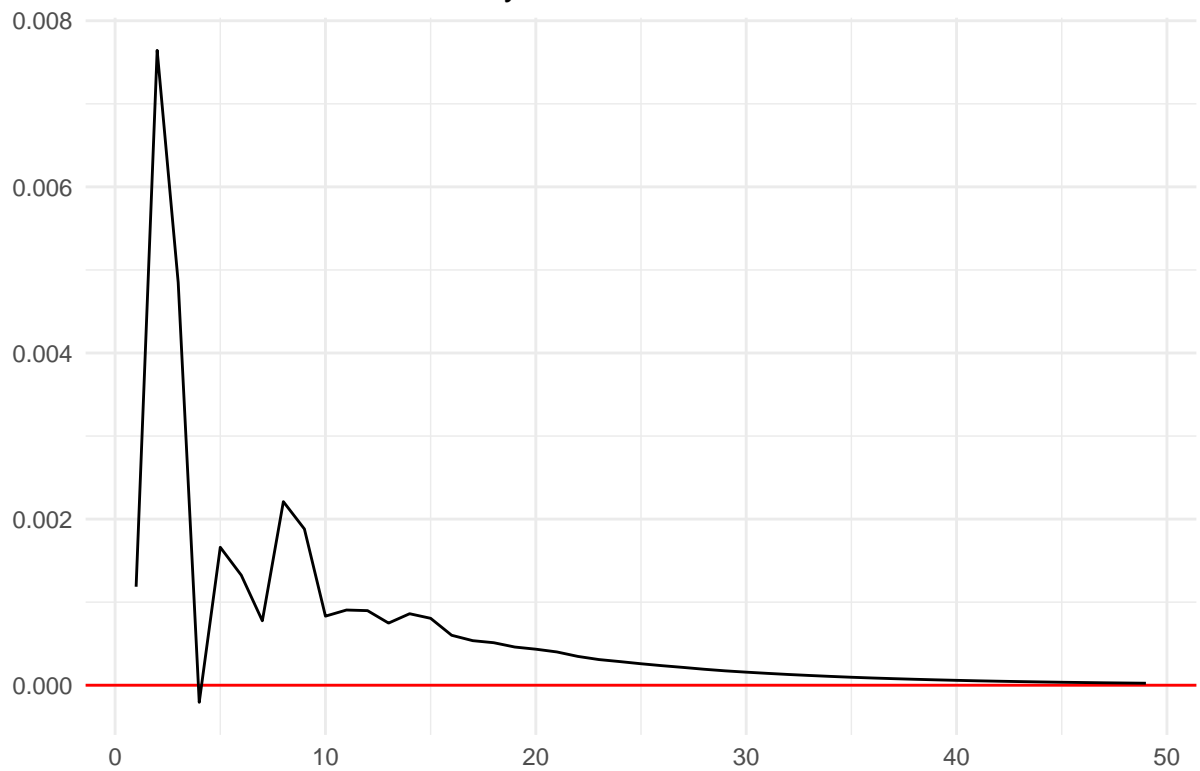
Y3 <- simul.VAR(c=c3, Phi = phi3, B = B.hat3, nb.sim ,y0.star=rep(0, n3*p3),
               indic.IRF = 1, u.shock = c(1,0))

#Plot the IRF
Yd3 = data.frame(
  period = 1:nrow(Y3),
  response = Y3[,2])

ggplot(Yd3,aes(x=period, y=response)) +
  geom_hline(yintercept = 0, color="red") +
  geom_line() +
  theme_light() +
  ggtitle("S&P IRF of tariff on Volatility") +
  ylab("")+
  xlab("") +
  theme_minimal()

```

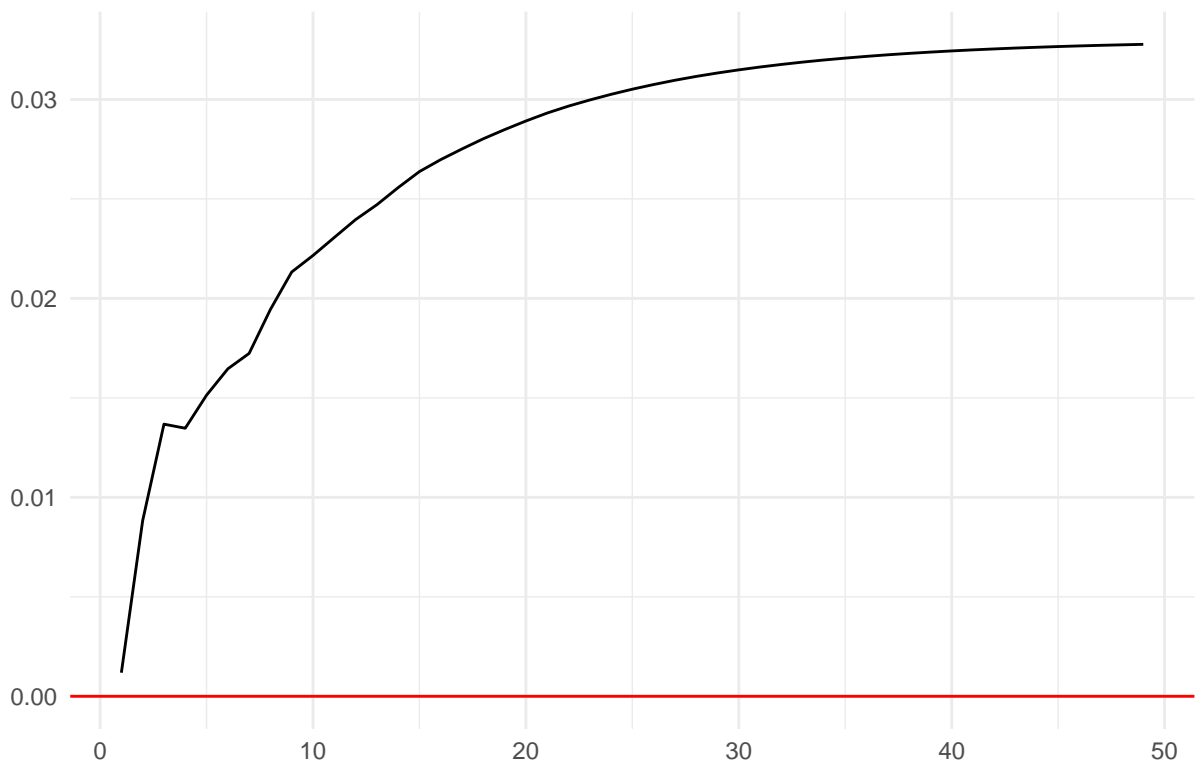
S&P IRF of tariff on Volatility



```
ggplot(Yd3,aes(x=period, y=cumsum(response))) +  
  geom_hline(yintercept = 0, color="red") +  
  geom_line() +  
  theme_light() +  
  ggtitle("S&P Cumulalitive IRF of tariff on Volatility") +  
  ylab("")+  
  xlab("") +  
  theme_minimal()
```



### S&P Cumulative IRF of tariff on Volatility



### Trade

```
y4 = cbind(Vdata$trade, Vdata$SPY_vol)
colnames(y4)[1:2] <- c("trade", "vol")
est.VAR4 <- VAR(y4,p=6)

#extract results
mod_vol4 = est.VAR4$varresult$vol
f4 = formula(mod_vol4)
d4 = model.frame(mod_vol4)
lm_clean4 = lm(f4, data= d4)

#apply Newey-West
nw_vcov4 = NeweyWest(lm_clean4, lag=6)
nw_se4 = sqrt(diag(nw_vcov4))

#t-stats
coef4 = coef(lm_clean4)
t_stat4 = coef4/nw_se4

#recalculate p-values
robust4 = 2*(1-pt(abs(t_stat4), df = df.residual(lm_clean4)))
```

## China

```
ychina = cbind(Vdata$china, Vdata$SPY_vol)
colnames(ychina)[1:2] <- c("china", "vol")
est.VARchina <- VAR(ychina,p=6)

#extract results
mod_volchina = est.VARchina$varresult$vol
fchina = formula(mod_volchina)
dchina = model.frame(mod_volchina)
lm_cleanchina = lm(fchina, data= dchina)

#apply Newey-West
nw_vcovchina = NeweyWest(lm_cleanchina, lag=6)
nw_sechina = sqrt(diag(nw_vcovchina))

#t-stats
coefchina = coef(lm_cleanchina)
t_statchina = coefchina/nw_sechina

#recalculate p-values
robustchina = 2*(1-pt(abs(t_statchina), df = df.residual(lm_cleanchina)))

dt_t = d %>%
  rename(X.11 = dummy.11,
         X.12 = dummy.12,
         X.13 = dummy.13,
         X.14 = dummy.14,
         X.15 = dummy.15,
         X.16 = dummy.16)

f_t <- as.formula("y ~ -1 + vol.11 + vol.12 + vol.13 + vol.14 + vol.15 + vol.16 +
                  X.11 + X.12 + X.13 + X.14 + X.15 + X.16 + const")
model <- lm(f_t, data = dt_t)

dt_t2 = d2 %>%
  rename(X.11 = N.11,
         X.12 = N.12,
         X.13 = N.13,
         X.14 = N.14,
         X.15 = N.15,
         X.16 = N.16)

f_t2 <- as.formula("y ~ -1 + vol.11 + vol.12 + vol.13 + vol.14 + vol.15 + vol.16 +
                  X.11 + X.12 + X.13 + X.14 + X.15 + X.16 + const")
model2 <- lm(f_t2, data = dt_t2)

dt_t3 = d3 %>%
  rename(X.11 = tariff.11,
```

```

X.12 = tariff.12,
X.13 = tariff.13,
X.14 = tariff.14,
X.15 = tariff.15,
X.16 = tariff.16)

f_t3 <- as.formula("y ~ -1 + vol.11 + vol.12 + vol.13 + vol.14 + vol.15 + vol.16 +
                  X.11 + X.12 + X.13 + X.14 + X.15 + X.16 + const")
model3 <- lm(f_t3, data = dt_t3)

dt_t4 = d4 %>%
  rename(X.11 = trade.11,
         X.12 = trade.12,
         X.13 = trade.13,
         X.14 = trade.14,
         X.15 = trade.15,
         X.16 = trade.16)

f_t4 <- as.formula("y ~ -1 + vol.11 + vol.12 + vol.13 + vol.14 + vol.15 + vol.16 +
                  X.11 + X.12 + X.13 + X.14 + X.15 + X.16 + const")
model4 <- lm(f_t4, data = dt_t4)

dt_tchina = dchina %>%
  rename(X.11 = china.11,
         X.12 = china.12,
         X.13 = china.13,
         X.14 = china.14,
         X.15 = china.15,
         X.16 = china.16)

f_tchina <- as.formula("y ~ -1 + vol.11 + vol.12 + vol.13 + vol.14 + vol.15 + vol.16 +
                      X.11 + X.12 + X.13 + X.14 + X.15 + X.16 + const")
modelchina <- lm(f_tchina, data = dt_tchina)

nw_se_t <- sqrt(diag(sandwich::NeweyWest(model, lag = 6)))
nw_se2_t <- sqrt(diag(sandwich::NeweyWest(model2, lag = 6)))
nw_se3_t <- sqrt(diag(sandwich::NeweyWest(model3, lag = 6)))
nw_se4_t <- sqrt(diag(sandwich::NeweyWest(model4, lag = 6)))
nw_sechina_t <- sqrt(diag(sandwich::NeweyWest(modelchina, lag = 6)))

robust_t <- 2 * (1-pt(abs(coef(model) / nw_se_t), df = df.residual(model)))
robust2_t <- 2 * (1-pt(abs(coef(model2) / nw_se2_t), df = df.residual(model2)))
robust3_t <- 2 * (1-pt(abs(coef(model3) / nw_se3_t), df = df.residual(model3)))
robust4_t <- 2 * (1-pt(abs(coef(model4) / nw_se4_t), df = df.residual(model4)))

```

```

robustchina_t <- 2 * (1-pt(abs(coef(modelchina) / nw_sechina_t), df = df.residual(modelchina)))

nw_se_t      <- nw_se_t[names(coef(model))]
robust_t      <- robust_t[names(coef(model))]
nw_se2_t     <- nw_se2_t[names(coef(model2))]
robust2_t     <- robust2_t[names(coef(model2))]
nw_se3_t     <- nw_se3_t[names(coef(model3))]
robust3_t     <- robust3_t[names(coef(model3))]
nw_se4_t     <- nw_se4_t[names(coef(model4))]
robust4_t     <- robust4_t[names(coef(model4))]
nw_sechina_t <- nw_sechina_t[names(coef(modelchina))]
robustchina_t <- robustchina_t[names(coef(modelchina))]

# Create list for models
models_list <- list(model, model2, model3, model4, modelchina)

# Create list for SE robustes
robust_ses <- list(nw_se_t, nw_se2_t, nw_se3_t, nw_se4_t, nw_sechina_t)

# Create list for p-value
robust_pvals <- list(robust_t, robust2_t, robust3_t, robust4_t, robustchina_t)

# Name of Variables
custom_names <- list(
  "vol.11" = "$AHV_{t-1}$",
  "vol.12" = "$AHV_{t-2}$",
  "vol.13" = "$AHV_{t-3}$",
  "vol.14" = "$AHV_{t-4}$",
  "vol.15" = "$AHV_{t-5}$",
  "vol.16" = "$AHV_{t-6}$",
  "X.11" = "$X_{t-1}$",
  "X.12" = "$X_{t-2}$",
  "X.13" = "$X_{t-3}$",
  "X.14" = "$X_{t-4}$",
  "X.15" = "$X_{t-5}$",
  "X.16" = "$X_{t-6}$",
  "const" = "Constant"
)

# Generate table
table_texreg <- texreg(
  l = models_list,
  override.se = robust_ses,
  custom.coef.map = custom_names,
  override.pvalues = robust_pvals,
  custom.model.names = c("TweetDummy", "TweetCount", "Tariff", "Trade", "China"),
  caption = "VAR Models of Average Hourly Volatility",
  label = "tab:VAR_Second_Term",

```

Table 1: VAR Models of Average Hourly Volatility

	TweetDummy	TweetCount	Tariff	Trade	China
$AHV_{t-1}$	0.344511*** (0.103790)	0.345011*** (0.104492)	0.342081*** (0.098665)	0.346107*** (0.101918)	0.344512*** (0.097994)
$AHV_{t-2}$	0.023714 (0.042739)	0.023575 (0.043816)	0.027464 (0.039912)	0.022949 (0.041538)	0.024149 (0.043585)
$AHV_{t-3}$	0.082941*** (0.007496)	0.082525*** (0.008145)	0.075380*** (0.011695)	0.081148*** (0.008258)	0.081646*** (0.009192)
$AHV_{t-4}$	0.096948 (0.059298)	0.096739 (0.060827)	0.088777 (0.063948)	0.095797 (0.057082)	0.094919 (0.058821)
$AHV_{t-5}$	0.022887*** (0.006876)	0.022593** (0.006952)	0.026049*** (0.006815)	0.023502** (0.007162)	0.022961** (0.007678)
$AHV_{t-6}$	0.164034*** (0.047379)	0.164442*** (0.049763)	0.167546*** (0.049876)	0.165323*** (0.049319)	0.166695** (0.054194)
$X_{t-1}$	0.000083 (0.000201)	0.000045 (0.000037)	0.019718 (0.018964)	0.003399 (0.003747)	0.006729 (0.006694)
$X_{t-2}$	-0.000473*** (0.000071)	-0.000116*** (0.000023)	0.005269 (0.004124)	0.005600 (0.004809)	0.002778 (0.004067)
$X_{t-3}$	-0.000804*** (0.000088)	-0.000213*** (0.000028)	-0.007797 (0.005183)	-0.003904* (0.001726)	-0.004652* (0.002066)
$X_{t-4}$	-0.000546*** (0.000088)	-0.000147*** (0.000021)	0.002275 (0.002454)	0.000725 (0.003458)	-0.002442* (0.001084)
$X_{t-5}$	-0.000579*** (0.000147)	-0.000119** (0.000041)	-0.001145 (0.002634)	-0.002363 (0.001901)	-0.000607 (0.000970)
$X_{t-6}$	-0.000099 (0.000101)	0.000000 (0.000028)	-0.002750 (0.002450)	-0.001543 (0.001228)	0.000596 (0.000981)
Constant	0.008726*** (0.001609)	0.007587*** (0.001578)	0.005770*** (0.001405)	0.005939*** (0.001536)	0.005857*** (0.001612)
Shock (IRF)	0.004171	0.003061	0.001189	0.000215	0.001937
R <sup>2</sup>	0.325745	0.325324	0.331931	0.325134	0.326344
Adj. R <sup>2</sup>	0.325306	0.324885	0.331496	0.324695	0.325905
Num. obs.	19965	19965	19965	19965	19965

*This table displays VAR regression with only two variables : AHV and X regressor. The column names represent the X variable for the selected model.*

```
caption.above = TRUE,
digits = 6,
custom.gof.rows = list("Shock (IRF)" = c(0.0041713, 0.003061, 0.001189, 0.000215, 0.001937)),
custom.note = "\\parbox[t]{0.9\\textwidth}{\\small\\textit{This table displays VAR regression with on}}
)
```

```
# print
table_texreg
```

```
# First and Second Mandate
```

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

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

## First Term

### Dummy

```
y_f_d = cbind(Vdata_f$dummy, Vdata_f$SPY_vol)
colnames(y_f_d)[1:2] <- c("dummy", "vol")
est.VAR_f_d <- VAR(y_f_d,p=6)

#extract results
mod_vol_f_d = est.VAR_f_d$varresult$vol
f_f_d = formula(mod_vol_f_d)
d_f_d = model.frame(mod_vol_f_d)
lm_clean_f_d = lm(f_f_d, data= d_f_d)

#apply Newey-West
nw_vcov_f_d = NeweyWest(lm_clean_f_d, lag=6)
nw_se_f_d = sqrt(diag(nw_vcov_f_d))

#t-stats
coef_f_d = coef(lm_clean_f_d)
t_stat_f_d = coef_f_d/nw_se_f_d

#recalculate p-values
robust_f_d = 2*(1-pt(abs(t_stat_f_d), df = df.residual(lm_clean_f_d)))
```

## N

```
y_f_n = cbind(Vdata_f$N, Vdata_f$SPY_vol)
colnames(y_f_n)[1:2] <- c("N", "vol")
est.VAR_f_n <- VAR(y_f_n,p=6)

#extract results
mod_vol_f_n = est.VAR_f_n$varresult$vol
f_f_n = formula(mod_vol_f_n)
d_f_n = model.frame(mod_vol_f_n)
lm_clean_f_n = lm(f_f_n, data= d_f_n)

#apply Newey-West
nw_vcov_f_n = NeweyWest(lm_clean_f_n, lag=6)
nw_se_f_n = sqrt(diag(nw_vcov_f_n))

#t-stats
coef_f_n = coef(lm_clean_f_n)
t_stat_f_n = coef_f_n/nw_se_f_n
```

```
#recalculate p-values
robust_f_n = 2*(1-pt(abs(t_stat_f_n), df = df.residual(lm_clean_f_n)))
```

## Tariff

```
y_f_ta = cbind(Vdata_f$tariff, Vdata_f$SPY_vol)
colnames(y_f_ta)[1:2] <- c("tariff", "vol")
est.VAR_f_ta <- VAR(y_f_ta,p=6)

#extract results
mod_vol_f_ta = est.VAR_f_ta$varresult$vol
f_f_ta = formula(mod_vol_f_ta)
d_f_ta = model.frame(mod_vol_f_ta)
lm_clean_f_ta = lm(f_f_ta, data= d_f_ta)

#apply Newey-West
nw_vcov_f_ta = NeweyWest(lm_clean_f_ta, lag=6)
nw_se_f_ta = sqrt(diag(nw_vcov_f_ta))

#t-stats
coef_f_ta = coef(lm_clean_f_ta)
t_stat_f_ta = coef_f_ta/nw_se_f_ta

#recalculate p-values
robust_f_ta = 2*(1-pt(abs(t_stat_f_ta), df = df.residual(lm_clean_f_ta)))
```

## Trade

```
y_f_tr = cbind(Vdata_f$trade, Vdata_f$SPY_vol)
colnames(y_f_tr)[1:2] <- c("trade", "vol")
est.VAR_f_tr <- VAR(y_f_tr,p=6)

#extract results
mod_vol_f_tr = est.VAR_f_tr$varresult$vol
f_f_tr = formula(mod_vol_f_tr)
d_f_tr = model.frame(mod_vol_f_tr)
lm_clean_f_tr = lm(f_f_tr, data= d_f_tr)

#apply Newey-West
nw_vcov_f_tr = NeweyWest(lm_clean_f_tr, lag=6)
nw_se_f_tr = sqrt(diag(nw_vcov_f_tr))

#t-stats
coef_f_tr = coef(lm_clean_f_tr)
t_stat_f_tr = coef_f_tr/nw_se_f_tr

#recalculate p-values
robust_f_tr = 2*(1-pt(abs(t_stat_f_tr), df = df.residual(lm_clean_f_tr)))
```

## China

```
y_f_ch = cbind(Vdata_f$china, Vdata_f$SPY_vol)
colnames(y_f_ch)[1:2] <- c("china", "vol")
est.VAR_f_ch <- VAR(y_f_ch,p=6)

#extract results
mod_vol_f_ch = est.VAR_f_ch$varresult$vol
f_f_ch = formula(mod_vol_f_ch)
d_f_ch = model.frame(mod_vol_f_ch)
lm_clean_f_ch = lm(f_f_ch, data= d_f_ch)

#apply Newey-West
nw_vcov_f_ch = NeweyWest(lm_clean_f_ch, lag=6)
nw_se_f_ch = sqrt(diag(nw_vcov_f_ch))

#t-stats
coef_f_ch = coef(lm_clean_f_ch)
t_stat_f_ch = coef_f_ch/nw_se_f_ch

#recalculate p-values
robust_f_ch = 2*(1-pt(abs(t_stat_f_ch), df = df.residual(lm_clean_f_ch)))
```

## Second Term

### Dummy

```
y_s_d = cbind(Vdata_s$dummy, Vdata_s$SPY_vol)
colnames(y_s_d)[1:2] <- c("dummy", "vol")
est.VAR_s_d <- VAR(y_s_d,p=6)

#extract results
mod_vol_s_d = est.VAR_s_d$varresult$vol
f_s_d = formula(mod_vol_s_d)
d_s_d = model.frame(mod_vol_s_d)
lm_clean_s_d = lm(f_s_d, data= d_s_d)

#apply Newey-West
nw_vcov_s_d = NeweyWest(lm_clean_s_d, lag=6)
nw_se_s_d = sqrt(diag(nw_vcov_s_d))

#t-stats
coef_s_d = coef(lm_clean_s_d)
t_stat_s_d = coef_s_d/nw_se_s_d

#recalculate p-values
robust_s_d = 2*(1-pt(abs(t_stat_s_d), df = df.residual(lm_clean_s_d)))
```



## N

```
y_s_n = cbind(Vdata_s$N, Vdata_s$SPY_vol)
colnames(y_s_n)[1:2] <- c("N", "vol")
est.VAR_s_n <- VAR(y_s_n,p=6)

#extract results
mod_vol_s_n = est.VAR_s_n$varresult$vol
f_s_n = formula(mod_vol_s_n)
d_s_n = model.frame(mod_vol_s_n)
lm_clean_s_n = lm(f_s_n, data= d_s_n)

#apply Newey-West
nw_vcov_s_n = NeweyWest(lm_clean_s_n, lag=6)
nw_se_s_n = sqrt(diag(nw_vcov_s_n))

#t-stats
coef_s_n = coef(lm_clean_s_n)
t_stat_s_n = coef_s_n/nw_se_s_n

#recalculate p-values
robust_s_n = 2*(1-pt(abs(t_stat_s_n), df = df.residual(lm_clean_s_n)))
```

## Tariff

```
y_s_ta = cbind(Vdata_s$tariff, Vdata_s$SPY_vol)
colnames(y_s_ta)[1:2] <- c("tariff", "vol")
est.VAR_s_ta <- VAR(y_s_ta,p=6)

#extract results
mod_vol_s_ta = est.VAR_s_ta$varresult$vol
f_s_ta = formula(mod_vol_s_ta)
d_s_ta = model.frame(mod_vol_s_ta)
lm_clean_s_ta = lm(f_s_ta, data= d_s_ta)

#apply Newey-West
nw_vcov_s_ta = NeweyWest(lm_clean_s_ta, lag=6)
nw_se_s_ta = sqrt(diag(nw_vcov_s_ta))

#t-stats
coef_s_ta = coef(lm_clean_s_ta)
t_stat_s_ta = coef_s_ta/nw_se_s_ta

#recalculate p-values
robust_s_ta = 2*(1-pt(abs(t_stat_s_ta), df = df.residual(lm_clean_s_ta)))
```

## Trade

```

y_s_tr = cbind(Vdata_s$trade, Vdata_s$SPY_vol)
colnames(y_s_tr)[1:2] <- c("trade", "vol")
est.VAR_s_tr <- VAR(y_s_tr,p=6)

#extract results
mod_vol_s_tr = est.VAR_s_tr$varresult$vol
f_s_tr = formula(mod_vol_s_tr)
d_s_tr = model.frame(mod_vol_s_tr)
lm_clean_s_tr = lm(f_s_tr, data= d_s_tr)

#apply Newey-West
nw_vcov_s_tr = NeweyWest(lm_clean_s_tr, lag=6)
nw_se_s_tr = sqrt(diag(nw_vcov_s_tr))

#t-stats
coef_s_tr = coef(lm_clean_s_tr)
t_stat_s_tr = coef_s_tr/nw_se_s_tr

#recalculate p-values
robust_s_tr = 2*(1-pt(abs(t_stat_s_tr), df = df.residual(lm_clean_s_tr)))

```

## China

```

y_s_ch = cbind(Vdata_s$china, Vdata_s$SPY_vol)
colnames(y_s_ch)[1:2] <- c("china", "vol")
est.VAR_s_ch <- VAR(y_s_ch,p=6)

#extract results
mod_vol_s_ch = est.VAR_s_ch$varresult$vol
f_s_ch = formula(mod_vol_s_ch)
d_s_ch = model.frame(mod_vol_s_ch)
lm_clean_s_ch = lm(f_s_ch, data= d_s_ch)

#apply Newey-West
nw_vcov_s_ch = NeweyWest(lm_clean_s_ch, lag=6)
nw_se_s_ch = sqrt(diag(nw_vcov_s_ch))

#t-stats
coef_s_ch = coef(lm_clean_s_ch)
t_stat_s_ch = coef_s_ch/nw_se_s_ch

#recalculate p-values
robust_s_ch = 2*(1-pt(abs(t_stat_s_ch), df = df.residual(lm_clean_s_ch)))

#Construct the Robust Omega Matrix
U_s_ch = residuals(est.VAR_s_ch)
T_s_ch = nrow(U_s_ch)
Omega_s_ch = matrix(0, ncol(U_s_ch), ncol(U_s_ch))
for(l in 0:L) {
  weight = 1 - 1/(L+1)
  Gamma_l__s_ch = t(U_s_ch[(l+1):T_s_ch, , drop=FALSE]) %*% U_s_ch[1:(T_s_ch-l), , drop=FALSE] /T_s_ch
}

```

```

if (l == 0){
  Omega_s_ch = Omega_s_ch + Gamma_l__s_ch
} else {
  Omega_s_ch = Omega_s_ch + weight*(Gamma_l__s_ch + t(Gamma_l__s_ch))
}
}

#make the B matrix
loss_s_ch <- function(param_s_ch){
  #Define the restriction
  B_s_ch <- matrix(c(param_s_ch[1], param_s_ch[2], 0, param_s_ch[3]), ncol = 2)

  #Make BB' approximatively equal to omega
  X_s_ch <- Omega_s_ch - B_s_ch %*% t(B_s_ch)

  #loss function
  loss_s_ch <- sum(X_s_ch^2)
  return(loss_s_ch)
}

res.opt_s_ch <- optim(c(1, 0, 1), loss_s_ch, method = "BFGS")
B.hat_s_ch <- matrix(c(res.opt_s_ch$par[1], res.opt_s_ch$par[2], 0, res.opt_s_ch$par[3]), ncol = 2)

#get back the coefficient of est.VAR
phi_s_ch <- Acoef(est.VAR_s_ch)
PHI_s_ch = make.PHI(phi_s_ch)

#take the constant
constant_s_ch <- sapply(est.VAR_s_ch$varresult, function(eq) coef(eq)["const"])
c_s_ch=as.matrix(constant_s_ch)

#Simulate the IRF
p_s_ch <- length(phi_s_ch)
n_s_ch <- dim(phi_s_ch)[1][1]

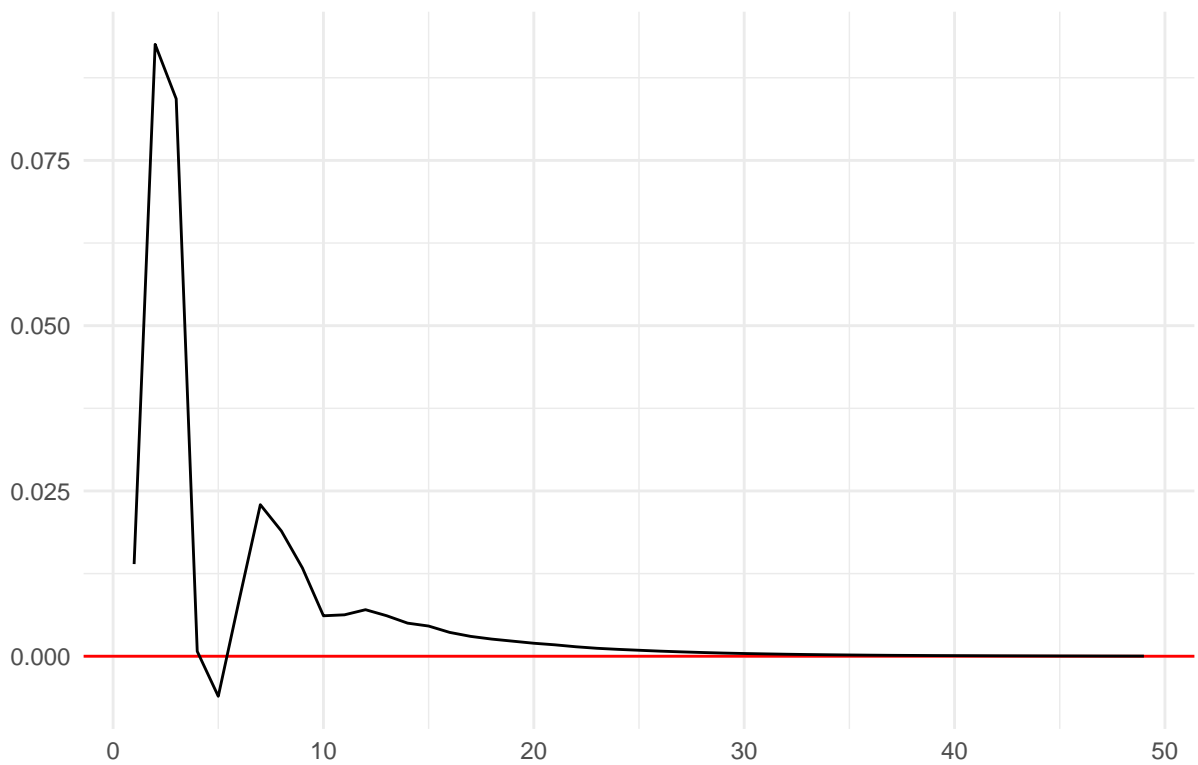
Y_s_ch <- simul.VAR(c=c_s_ch, Phi = phi_s_ch, B = B.hat_s_ch, nb.sim ,y0.star=rep(0, n_s_ch*p_s_ch),
  indic.IRF = 1, u.shock = c(1,0))

#Plot the IRF
Yd_s_ch = data.frame(
  period = 1:nrow(Y_s_ch),
  response = Y_s_ch[,2])

ggplot(Yd_s_ch,aes(x=period, y=response)) +
  geom_hline(yintercept = 0, color="red") +
  geom_line() +
  theme_light() +
  ggtitle("S&P IRF of Second Term China on Volatility") +
  ylab("")+
  xlab("") +
  theme_minimal()

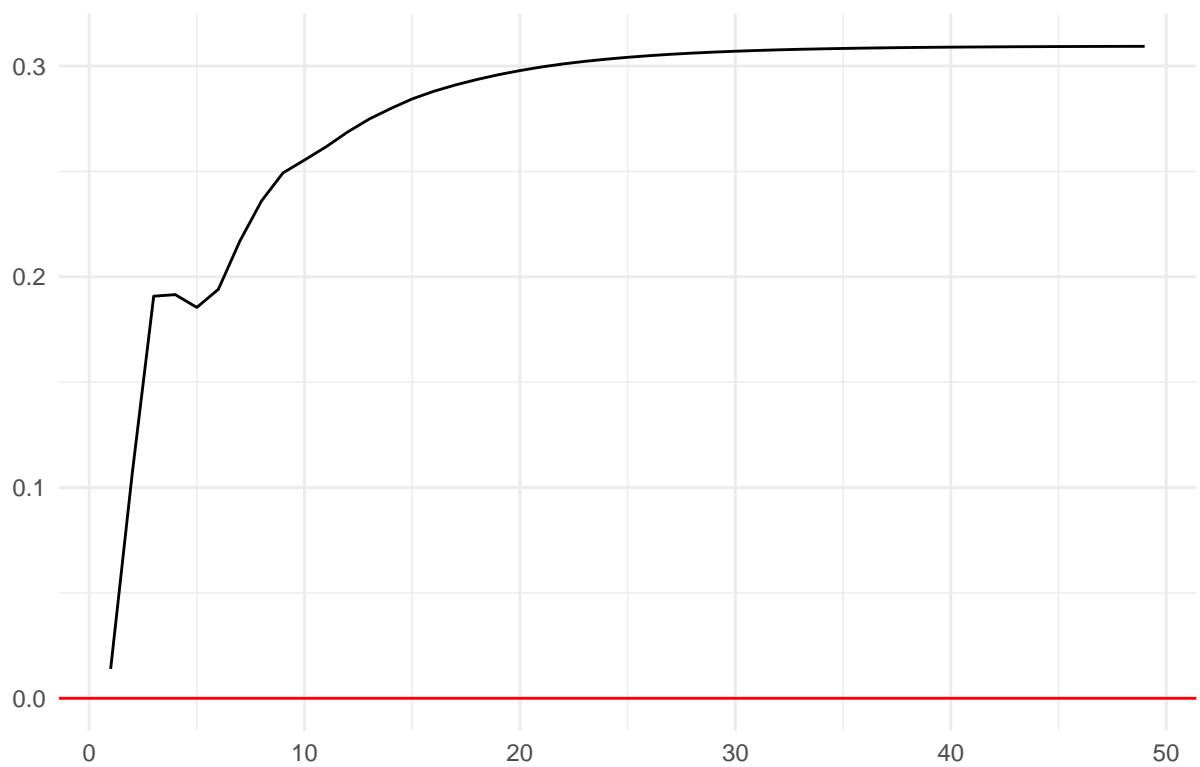
```

### S&P IRF of Second Term China on Volatility



```
ggplot(Yd_s_ch,aes(x=period, y=cumsum(response))) +  
  geom_hline(yintercept = 0, color="red") +  
  geom_line() +  
  theme_light() +  
  ggtitle("S&P Cumulalitive IRF of Second Term China on Volatility") +  
  ylab("")+  
  xlab("") +  
  theme_minimal()
```

### S&P Cumulative IRF of Second Term China on Volatility



### Tables Terms

```
#first

d_f_d_t = d_f_d %>%
  rename(X.11 = dummy.11,
         X.12 = dummy.12,
         X.13 = dummy.13,
         X.14 = dummy.14,
         X.15 = dummy.15,
         X.16 = dummy.16)

f_t_f_d <- as.formula("y ~ -1 + vol.11 + vol.12 + vol.13 + vol.14 + vol.15 + vol.16 +
                     X.11 + X.12 + X.13 + X.14 + X.15 + X.16 + const")
model_f_d <- lm(f_t_f_d, data = d_f_d_t)

d_f_n_t = d_f_n %>%
  rename(X.11 = N.11,
         X.12 = N.12,
         X.13 = N.13,
         X.14 = N.14,
         X.15 = N.15,
         X.16 = N.16)
```

```

f_t_f_n <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_f_n <- lm(f_t_f_n, data = d_f_n_t)

d_f_ta_t = d_f_ta %>%
  rename(X.l1 = tariff.l1,
         X.l2 = tariff.l2,
         X.l3 = tariff.l3,
         X.l4 = tariff.l4,
         X.l5 = tariff.l5,
         X.l6 = tariff.l6)

f_t_f_ta <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_f_ta <- lm(f_t_f_ta, data = d_f_ta_t)

d_f_tr_t = d_f_tr %>%
  rename(X.l1 = trade.l1,
         X.l2 = trade.l2,
         X.l3 = trade.l3,
         X.l4 = trade.l4,
         X.l5 = trade.l5,
         X.l6 = trade.l6)

f_t_f_tr <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_f_tr <- lm(f_t_f_tr, data = d_f_tr_t)

d_f_ch_t = d_f_ch %>%
  rename(X.l1 = china.l1,
         X.l2 = china.l2,
         X.l3 = china.l3,
         X.l4 = china.l4,
         X.l5 = china.l5,
         X.l6 = china.l6)

f_t_f_ch <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_f_ch <- lm(f_t_f_ch, data = d_f_ch_t)

nw_se_f_d_t <- sqrt(diag(sandwich::NeweyWest(model_f_d, lag = 6)))
nw_se_f_n_t <- sqrt(diag(sandwich::NeweyWest(model_f_n, lag = 6)))
nw_se_f_ta_t <- sqrt(diag(sandwich::NeweyWest(model_f_ta, lag = 6)))
nw_se_f_tr_t <- sqrt(diag(sandwich::NeweyWest(model_f_tr, lag = 6)))
nw_se_f_china_t <- sqrt(diag(sandwich::NeweyWest(model_f_ch, lag = 6)))

robust_f_d_t <- 2 * (1-pt(abs(coef(model_f_d) / nw_se_f_d_t), df = df.residual(model_f_d)))

```

```

robust_f_n_t <- 2 * (1-pt(abs(coef(model_f_n) / nw_se_f_n_t), df = df.residual(model_f_n)))
robust_f_ta_t <- 2 * (1-pt(abs(coef(model_f_ta) / nw_se_f_ta_t), df = df.residual(model_f_ta)))
robust_f_tr_t <- 2 * (1-pt(abs(coef(model_f_tr) / nw_se_f_tr_t), df = df.residual(model_f_tr)))
robust_f_ch_t <- 2 * (1-pt(abs(coef(model_f_ch) / nw_se_f_china_t), df = df.residual(model_f_ch)))

nw_se_f_d_t <- nw_se_f_d_t[names(coef(model_f_d))]
robust_f_d_t <- robust_f_d_t[names(coef(model_f_d))]
nw_se_f_n_t <- nw_se_f_n_t[names(coef(model_f_n))]
robust_f_n_t <- robust_f_n_t[names(coef(model_f_n))]
nw_se_f_ta_t <- nw_se_f_ta_t[names(coef(model_f_ta))]
robust_f_ta_t <- robust_f_ta_t[names(coef(model_f_ta))]
nw_se_f_tr_t <- nw_se_f_tr_t[names(coef(model_f_tr))]
robust_f_tr_t <- robust_f_tr_t[names(coef(model_f_tr))]
nw_se_f_china_t <- nw_se_f_china_t[names(coef(model_f_ch))]
robust_f_ch_t <- robust_f_ch_t[names(coef(model_f_ch))]

# list of models, SE and p-value
models_list_f <- list(model_f_d, model_f_n, model_f_ta, model_f_tr, model_f_ch)
robust_ses_f <- list(nw_se_f_d_t, nw_se_f_n_t, nw_se_f_ta_t, nw_se_f_tr_t, nw_se_f_china_t)
robust_pvals_f <- list(robust_f_d_t, robust_f_n_t, robust_f_ta_t, robust_f_tr_t, robust_f_ch_t)

# Name of coefficient
custom_names <- list(
  "vol.11" = "$AHV_{t-1}$",
  "vol.12" = "$AHV_{t-2}$",
  "vol.13" = "$AHV_{t-3}$",
  "vol.14" = "$AHV_{t-4}$",
  "vol.15" = "$AHV_{t-5}$",
  "vol.16" = "$AHV_{t-6}$",
  "X.11" = "$X_{t-1}$",
  "X.12" = "$X_{t-2}$",
  "X.13" = "$X_{t-3}$",
  "X.14" = "$X_{t-4}$",
  "X.15" = "$X_{t-5}$",
  "X.16" = "$X_{t-6}$",
  "const" = "Constant"
)

# Generate table
table_texreg_f <- texreg(
  l = models_list_f,
  override.se = robust_ses_f,
  override.pvalues = robust_pvals_f,
  custom.model.names = c("TweetDummy", "TweetCount", "Tariff", "Trade", "China"),
  custom.coef.map = custom_names,
  caption = "First-Term VAR Models of Average Hourly Volatility",
  label = "tab:VAR_First_Term",
  caption.above = TRUE,
  digits = 6,
  custom.gof.rows = list("Shock (IRF)" = c(0.002919, 0.002236, 0.000484, 0.000702, 0.000904)),
  star.cutoffs = c(0.001, 0.01, 0.05),

```

Table 2: First-Term VAR Models of Average Hourly Volatility

	TweetDummy	TweetCount	Tariff	Trade	China
$AHV_{t-1}$	0.541944*** (0.074062)	0.542426*** (0.074300)	0.543570*** (0.074985)	0.543958*** (0.075228)	0.543471*** (0.074985)
$AHV_{t-2}$	-0.113920** (0.038762)	-0.113855** (0.039289)	-0.115106** (0.039650)	-0.115566** (0.039098)	-0.115002** (0.039605)
$AHV_{t-3}$	0.058050* (0.027504)	0.057592* (0.027211)	0.053635* (0.027121)	0.053636* (0.026885)	0.054382* (0.027488)
$AHV_{t-4}$	0.188383 (0.132562)	0.187417 (0.131408)	0.184183 (0.130566)	0.184102 (0.133609)	0.184610 (0.130953)
$AHV_{t-5}$	-0.088758 (0.091453)	-0.089704 (0.090665)	-0.091496 (0.090960)	-0.091655 (0.093255)	-0.091848 (0.091105)
$AHV_{t-6}$	0.336662*** (0.049019)	0.337701*** (0.048828)	0.343373*** (0.048409)	0.343466*** (0.048454)	0.343184*** (0.048945)
$X_{t-1}$	-0.000478*** (0.000133)	-0.000163** (0.000055)	-0.000454 (0.000352)	-0.001838* (0.000715)	-0.000352 (0.000375)
$X_{t-2}$	-0.000184** (0.000069)	-0.000063* (0.000029)	-0.000289 (0.000274)	0.000221 (0.000520)	-0.000048 (0.000233)
$X_{t-3}$	-0.000693*** (0.000160)	-0.000263*** (0.000064)	-0.001007*** (0.000269)	-0.000949** (0.000301)	-0.001412*** (0.000373)
$X_{t-4}$	-0.000564*** (0.000166)	-0.000208** (0.000064)	-0.000274 (0.000400)	-0.000612 (0.000408)	-0.000202 (0.000454)
$X_{t-5}$	-0.000435*** (0.000113)	-0.000125** (0.000044)	-0.000468 (0.000281)	-0.000605 (0.000353)	-0.000057 (0.000352)
$X_{t-6}$	0.000118 (0.000118)	0.000099* (0.000047)	0.000240 (0.000344)	-0.000121 (0.000412)	0.000275 (0.000370)
Constant	0.004020*** (0.000669)	0.003079*** (0.000520)	0.001510*** (0.000316)	0.001657*** (0.000329)	0.001593*** (0.000312)
Shock (IRF)	0.002919	0.002236	0.000484	0.000702	0.000904
R <sup>2</sup>	0.687909	0.687236	0.685341	0.685489	0.685533
Adj. R <sup>2</sup>	0.687331	0.686657	0.684758	0.684907	0.684951
Num. obs.	7036	7036	7036	7036	7036

This table displays VAR regression with only two variables : AHV and the X regressor. The column names represent the X variable for the selected model.

```
custom.note = "This table displays VAR regression with only two variables : AHV and the X regressor."
)
```

```
# Print table
table_texreg_f
```

```
#Second
```

```
d_s_d_t = d_s_d %>%
  rename(X.11 = dummy.11,
         X.12 = dummy.12,
         X.13 = dummy.13,
         X.14 = dummy.14,
         X.15 = dummy.15,
         X.16 = dummy.16)
```



```

f_t_s_d <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_s_d <- lm(f_t_s_d, data = d_s_d_t)

d_s_n_t = d_s_n %>%
  rename(X.l1 = N.l1,
         X.l2 = N.l2,
         X.l3 = N.l3,
         X.l4 = N.l4,
         X.l5 = N.l5,
         X.l6 = N.l6)

f_t_s_n <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_s_n <- lm(f_t_s_n, data = d_s_n_t)

d_s_ta_t = d_s_ta %>%
  rename(X.l1 = tariff.l1,
         X.l2 = tariff.l2,
         X.l3 = tariff.l3,
         X.l4 = tariff.l4,
         X.l5 = tariff.l5,
         X.l6 = tariff.l6)

f_t_s_ta <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_s_ta <- lm(f_t_s_ta, data = d_s_ta_t)

d_s_tr_t = d_s_tr %>%
  rename(X.l1 = trade.l1,
         X.l2 = trade.l2,
         X.l3 = trade.l3,
         X.l4 = trade.l4,
         X.l5 = trade.l5,
         X.l6 = trade.l6)

f_t_s_tr <- as.formula("y ~ -1 + vol.l1 + vol.l2 + vol.l3 + vol.l4 + vol.l5 + vol.l6 +
                      X.l1 + X.l2 + X.l3 + X.l4 + X.l5 + X.l6 + const")
model_s_tr <- lm(f_t_s_tr, data = d_s_tr_t)

d_s_ch_t = d_s_ch %>%
  rename(X.l1 = china.l1,
         X.l2 = china.l2,
         X.l3 = china.l3,
         X.l4 = china.l4,
         X.l5 = china.l5,
         X.l6 = china.l6)

```

```

f_t_s_ch <- as.formula("y ~ -1 + vol.11 + vol.12 + vol.13 + vol.14 + vol.15 + vol.16 +
                      X.11 + X.12 + X.13 + X.14 + X.15 + X.16 + const")
model_s_ch <- lm(f_t_s_ch, data = d_s_ch_t)

nw_se_s_d_t <- sqrt(diag(sandwich::NeweyWest(model_s_d, lag = 6)))
nw_se_s_n_t <- sqrt(diag(sandwich::NeweyWest(model_s_n, lag = 6)))
nw_se_s_ta_t <- sqrt(diag(sandwich::NeweyWest(model_s_ta, lag = 6)))
nw_se_s_tr_t <- sqrt(diag(sandwich::NeweyWest(model_s_tr, lag = 6)))
nw_se_s_china_t <- sqrt(diag(sandwich::NeweyWest(model_s_ch, lag = 6)))

robust_s_d_t <- 2 * (1-pt(abs(coef(model_s_d) / nw_se_s_d_t), df = df.residual(model_s_d)))
robust_s_n_t <- 2 * (1-pt(abs(coef(model_s_n) / nw_se_s_n_t), df = df.residual(model_s_n)))
robust_s_ta_t <- 2 * (1-pt(abs(coef(model_s_ta) / nw_se_s_ta_t), df = df.residual(model_s_ta)))
robust_s_tr_t <- 2 * (1-pt(abs(coef(model_s_tr) / nw_se_s_tr_t), df = df.residual(model_s_tr)))
robust_s_ch_t <- 2 * (1-pt(abs(coef(model_s_ch) / nw_se_s_china_t), df = df.residual(model_s_ch)))

nw_se_s_d_t <- nw_se_s_d_t[names(coef(model_s_d))]
robust_s_d_t <- robust_s_d_t[names(coef(model_s_d))]
nw_se_s_n_t <- nw_se_s_n_t[names(coef(model_s_n))]
robust_s_n_t <- robust_s_n_t[names(coef(model_s_n))]
nw_se_s_ta_t <- nw_se_s_ta_t[names(coef(model_s_ta))]
robust_s_ta_t <- robust_s_ta_t[names(coef(model_s_ta))]
nw_se_s_tr_t <- nw_se_s_tr_t[names(coef(model_s_tr))]
robust_s_tr_t <- robust_s_tr_t[names(coef(model_s_tr))]
nw_se_s_china_t <- nw_se_s_china_t[names(coef(model_s_ch))]
robust_s_ch_t <- robust_s_ch_t[names(coef(model_s_ch))]

# lists of model, robust SE and p-values
models_list_s <- list(model_s_d, model_s_n, model_s_ta, model_s_tr, model_s_ch)
robust_ses_s <- list(nw_se_s_d_t, nw_se_s_n_t, nw_se_s_ta_t, nw_se_s_tr_t, nw_se_s_china_t)
robust_pvals_s <- list(robust_s_d_t, robust_s_n_t, robust_s_ta_t, robust_s_tr_t, robust_s_ch_t)

# Generate table
table_texreg_s <- texreg(
  l = models_list_s,
  override.se = robust_ses_s,
  override.pvalues = robust_pvals_s,
  custom.model.names = c("TweetDummy", "TweetCount", "Tariff", "Trade", "China"),
  custom.coef.map = custom_names,
  caption = "Second-Term VAR Models of Average Hourly Volatility",
  label = "tab:VAR_Second_Term",
  caption.above = TRUE,
  digits = 6,
  custom.gof.rows = list("Shock (IRF)" = c(0.014659, 0.013315, 0.010752, -0.005665, 0.013937)),
  star.cutoffs = c(0.05, 0.01, 0.001),
  custom.note = "This table displays VAR regression with only two variables : AHV and the X regressor. "
)

# Print

```

Table 3: Second-Term VAR Models of Average Hourly Volatility

	TweetDummy	TweetCount	Tariff	Trade	China
$AHV_{t-1}$	0.299398** (0.112369)	0.299350* (0.115966)	0.294752** (0.110305)	0.301160** (0.111228)	0.274419*** (0.078452)
$AHV_{t-2}$	0.015406 (0.043748)	0.013567 (0.045193)	0.020667 (0.038728)	0.011769 (0.043649)	0.031670 (0.028307)
$AHV_{t-3}$	0.076169*** (0.008464)	0.076851*** (0.008788)	0.068749*** (0.016281)	0.072284*** (0.014041)	0.052697 (0.034520)
$AHV_{t-4}$	0.084229 (0.067860)	0.085108 (0.070966)	0.074401 (0.079828)	0.080544 (0.066709)	0.035573 (0.100929)
$AHV_{t-5}$	0.013424** (0.005076)	0.010406 (0.005958)	0.015342** (0.005363)	0.017631* (0.008269)	0.005467 (0.032198)
$AHV_{t-6}$	0.126612* (0.050031)	0.126324* (0.050865)	0.132056** (0.049243)	0.124277* (0.051402)	0.150909** (0.051059)
$X_{t-1}$	0.006569 (0.010145)	0.000947 (0.001307)	0.027028 (0.028623)	0.020463 (0.029865)	0.154584 (0.138092)
$X_{t-2}$	-0.003222** (0.001039)	-0.000736 (0.000524)	0.008588 (0.007211)	0.047163 (0.041341)	0.099315 (0.095007)
$X_{t-3}$	-0.005538** (0.001707)	-0.001637* (0.000717)	-0.010306 (0.007584)	-0.026631 (0.021348)	-0.047690 (0.030038)
$X_{t-4}$	0.002474 (0.004957)	0.000136 (0.000914)	0.002002 (0.002962)	0.019925 (0.031571)	-0.020669 (0.012428)
$X_{t-5}$	-0.008527* (0.003989)	-0.001651 (0.001068)	-0.002649 (0.004280)	-0.012965 (0.014973)	-0.004470 (0.018255)
$X_{t-6}$	-0.003594 (0.003191)	-0.000627 (0.000760)	-0.004279 (0.003854)	-0.011100 (0.010317)	0.008027 (0.022286)
Constant	0.072524** (0.024156)	0.068423** (0.021308)	0.049265** (0.015262)	0.052127*** (0.014290)	0.044027* (0.017471)
Shock (IRF)	0.014659	0.013315	0.010752	-0.005665	0.013937
R <sup>2</sup>	0.244117	0.240788	0.251263	0.244406	0.285165
Adj. R <sup>2</sup>	0.224424	0.221009	0.231757	0.224721	0.266543
Num. obs.	512	512	512	512	512

This table displays VAR regression with only two variables : AHV and the X regressor. The column names represent the X variable for the selected model.

table\_texreg\_s