

# Who are the financial profiteers of war?

University of Applied Sciences Lucerne

Master of Science in Applied Information and Data Science

Time Series in Finance (TSA01)

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```
install.packages("readr")
install.packages("colorspace")
install.packages("vctrs")
install.packages("gtrendsR")
```

```
## Warning in register(): Can't find generic `scale_type` in package ggplot2 to
## register S3 method.
```

## Potential structure

- Context and Goal (Literature?)
- Methods
- Data
  - Import data (indices & Google words)
  - Describe data
  - Preprocessing
- VAR & Causality Testing
- Results & Discussion

## 1. Context and Goal

With recent outbreaks of war (e.g., in Israel or in the Ukraine), the question arises of how stock markets react to this and if there are sectors that profit from such crises. Specifically, the case study should examine if certain indices from specific economic sectors perform well in situations of crisis. To do this, the performance of several sector-specific indices in relation to an overall crisis measure should be compared and evaluated with the goal of examining if positive correlations between situations of crisis and stock market profits exist. Alternatively, the research question could be evaluated by comparing the development of sector-specific indices since the outbreak of the war in the Ukraine with the development of non-sector-specific indices (like SMI or S&P 500). If they perform better than overall indices this would indicate that they profit from war.

## 2. Methods

The precise methods to examine the hypothesis are not clear yet and will have to be decided once more methods are introduced in the lectures. However, correlation measurements as well as potential tests for causality will have to be included. If we use the alternative way to answer our research question we could probably use OLS (as described in class last week).

## 3. Data

Import Time Series Data

TODO: - Justify why Adjusted values and not close values - Timeframe: December 2021 until December 2022

```
# Ticker Data
ticker_data <- NULL
tickers_index <- c("XLK", "XLF", "XLV", "XLY", "XLE", "XLU")

for (Ticker in tickers_index){
```

```
ticker_data <- cbind(ticker_data,
  getSymbols.yahoo(Ticker, from="2021-12-01", to="2023-12-01",
    periodicity = "weekly",auto.assign=FALSE)[,6])
}
```

```
# Check length and min max date
length(ticker_data$XLK.Adjusted)
```

```
## [1] 105
```

```
summary(ticker_data)[c(1, 6)]
```

```
## [1] "Min.      :2021-11-29  " "Max.      :2023-11-27  "
```

```
head(ticker_data)
```

```
##           XLK.Adjusted XLF.Adjusted XLV.Adjusted XLY.Adjusted XLE.Adjusted
## 2021-11-29      162.1687      36.56124      126.3468      196.2840      50.84305
## 2021-12-06      171.7439      37.54185      130.4269      201.5340      52.77941
## 2021-12-13      164.8694      37.09962      133.6638      191.9975      50.13306
## 2021-12-20      169.8387      37.32074      135.0012      199.7643      50.62176
## 2021-12-27      171.0750      37.72171      137.0669      201.2943      51.83763
## 2022-01-03      163.2626      39.76960      130.7044      196.4106      57.29226
##           XLU.Adjusted
## 2021-11-29      63.42516
## 2021-12-06      65.07197
## 2021-12-13      65.88125
## 2021-12-20      65.60834
## 2021-12-27      67.88811
## 2022-01-03      66.77846
```

```
# Google Trends data
gtrends_war_web <- gtrends(
  keyword = "war",
  time = "2021-11-30 2023-12-01",
  gprop = "web"
)$interest_over_time
gtrends_war_web
```

```
##           date hits keyword  geo           time gprop category
## 1  2021-12-05   34    war world 2021-11-30 2023-12-01  web         0
## 2  2021-12-12   36    war world 2021-11-30 2023-12-01  web         0
## 3  2021-12-19   31    war world 2021-11-30 2023-12-01  web         0
## 4  2021-12-26   34    war world 2021-11-30 2023-12-01  web         0
## 5  2022-01-02   35    war world 2021-11-30 2023-12-01  web         0
## 6  2022-01-09   40    war world 2021-11-30 2023-12-01  web         0
## 7  2022-01-16   44    war world 2021-11-30 2023-12-01  web         0
## 8  2022-01-23   49    war world 2021-11-30 2023-12-01  web         0
## 9  2022-01-30   43    war world 2021-11-30 2023-12-01  web         0
## 10 2022-02-06   41    war world 2021-11-30 2023-12-01  web         0
## 11 2022-02-13   45    war world 2021-11-30 2023-12-01  web         0
```

##	12	2022-02-20	98	war world	2021-11-30	2023-12-01	web	0
##	13	2022-02-27	100	war world	2021-11-30	2023-12-01	web	0
##	14	2022-03-06	73	war world	2021-11-30	2023-12-01	web	0
##	15	2022-03-13	59	war world	2021-11-30	2023-12-01	web	0
##	16	2022-03-20	55	war world	2021-11-30	2023-12-01	web	0
##	17	2022-03-27	59	war world	2021-11-30	2023-12-01	web	0
##	18	2022-04-03	51	war world	2021-11-30	2023-12-01	web	0
##	19	2022-04-10	48	war world	2021-11-30	2023-12-01	web	0
##	20	2022-04-17	53	war world	2021-11-30	2023-12-01	web	0
##	21	2022-04-24	51	war world	2021-11-30	2023-12-01	web	0
##	22	2022-05-01	52	war world	2021-11-30	2023-12-01	web	0
##	23	2022-05-08	48	war world	2021-11-30	2023-12-01	web	0
##	24	2022-05-15	48	war world	2021-11-30	2023-12-01	web	0
##	25	2022-05-22	43	war world	2021-11-30	2023-12-01	web	0
##	26	2022-05-29	36	war world	2021-11-30	2023-12-01	web	0
##	27	2022-06-05	41	war world	2021-11-30	2023-12-01	web	0
##	28	2022-06-12	37	war world	2021-11-30	2023-12-01	web	0
##	29	2022-06-19	41	war world	2021-11-30	2023-12-01	web	0
##	30	2022-06-26	39	war world	2021-11-30	2023-12-01	web	0
##	31	2022-07-03	43	war world	2021-11-30	2023-12-01	web	0
##	32	2022-07-10	38	war world	2021-11-30	2023-12-01	web	0
##	33	2022-07-17	39	war world	2021-11-30	2023-12-01	web	0
##	34	2022-07-24	37	war world	2021-11-30	2023-12-01	web	0
##	35	2022-07-31	41	war world	2021-11-30	2023-12-01	web	0
##	36	2022-08-07	37	war world	2021-11-30	2023-12-01	web	0
##	37	2022-08-14	37	war world	2021-11-30	2023-12-01	web	0
##	38	2022-08-21	37	war world	2021-11-30	2023-12-01	web	0
##	39	2022-08-28	36	war world	2021-11-30	2023-12-01	web	0
##	40	2022-09-04	39	war world	2021-11-30	2023-12-01	web	0
##	41	2022-09-11	44	war world	2021-11-30	2023-12-01	web	0
##	42	2022-09-18	46	war world	2021-11-30	2023-12-01	web	0
##	43	2022-09-25	43	war world	2021-11-30	2023-12-01	web	0
##	44	2022-10-02	46	war world	2021-11-30	2023-12-01	web	0
##	45	2022-10-09	45	war world	2021-11-30	2023-12-01	web	0
##	46	2022-10-16	45	war world	2021-11-30	2023-12-01	web	0
##	47	2022-10-23	44	war world	2021-11-30	2023-12-01	web	0
##	48	2022-10-30	52	war world	2021-11-30	2023-12-01	web	0
##	49	2022-11-06	74	war world	2021-11-30	2023-12-01	web	0
##	50	2022-11-13	72	war world	2021-11-30	2023-12-01	web	0
##	51	2022-11-20	55	war world	2021-11-30	2023-12-01	web	0
##	52	2022-11-27	52	war world	2021-11-30	2023-12-01	web	0
##	53	2022-12-04	51	war world	2021-11-30	2023-12-01	web	0
##	54	2022-12-11	49	war world	2021-11-30	2023-12-01	web	0
##	55	2022-12-18	50	war world	2021-11-30	2023-12-01	web	0
##	56	2022-12-25	47	war world	2021-11-30	2023-12-01	web	0
##	57	2023-01-01	43	war world	2021-11-30	2023-12-01	web	0
##	58	2023-01-08	45	war world	2021-11-30	2023-12-01	web	0
##	59	2023-01-15	46	war world	2021-11-30	2023-12-01	web	0
##	60	2023-01-22	49	war world	2021-11-30	2023-12-01	web	0
##	61	2023-01-29	47	war world	2021-11-30	2023-12-01	web	0
##	62	2023-02-05	46	war world	2021-11-30	2023-12-01	web	0
##	63	2023-02-12	44	war world	2021-11-30	2023-12-01	web	0
##	64	2023-02-19	49	war world	2021-11-30	2023-12-01	web	0
##	65	2023-02-26	43	war world	2021-11-30	2023-12-01	web	0

## 66	2023-03-05	44	war world	2021-11-30	2023-12-01	web	0
## 67	2023-03-12	38	war world	2021-11-30	2023-12-01	web	0
## 68	2023-03-19	41	war world	2021-11-30	2023-12-01	web	0
## 69	2023-03-26	41	war world	2021-11-30	2023-12-01	web	0
## 70	2023-04-02	42	war world	2021-11-30	2023-12-01	web	0
## 71	2023-04-09	40	war world	2021-11-30	2023-12-01	web	0
## 72	2023-04-16	43	war world	2021-11-30	2023-12-01	web	0
## 73	2023-04-23	45	war world	2021-11-30	2023-12-01	web	0
## 74	2023-04-30	44	war world	2021-11-30	2023-12-01	web	0
## 75	2023-05-07	42	war world	2021-11-30	2023-12-01	web	0
## 76	2023-05-14	42	war world	2021-11-30	2023-12-01	web	0
## 77	2023-05-21	39	war world	2021-11-30	2023-12-01	web	0
## 78	2023-05-28	35	war world	2021-11-30	2023-12-01	web	0
## 79	2023-06-04	39	war world	2021-11-30	2023-12-01	web	0
## 80	2023-06-11	36	war world	2021-11-30	2023-12-01	web	0
## 81	2023-06-18	39	war world	2021-11-30	2023-12-01	web	0
## 82	2023-06-25	37	war world	2021-11-30	2023-12-01	web	0
## 83	2023-07-02	36	war world	2021-11-30	2023-12-01	web	0
## 84	2023-07-09	36	war world	2021-11-30	2023-12-01	web	0
## 85	2023-07-16	38	war world	2021-11-30	2023-12-01	web	0
## 86	2023-07-23	37	war world	2021-11-30	2023-12-01	web	0
## 87	2023-07-30	35	war world	2021-11-30	2023-12-01	web	0
## 88	2023-08-06	38	war world	2021-11-30	2023-12-01	web	0
## 89	2023-08-13	34	war world	2021-11-30	2023-12-01	web	0
## 90	2023-08-20	34	war world	2021-11-30	2023-12-01	web	0
## 91	2023-08-27	39	war world	2021-11-30	2023-12-01	web	0
## 92	2023-09-03	36	war world	2021-11-30	2023-12-01	web	0
## 93	2023-09-10	36	war world	2021-11-30	2023-12-01	web	0
## 94	2023-09-17	36	war world	2021-11-30	2023-12-01	web	0
## 95	2023-09-24	38	war world	2021-11-30	2023-12-01	web	0
## 96	2023-10-01	42	war world	2021-11-30	2023-12-01	web	0
## 97	2023-10-08	69	war world	2021-11-30	2023-12-01	web	0
## 98	2023-10-15	57	war world	2021-11-30	2023-12-01	web	0
## 99	2023-10-22	50	war world	2021-11-30	2023-12-01	web	0
## 100	2023-10-29	49	war world	2021-11-30	2023-12-01	web	0
## 101	2023-11-05	47	war world	2021-11-30	2023-12-01	web	0
## 102	2023-11-12	46	war world	2021-11-30	2023-12-01	web	0
## 103	2023-11-19	38	war world	2021-11-30	2023-12-01	web	0
## 104	2023-11-26	43	war world	2021-11-30	2023-12-01	web	0

*# Too many requests exclude?*

```
gtrends_war_news <- gtrends(
  keyword = "war",
  time = "2021-12-01 2023-12-01",
  gprop = "news"
)$interest_over_time
```

*# If gtrends does not work --> response 429*

```
library(lubridate)

gtrends_war_web <- read.csv('gtrends_war_web.csv')
gtrends_war_web <- gtrends_war_web %>%
  mutate(date = ymd(date))
```

Google Trends delivers data always from Sunday weekly. This has to be put to the weekly data from the financial tickers, which always starts at Monday.

```
# Increase date by one day to match ticker data
gtrends_war_web$date <- gtrends_war_web$date + days(1)

# Check length and min max date
length(gtrends_war_web$date)
```

```
## [1] 104
```

```
min(gtrends_war_web$date)
```

```
## [1] "2021-12-06 GMT"
```

```
max(gtrends_war_web$date)
```

```
## [1] "2023-11-27 GMT"
```

```
# Remove first date of ticker data to match gtrends data
ticker_data <- ticker_data[-1,]
ticker_data
```

##	XLK.Adjusted	XLF.Adjusted	XLV.Adjusted	XLY.Adjusted	XLE.Adjusted
## 2021-12-06	171.7439	37.54185	130.4269	201.5340	52.77941
## 2021-12-13	164.8694	37.09962	133.6638	191.9975	50.13306
## 2021-12-20	169.8387	37.32074	135.0012	199.7643	50.62176
## 2021-12-27	171.0750	37.72171	137.0669	201.2943	51.83763
## 2022-01-03	163.2626	39.76960	130.7044	196.4106	57.29226
## 2022-01-10	163.0954	39.44117	130.4319	193.4961	60.25307
## 2022-01-17	151.8491	36.90063	125.9568	177.6438	58.32901
## 2022-01-24	155.4601	37.40294	126.9393	175.3595	61.29916
## 2022-01-31	157.0344	38.73600	128.7100	181.5626	64.35339
## 2022-02-07	152.4001	38.74566	126.7156	177.7029	65.76375
## 2022-02-14	149.9895	37.88593	124.0500	177.2303	63.55947
## 2022-02-21	151.8688	37.77001	127.3966	173.4789	64.33469
## 2022-02-28	147.3427	35.96362	128.9240	168.9596	70.26567
## 2022-03-07	141.7442	35.16185	125.4412	164.1547	71.77878
## 2022-03-14	152.5772	37.67341	133.2727	179.0814	69.00476
## 2022-03-21	155.6766	38.17572	132.5723	180.5386	73.55340
## 2022-03-28	156.2008	37.06440	134.7424	182.6600	72.66338
## 2022-04-04	150.2371	36.74438	139.3877	176.9898	74.99247
## 2022-04-11	144.5493	35.77462	135.2987	175.9248	75.29421
## 2022-04-18	141.0401	35.07638	130.4485	173.3806	71.85244
## 2022-04-25	139.4038	33.46658	127.1499	160.6201	70.86237
## 2022-05-02	138.5659	33.68962	126.6522	155.9557	78.18904
## 2022-05-09	133.9230	32.51620	125.5006	150.2067	76.17113
## 2022-05-16	129.1915	31.92464	126.6522	138.4619	77.10466
## 2022-05-23	139.4432	34.49452	130.7900	151.6266	83.47898
## 2022-05-30	137.9941	33.81569	126.6913	150.8772	84.40306
## 2022-06-06	129.2210	31.54644	122.4656	142.4656	83.64870

## 2022-06-13	122.8433	29.99482	117.0006	134.2117	69.29707
## 2022-06-20	131.5474	31.36218	126.0862	144.9506	67.50547
## 2022-06-27	125.9199	31.08089	127.0889	138.3867	69.20649
## 2022-07-04	131.3160	31.27588	128.1277	144.6730	67.65225
## 2022-07-11	130.8318	30.98340	127.5985	143.1607	65.40194
## 2022-07-18	135.6151	31.92909	127.2359	152.9558	67.84296
## 2022-07-25	142.5333	32.86502	129.7545	160.9421	74.77504
## 2022-08-01	145.3005	32.84552	128.8235	162.4050	69.68326
## 2022-08-08	148.8485	34.66865	130.9501	167.9400	74.82272
## 2022-08-15	146.3778	34.08369	130.2642	165.5876	75.76670
## 2022-08-22	138.2440	32.87477	124.7466	157.8286	78.98960
## 2022-08-29	131.2962	32.06557	122.4926	153.6872	76.24347
## 2022-09-05	135.5954	33.49874	127.8925	162.5730	76.85371
## 2022-09-12	127.2047	32.23132	124.9034	156.1088	74.79412
## 2022-09-19	122.2928	30.27170	120.2778	144.7224	67.20410
## 2022-09-26	117.6806	29.75470	119.1632	141.0932	69.42125
## 2022-10-03	119.6522	30.27413	120.6490	139.3104	78.84836
## 2022-10-10	115.7190	30.39174	121.9084	133.9816	77.38320
## 2022-10-17	123.1892	31.54821	124.5059	141.0437	83.79324
## 2022-10-24	128.3807	33.50834	130.7243	143.5793	86.02953
## 2022-10-31	119.8702	33.23392	128.7073	136.1904	88.12122
## 2022-11-07	131.9077	35.15484	130.9900	143.7081	89.76952
## 2022-11-14	130.8674	34.66481	132.4069	139.6471	88.32365
## 2022-11-21	132.3635	35.39006	134.9454	141.2715	88.55499
## 2022-11-28	134.1072	35.21365	137.5331	144.5698	87.05128
## 2022-12-05	129.6984	33.84156	135.7620	138.1020	79.69659
## 2022-12-12	126.3001	33.02811	133.3514	132.6346	81.31597
## 2022-12-19	123.4468	33.27312	133.9123	128.1972	83.91855
## 2022-12-26	123.6423	33.72831	134.2169	128.2804	85.18214
## 2023-01-02	123.9304	34.89204	134.0391	131.1706	85.26978
## 2023-01-09	129.6535	35.62183	133.8217	138.7486	87.59726
## 2023-01-16	130.4980	34.86245	132.3002	138.0335	88.11341
## 2023-01-23	135.8237	35.75004	131.2628	146.8829	88.84379
## 2023-01-30	140.8612	36.08535	131.0949	150.3193	83.71163
## 2023-02-06	139.4801	35.98673	130.8973	147.1411	87.85046
## 2023-02-13	138.9237	35.88811	130.4033	149.5446	82.28008
## 2023-02-20	135.2176	35.16818	126.9651	142.8803	82.44564
## 2023-02-27	139.2416	35.49363	127.6172	145.3136	84.97763
## 2023-03-06	134.8996	32.47583	122.6575	137.2589	80.46873
## 2023-03-13	142.5403	30.55272	124.3470	140.3775	74.95677
## 2023-03-20	145.0243	30.56259	125.7697	140.6158	75.85271
## 2023-03-27	150.3732	31.86395	128.4026	148.9748	81.50535
## 2023-04-03	148.4413	31.70538	132.4294	144.3822	83.62096
## 2023-04-10	148.0231	32.58746	133.4709	146.3448	85.83498
## 2023-04-17	147.1369	32.92443	133.2031	146.8130	83.62096
## 2023-04-24	150.1939	32.87487	132.4393	147.3012	83.76855
## 2023-05-01	150.6022	32.04235	132.4989	146.6337	78.94693
## 2023-05-08	150.3134	31.61618	131.1103	147.2713	77.26427
## 2023-05-15	156.8159	32.30995	130.2375	150.9772	78.36636
## 2023-05-22	164.0851	31.82431	126.4884	151.3957	77.51027
## 2023-05-29	166.1961	32.50817	129.2556	156.4066	78.62221
## 2023-06-05	165.3099	32.85506	129.3548	160.5908	80.02934
## 2023-06-12	172.4596	33.28123	131.1301	165.7512	79.56685
## 2023-06-19	167.9388	32.44871	130.9219	164.8247	76.12283



##	2023-06-26	173.4894	33.55998	132.1878	169.5085	80.57540
##	2023-07-03	170.8451	33.44052	128.4730	169.0693	80.19819
##	2023-07-10	175.6149	34.09758	131.1620	174.6094	80.85336
##	2023-07-17	175.7546	35.10308	135.6835	170.6764	83.68248
##	2023-07-24	177.5607	35.04335	134.6378	172.4533	85.22112
##	2023-07-31	170.7952	34.75464	131.8591	171.2454	86.28329
##	2023-08-07	166.5443	34.76460	135.1158	169.4187	89.24146
##	2023-08-14	164.6084	33.82878	132.9845	162.3712	88.15944
##	2023-08-21	168.3504	33.83874	132.8650	164.3677	86.94837
##	2023-08-28	175.8244	34.53562	133.0244	169.3688	90.07530
##	2023-09-04	172.4217	34.14736	131.5205	168.4504	91.37571
##	2023-09-11	168.5400	34.67500	131.6500	171.4850	91.33600
##	2023-09-18	164.0596	33.51020	129.6183	160.6443	88.65578
##	2023-09-25	163.9300	33.17000	128.7400	160.9800	90.39000
##	2023-10-02	168.2200	33.04000	130.0100	160.6100	85.73000
##	2023-10-09	168.6300	33.21000	130.1900	158.9700	89.59000
##	2023-10-16	163.9400	32.20000	128.0600	151.6900	90.26000
##	2023-10-23	161.1200	31.45000	123.1400	149.5900	84.63000
##	2023-10-30	171.7600	33.78000	127.4100	160.2200	86.68000
##	2023-11-06	179.5200	33.91000	126.2700	161.4000	83.41000
##	2023-11-13	182.8000	35.01000	128.2500	167.1400	84.69000
##	2023-11-20	184.4100	35.38000	131.1300	168.2400	84.93000
##	2023-11-27	185.1600	35.90000	131.3100	168.7800	84.58000
##	XLU.Adjusted					
##	2021-12-06	65.07197				
##	2021-12-13	65.88125				
##	2021-12-20	65.60834				
##	2021-12-27	67.88811				
##	2022-01-03	66.77846				
##	2022-01-10	65.82055				
##	2022-01-17	65.28944				
##	2022-01-24	64.45482				
##	2022-01-31	64.94799				
##	2022-02-07	63.57279				
##	2022-02-14	62.80457				
##	2022-02-21	64.09442				
##	2022-02-28	67.23368				
##	2022-03-07	66.79742				
##	2022-03-14	67.15781				
##	2022-03-21	69.02622				
##	2022-03-28	72.08437				
##	2022-04-04	73.47832				
##	2022-04-11	72.64768				
##	2022-04-18	70.89093				
##	2022-04-25	68.03619				
##	2022-05-02	68.94323				
##	2022-05-09	68.19852				
##	2022-05-16	68.49449				
##	2022-05-23	71.96027				
##	2022-05-30	70.98640				
##	2022-06-06	68.11258				
##	2022-06-13	61.93529				
##	2022-06-20	65.88800				
##	2022-06-27	69.14847				

##	2022-07-04	67.19480
##	2022-07-11	67.13705
##	2022-07-18	66.81947
##	2022-07-25	71.16952
##	2022-08-01	71.43900
##	2022-08-08	73.83537
##	2022-08-15	74.77852
##	2022-08-22	72.86334
##	2022-08-29	71.79508
##	2022-09-05	74.47054
##	2022-09-12	71.66997
##	2022-09-19	69.06187
##	2022-09-26	63.47388
##	2022-10-03	61.77827
##	2022-10-10	60.21831
##	2022-10-17	61.34226
##	2022-10-24	65.31482
##	2022-10-31	65.00477
##	2022-11-07	65.96400
##	2022-11-14	66.71007
##	2022-11-21	68.73511
##	2022-11-28	68.82231
##	2022-12-05	68.62852
##	2022-12-12	68.28941
##	2022-12-19	68.70605
##	2022-12-26	68.86770
##	2023-01-02	69.35612
##	2023-01-09	69.67848
##	2023-01-16	67.62711
##	2023-01-23	67.29497
##	2023-01-30	66.33768
##	2023-02-06	66.14230
##	2023-02-13	66.89447
##	2023-02-20	65.06776
##	2023-02-27	64.71609
##	2023-03-06	62.92847
##	2023-03-13	65.41943
##	2023-03-20	64.16907
##	2023-03-27	66.61012
##	2023-04-03	68.69630
##	2023-04-10	67.79098
##	2023-04-17	68.50934
##	2023-04-24	67.87955
##	2023-05-01	67.92875
##	2023-05-08	67.92875
##	2023-05-15	65.05534
##	2023-05-22	63.55957
##	2023-05-29	64.08113
##	2023-06-05	65.33086
##	2023-06-12	66.22635
##	2023-06-19	63.99256
##	2023-06-26	64.91399
##	2023-07-03	64.86439
##	2023-07-10	66.31264

```
## 2023-07-17      67.90971
## 2023-07-24      66.50112
## 2023-07-31      63.47564
## 2023-08-07      64.05097
## 2023-08-14      62.97966
## 2023-08-21      63.11853
## 2023-08-28      62.13649
## 2023-09-04      62.67215
## 2023-09-11      64.41801
## 2023-09-18      62.78127
## 2023-09-25      58.93000
## 2023-10-02      57.25000
## 2023-10-09      59.30000
## 2023-10-16      58.03000
## 2023-10-23      58.73000
## 2023-10-30      61.86000
## 2023-11-06      60.32000
## 2023-11-13      62.29000
## 2023-11-20      62.69000
## 2023-11-27      62.76000
```

## Visualize Ticker Data

```
# Visualization
ticker_data_df <- fortify.zoo(ticker_data)
colnames(ticker_data_df)[1] <- "Date"
ticker_data_df <- gather(ticker_data_df, key="Ticker", value="Value",
                        c("XLK.Adjusted", "XLF.Adjusted", "XLV.Adjusted",
                          "XLY.Adjusted", "XLE.Adjusted", "XLU.Adjusted"), -Date)

ticker_data_df
```

```
##           Date      Ticker      Value
## 1  2021-12-06  XLK.Adjusted  171.74385
## 2  2021-12-13  XLK.Adjusted  164.86938
## 3  2021-12-20  XLK.Adjusted  169.83865
## 4  2021-12-27  XLK.Adjusted  171.07500
## 5  2022-01-03  XLK.Adjusted  163.26263
## 6  2022-01-10  XLK.Adjusted  163.09537
## 7  2022-01-17  XLK.Adjusted  151.84914
## 8  2022-01-24  XLK.Adjusted  155.46011
## 9  2022-01-31  XLK.Adjusted  157.03441
## 10 2022-02-07  XLK.Adjusted  152.40009
## 11 2022-02-14  XLK.Adjusted  149.98950
## 12 2022-02-21  XLK.Adjusted  151.86880
## 13 2022-02-28  XLK.Adjusted  147.34274
## 14 2022-03-07  XLK.Adjusted  141.74420
## 15 2022-03-14  XLK.Adjusted  152.57722
## 16 2022-03-21  XLK.Adjusted  155.67656
## 17 2022-03-28  XLK.Adjusted  156.20081
## 18 2022-04-04  XLK.Adjusted  150.23706
## 19 2022-04-11  XLK.Adjusted  144.54935
```

##	20	2022-04-18	XLK.Adjusted	141.04008
##	21	2022-04-25	XLK.Adjusted	139.40376
##	22	2022-05-02	XLK.Adjusted	138.56587
##	23	2022-05-09	XLK.Adjusted	133.92302
##	24	2022-05-16	XLK.Adjusted	129.19147
##	25	2022-05-23	XLK.Adjusted	139.44318
##	26	2022-05-30	XLK.Adjusted	137.99414
##	27	2022-06-06	XLK.Adjusted	129.22101
##	28	2022-06-13	XLK.Adjusted	122.84328
##	29	2022-06-20	XLK.Adjusted	131.54739
##	30	2022-06-27	XLK.Adjusted	125.91987
##	31	2022-07-04	XLK.Adjusted	131.31601
##	32	2022-07-11	XLK.Adjusted	130.83176
##	33	2022-07-18	XLK.Adjusted	135.61513
##	34	2022-07-25	XLK.Adjusted	142.53328
##	35	2022-08-01	XLK.Adjusted	145.30052
##	36	2022-08-08	XLK.Adjusted	148.84854
##	37	2022-08-15	XLK.Adjusted	146.37778
##	38	2022-08-22	XLK.Adjusted	138.24405
##	39	2022-08-29	XLK.Adjusted	131.29623
##	40	2022-09-05	XLK.Adjusted	135.59535
##	41	2022-09-12	XLK.Adjusted	127.20466
##	42	2022-09-19	XLK.Adjusted	122.29279
##	43	2022-09-26	XLK.Adjusted	117.68064
##	44	2022-10-03	XLK.Adjusted	119.65221
##	45	2022-10-10	XLK.Adjusted	115.71897
##	46	2022-10-17	XLK.Adjusted	123.18918
##	47	2022-10-24	XLK.Adjusted	128.38066
##	48	2022-10-31	XLK.Adjusted	119.87019
##	49	2022-11-07	XLK.Adjusted	131.90775
##	50	2022-11-14	XLK.Adjusted	130.86743
##	51	2022-11-21	XLK.Adjusted	132.36348
##	52	2022-11-28	XLK.Adjusted	134.10719
##	53	2022-12-05	XLK.Adjusted	129.69836
##	54	2022-12-12	XLK.Adjusted	126.30013
##	55	2022-12-19	XLK.Adjusted	123.44678
##	56	2022-12-26	XLK.Adjusted	123.64227
##	57	2023-01-02	XLK.Adjusted	123.93040
##	58	2023-01-09	XLK.Adjusted	129.65347
##	59	2023-01-16	XLK.Adjusted	130.49802
##	60	2023-01-23	XLK.Adjusted	135.82367
##	61	2023-01-30	XLK.Adjusted	140.86118
##	62	2023-02-06	XLK.Adjusted	139.48007
##	63	2023-02-13	XLK.Adjusted	138.92368
##	64	2023-02-20	XLK.Adjusted	135.21759
##	65	2023-02-27	XLK.Adjusted	139.24161
##	66	2023-03-06	XLK.Adjusted	134.89963
##	67	2023-03-13	XLK.Adjusted	142.54034
##	68	2023-03-20	XLK.Adjusted	145.02431
##	69	2023-03-27	XLK.Adjusted	150.37315
##	70	2023-04-03	XLK.Adjusted	148.44135
##	71	2023-04-10	XLK.Adjusted	148.02310
##	72	2023-04-17	XLK.Adjusted	147.13686
##	73	2023-04-24	XLK.Adjusted	150.19392

## 74	2023-05-01	XLK.Adjusted	150.60220
## 75	2023-05-08	XLK.Adjusted	150.31340
## 76	2023-05-15	XLK.Adjusted	156.81587
## 77	2023-05-22	XLK.Adjusted	164.08508
## 78	2023-05-29	XLK.Adjusted	166.19614
## 79	2023-06-05	XLK.Adjusted	165.30989
## 80	2023-06-12	XLK.Adjusted	172.45963
## 81	2023-06-19	XLK.Adjusted	167.93877
## 82	2023-06-26	XLK.Adjusted	173.48943
## 83	2023-07-03	XLK.Adjusted	170.84508
## 84	2023-07-10	XLK.Adjusted	175.61488
## 85	2023-07-17	XLK.Adjusted	175.75459
## 86	2023-07-24	XLK.Adjusted	177.56073
## 87	2023-07-31	XLK.Adjusted	170.79518
## 88	2023-08-07	XLK.Adjusted	166.54425
## 89	2023-08-14	XLK.Adjusted	164.60840
## 90	2023-08-21	XLK.Adjusted	168.35040
## 91	2023-08-28	XLK.Adjusted	175.82443
## 92	2023-09-04	XLK.Adjusted	172.42169
## 93	2023-09-11	XLK.Adjusted	168.53999
## 94	2023-09-18	XLK.Adjusted	164.05957
## 95	2023-09-25	XLK.Adjusted	163.92999
## 96	2023-10-02	XLK.Adjusted	168.22000
## 97	2023-10-09	XLK.Adjusted	168.63000
## 98	2023-10-16	XLK.Adjusted	163.94000
## 99	2023-10-23	XLK.Adjusted	161.12000
## 100	2023-10-30	XLK.Adjusted	171.75999
## 101	2023-11-06	XLK.Adjusted	179.52000
## 102	2023-11-13	XLK.Adjusted	182.80000
## 103	2023-11-20	XLK.Adjusted	184.41000
## 104	2023-11-27	XLK.Adjusted	185.16000
## 105	2021-12-06	XLF.Adjusted	37.54185
## 106	2021-12-13	XLF.Adjusted	37.09962
## 107	2021-12-20	XLF.Adjusted	37.32074
## 108	2021-12-27	XLF.Adjusted	37.72171
## 109	2022-01-03	XLF.Adjusted	39.76960
## 110	2022-01-10	XLF.Adjusted	39.44117
## 111	2022-01-17	XLF.Adjusted	36.90063
## 112	2022-01-24	XLF.Adjusted	37.40294
## 113	2022-01-31	XLF.Adjusted	38.73600
## 114	2022-02-07	XLF.Adjusted	38.74566
## 115	2022-02-14	XLF.Adjusted	37.88593
## 116	2022-02-21	XLF.Adjusted	37.77001
## 117	2022-02-28	XLF.Adjusted	35.96362
## 118	2022-03-07	XLF.Adjusted	35.16185
## 119	2022-03-14	XLF.Adjusted	37.67341
## 120	2022-03-21	XLF.Adjusted	38.17572
## 121	2022-03-28	XLF.Adjusted	37.06440
## 122	2022-04-04	XLF.Adjusted	36.74438
## 123	2022-04-11	XLF.Adjusted	35.77462
## 124	2022-04-18	XLF.Adjusted	35.07638
## 125	2022-04-25	XLF.Adjusted	33.46658
## 126	2022-05-02	XLF.Adjusted	33.68962
## 127	2022-05-09	XLF.Adjusted	32.51620

##	128	2022-05-16	XLF.Adjusted	31.92464
##	129	2022-05-23	XLF.Adjusted	34.49452
##	130	2022-05-30	XLF.Adjusted	33.81569
##	131	2022-06-06	XLF.Adjusted	31.54644
##	132	2022-06-13	XLF.Adjusted	29.99482
##	133	2022-06-20	XLF.Adjusted	31.36218
##	134	2022-06-27	XLF.Adjusted	31.08089
##	135	2022-07-04	XLF.Adjusted	31.27588
##	136	2022-07-11	XLF.Adjusted	30.98340
##	137	2022-07-18	XLF.Adjusted	31.92909
##	138	2022-07-25	XLF.Adjusted	32.86502
##	139	2022-08-01	XLF.Adjusted	32.84552
##	140	2022-08-08	XLF.Adjusted	34.66865
##	141	2022-08-15	XLF.Adjusted	34.08369
##	142	2022-08-22	XLF.Adjusted	32.87477
##	143	2022-08-29	XLF.Adjusted	32.06557
##	144	2022-09-05	XLF.Adjusted	33.49874
##	145	2022-09-12	XLF.Adjusted	32.23132
##	146	2022-09-19	XLF.Adjusted	30.27170
##	147	2022-09-26	XLF.Adjusted	29.75470
##	148	2022-10-03	XLF.Adjusted	30.27413
##	149	2022-10-10	XLF.Adjusted	30.39174
##	150	2022-10-17	XLF.Adjusted	31.54821
##	151	2022-10-24	XLF.Adjusted	33.50834
##	152	2022-10-31	XLF.Adjusted	33.23392
##	153	2022-11-07	XLF.Adjusted	35.15484
##	154	2022-11-14	XLF.Adjusted	34.66481
##	155	2022-11-21	XLF.Adjusted	35.39006
##	156	2022-11-28	XLF.Adjusted	35.21365
##	157	2022-12-05	XLF.Adjusted	33.84156
##	158	2022-12-12	XLF.Adjusted	33.02811
##	159	2022-12-19	XLF.Adjusted	33.27312
##	160	2022-12-26	XLF.Adjusted	33.72831
##	161	2023-01-02	XLF.Adjusted	34.89204
##	162	2023-01-09	XLF.Adjusted	35.62183
##	163	2023-01-16	XLF.Adjusted	34.86245
##	164	2023-01-23	XLF.Adjusted	35.75004
##	165	2023-01-30	XLF.Adjusted	36.08535
##	166	2023-02-06	XLF.Adjusted	35.98673
##	167	2023-02-13	XLF.Adjusted	35.88811
##	168	2023-02-20	XLF.Adjusted	35.16818
##	169	2023-02-27	XLF.Adjusted	35.49363
##	170	2023-03-06	XLF.Adjusted	32.47583
##	171	2023-03-13	XLF.Adjusted	30.55272
##	172	2023-03-20	XLF.Adjusted	30.56259
##	173	2023-03-27	XLF.Adjusted	31.86395
##	174	2023-04-03	XLF.Adjusted	31.70538
##	175	2023-04-10	XLF.Adjusted	32.58746
##	176	2023-04-17	XLF.Adjusted	32.92443
##	177	2023-04-24	XLF.Adjusted	32.87487
##	178	2023-05-01	XLF.Adjusted	32.04235
##	179	2023-05-08	XLF.Adjusted	31.61618
##	180	2023-05-15	XLF.Adjusted	32.30995
##	181	2023-05-22	XLF.Adjusted	31.82431

##	182	2023-05-29	XLF.Adjusted	32.50817
##	183	2023-06-05	XLF.Adjusted	32.85506
##	184	2023-06-12	XLF.Adjusted	33.28123
##	185	2023-06-19	XLF.Adjusted	32.44871
##	186	2023-06-26	XLF.Adjusted	33.55998
##	187	2023-07-03	XLF.Adjusted	33.44052
##	188	2023-07-10	XLF.Adjusted	34.09758
##	189	2023-07-17	XLF.Adjusted	35.10308
##	190	2023-07-24	XLF.Adjusted	35.04335
##	191	2023-07-31	XLF.Adjusted	34.75464
##	192	2023-08-07	XLF.Adjusted	34.76460
##	193	2023-08-14	XLF.Adjusted	33.82878
##	194	2023-08-21	XLF.Adjusted	33.83874
##	195	2023-08-28	XLF.Adjusted	34.53562
##	196	2023-09-04	XLF.Adjusted	34.14736
##	197	2023-09-11	XLF.Adjusted	34.67500
##	198	2023-09-18	XLF.Adjusted	33.51020
##	199	2023-09-25	XLF.Adjusted	33.17000
##	200	2023-10-02	XLF.Adjusted	33.04000
##	201	2023-10-09	XLF.Adjusted	33.21000
##	202	2023-10-16	XLF.Adjusted	32.20000
##	203	2023-10-23	XLF.Adjusted	31.45000
##	204	2023-10-30	XLF.Adjusted	33.78000
##	205	2023-11-06	XLF.Adjusted	33.91000
##	206	2023-11-13	XLF.Adjusted	35.01000
##	207	2023-11-20	XLF.Adjusted	35.38000
##	208	2023-11-27	XLF.Adjusted	35.90000
##	209	2021-12-06	XLV.Adjusted	130.42688
##	210	2021-12-13	XLV.Adjusted	133.66382
##	211	2021-12-20	XLV.Adjusted	135.00124
##	212	2021-12-27	XLV.Adjusted	137.06688
##	213	2022-01-03	XLV.Adjusted	130.70438
##	214	2022-01-10	XLV.Adjusted	130.43195
##	215	2022-01-17	XLV.Adjusted	125.95679
##	216	2022-01-24	XLV.Adjusted	126.93934
##	217	2022-01-31	XLV.Adjusted	128.70999
##	218	2022-02-07	XLV.Adjusted	126.71561
##	219	2022-02-14	XLV.Adjusted	124.04996
##	220	2022-02-21	XLV.Adjusted	127.39662
##	221	2022-02-28	XLV.Adjusted	128.92403
##	222	2022-03-07	XLV.Adjusted	125.44116
##	223	2022-03-14	XLV.Adjusted	133.27271
##	224	2022-03-21	XLV.Adjusted	132.57227
##	225	2022-03-28	XLV.Adjusted	134.74243
##	226	2022-04-04	XLV.Adjusted	139.38770
##	227	2022-04-11	XLV.Adjusted	135.29868
##	228	2022-04-18	XLV.Adjusted	130.44847
##	229	2022-04-25	XLV.Adjusted	127.14992
##	230	2022-05-02	XLV.Adjusted	126.65221
##	231	2022-05-09	XLV.Adjusted	125.50065
##	232	2022-05-16	XLV.Adjusted	126.65221
##	233	2022-05-23	XLV.Adjusted	130.79004
##	234	2022-05-30	XLV.Adjusted	126.69125
##	235	2022-06-06	XLV.Adjusted	122.46560

```

## 236 2022-06-13 XLV.Adjusted 117.00056
## 237 2022-06-20 XLV.Adjusted 126.08620
## 238 2022-06-27 XLV.Adjusted 127.08887
## 239 2022-07-04 XLV.Adjusted 128.12772
## 240 2022-07-11 XLV.Adjusted 127.59850
## 241 2022-07-18 XLV.Adjusted 127.23589
## 242 2022-07-25 XLV.Adjusted 129.75453
## 243 2022-08-01 XLV.Adjusted 128.82352
## 244 2022-08-08 XLV.Adjusted 130.95015
## 245 2022-08-15 XLV.Adjusted 130.26416
## 246 2022-08-22 XLV.Adjusted 124.74664
## 247 2022-08-29 XLV.Adjusted 122.49260
## 248 2022-09-05 XLV.Adjusted 127.89250
## 249 2022-09-12 XLV.Adjusted 124.90343
## 250 2022-09-19 XLV.Adjusted 120.27776
## 251 2022-09-26 XLV.Adjusted 119.16323
## 252 2022-10-03 XLV.Adjusted 120.64896
## 253 2022-10-10 XLV.Adjusted 121.90839
## 254 2022-10-17 XLV.Adjusted 124.50594
## 255 2022-10-24 XLV.Adjusted 130.72435
## 256 2022-10-31 XLV.Adjusted 128.70731
## 257 2022-11-07 XLV.Adjusted 130.99002
## 258 2022-11-14 XLV.Adjusted 132.40688
## 259 2022-11-21 XLV.Adjusted 134.94539
## 260 2022-11-28 XLV.Adjusted 137.53311
## 261 2022-12-05 XLV.Adjusted 135.76204
## 262 2022-12-12 XLV.Adjusted 133.35144
## 263 2022-12-19 XLV.Adjusted 133.91228
## 264 2022-12-26 XLV.Adjusted 134.21690
## 265 2023-01-02 XLV.Adjusted 134.03906
## 266 2023-01-09 XLV.Adjusted 133.82170
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## 269 2023-01-30 XLV.Adjusted 131.09489
## 270 2023-02-06 XLV.Adjusted 130.89729
## 271 2023-02-13 XLV.Adjusted 130.40331
## 272 2023-02-20 XLV.Adjusted 126.96513
## 273 2023-02-27 XLV.Adjusted 127.61719
## 274 2023-03-06 XLV.Adjusted 122.65755
## 275 2023-03-13 XLV.Adjusted 124.34700
## 276 2023-03-20 XLV.Adjusted 125.76968
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## 278 2023-04-03 XLV.Adjusted 132.42944
## 279 2023-04-10 XLV.Adjusted 133.47087
## 280 2023-04-17 XLV.Adjusted 133.20306
## 281 2023-04-24 XLV.Adjusted 132.43935
## 282 2023-05-01 XLV.Adjusted 132.49886
## 283 2023-05-08 XLV.Adjusted 131.11031
## 284 2023-05-15 XLV.Adjusted 130.23747
## 285 2023-05-22 XLV.Adjusted 126.48836
## 286 2023-05-29 XLV.Adjusted 129.25557
## 287 2023-06-05 XLV.Adjusted 129.35475
## 288 2023-06-12 XLV.Adjusted 131.13014
## 289 2023-06-19 XLV.Adjusted 130.92186

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## 315 2021-12-20 XLY.Adjusted 199.76434
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## 397 2023-07-17 XLY.Adjusted 170.67644

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## 399 2023-07-31 XLY.Adjusted 171.24542
## 400 2023-08-07 XLY.Adjusted 169.41867
## 401 2023-08-14 XLY.Adjusted 162.37122
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## 406 2023-09-18 XLY.Adjusted 160.64427
## 407 2023-09-25 XLY.Adjusted 160.98000
## 408 2023-10-02 XLY.Adjusted 160.61000
## 409 2023-10-09 XLY.Adjusted 158.97000
## 410 2023-10-16 XLY.Adjusted 151.69000
## 411 2023-10-23 XLY.Adjusted 149.59000
## 412 2023-10-30 XLY.Adjusted 160.22000
## 413 2023-11-06 XLY.Adjusted 161.39999
## 414 2023-11-13 XLY.Adjusted 167.14000
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## 416 2023-11-27 XLY.Adjusted 168.78000
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## 434 2022-04-04 XLE.Adjusted 74.99247
## 435 2022-04-11 XLE.Adjusted 75.29421
## 436 2022-04-18 XLE.Adjusted 71.85244
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## 438 2022-05-02 XLE.Adjusted 78.18904
## 439 2022-05-09 XLE.Adjusted 76.17113
## 440 2022-05-16 XLE.Adjusted 77.10466
## 441 2022-05-23 XLE.Adjusted 83.47898
## 442 2022-05-30 XLE.Adjusted 84.40306
## 443 2022-06-06 XLE.Adjusted 83.64870
## 444 2022-06-13 XLE.Adjusted 69.29707
## 445 2022-06-20 XLE.Adjusted 67.50547
## 446 2022-06-27 XLE.Adjusted 69.20649
## 447 2022-07-04 XLE.Adjusted 67.65225
## 448 2022-07-11 XLE.Adjusted 65.40194
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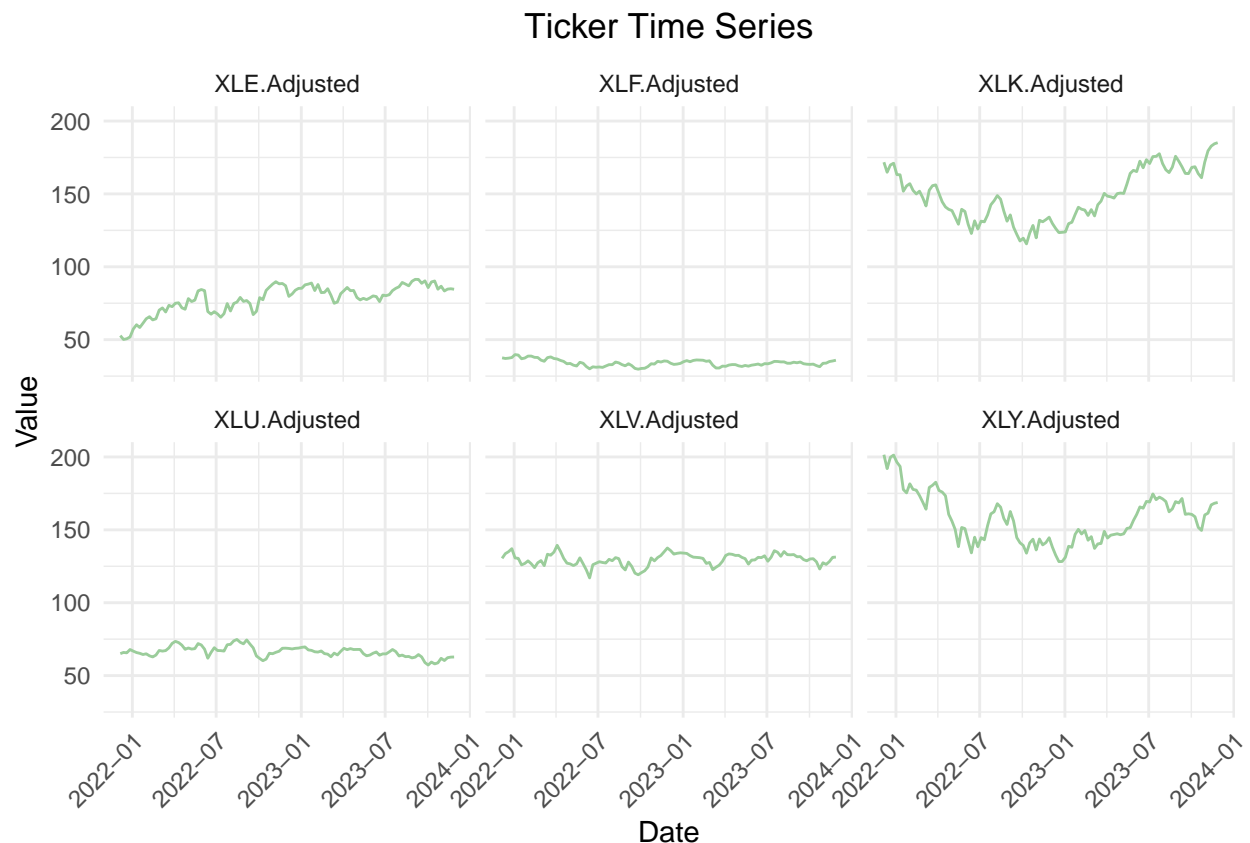
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##	463	2022-10-24	XLE.Adjusted	86.02953
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##	469	2022-12-05	XLE.Adjusted	79.69659
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##	472	2022-12-26	XLE.Adjusted	85.18214
##	473	2023-01-02	XLE.Adjusted	85.26978
##	474	2023-01-09	XLE.Adjusted	87.59726
##	475	2023-01-16	XLE.Adjusted	88.11341
##	476	2023-01-23	XLE.Adjusted	88.84379
##	477	2023-01-30	XLE.Adjusted	83.71163
##	478	2023-02-06	XLE.Adjusted	87.85046
##	479	2023-02-13	XLE.Adjusted	82.28008
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##	481	2023-02-27	XLE.Adjusted	84.97763
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##	484	2023-03-20	XLE.Adjusted	75.85271
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##	554	2022-07-25	XLU.Adjusted	71.16952
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##	599	2023-06-05	XLU.Adjusted	65.33086
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## 619 2023-10-23 XLU.Adjusted 58.73000
## 620 2023-10-30 XLU.Adjusted 61.86000
## 621 2023-11-06 XLU.Adjusted 60.32000
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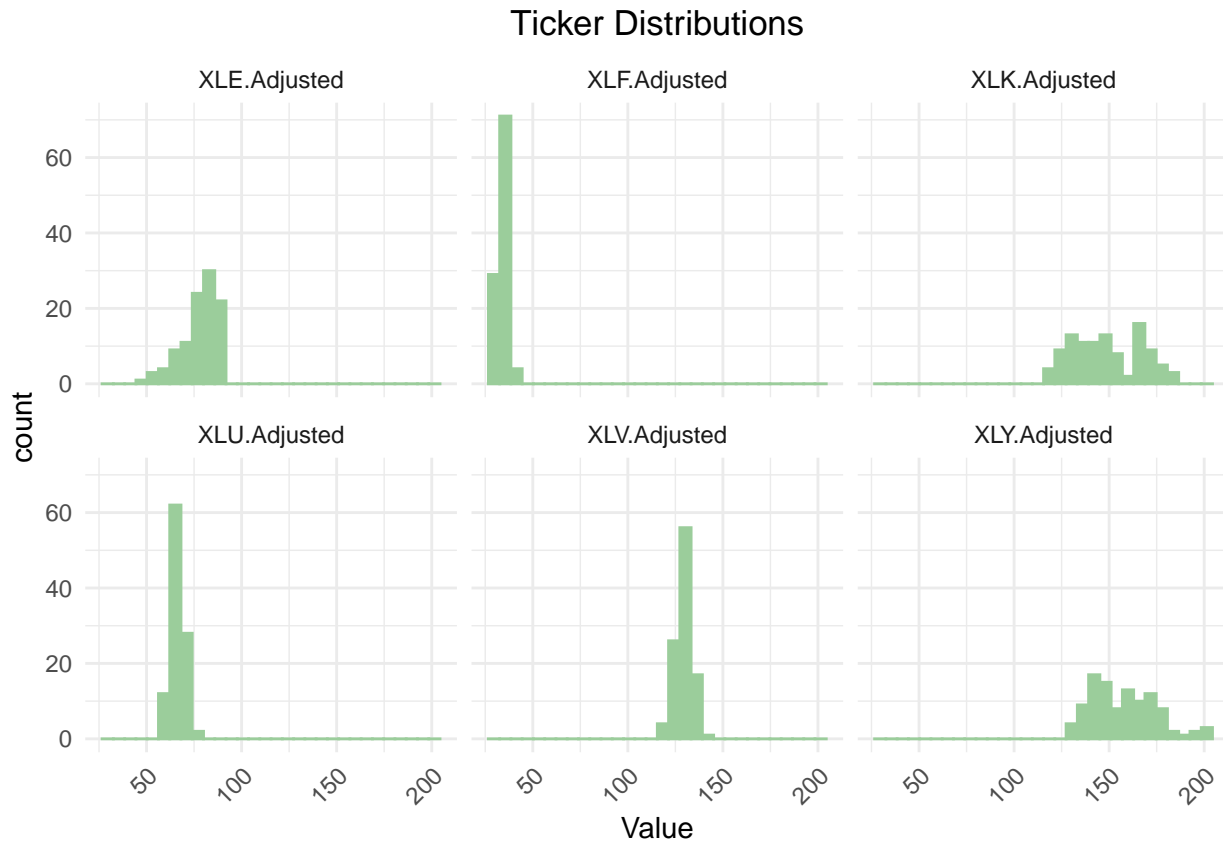
```
# Line Chart
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  facet_wrap(~Ticker) +
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  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        plot.title = element_text(hjust = 0.5))
```



```
# Histogram
ggplot(ticker_data_df, aes(Value)) +
  geom_histogram(color='darkseagreen3', fill='darkseagreen3') +
  facet_wrap(~Ticker) +
```

```
ggtitle("Ticker Distributions") +
theme_minimal() +
theme(axis.text.x = element_text(angle = 45, hjust = 1),
      plot.title = element_text(hjust = 0.5))
```

## `stat\_bin()` using `bins = 30`. Pick better value with `binwidth`.



*# Line chart*

*# Convert 'date' column to POSIXct format*

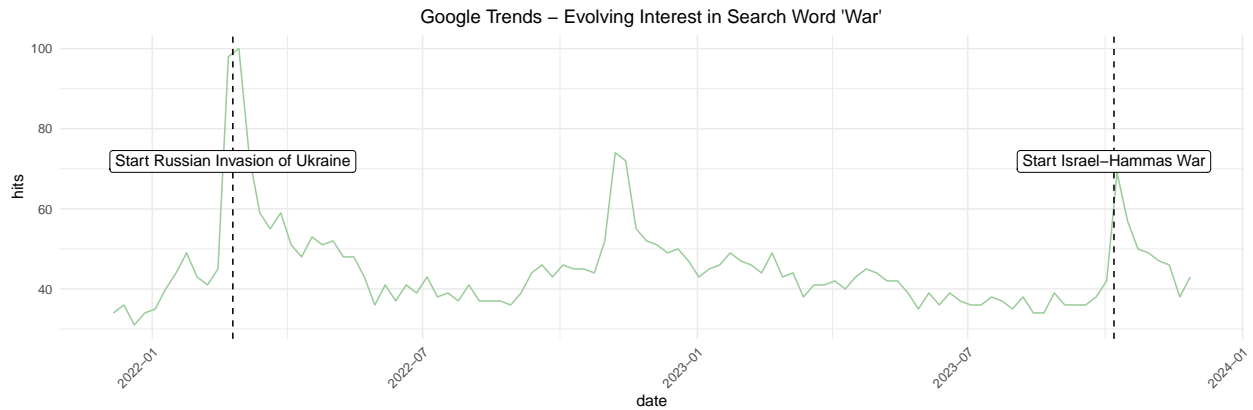
```
gtrends_war_web$date <- as.POSIXct(gtrends_war_web$date, format = "%Y-%m-%d")
```

```
ggplot(gtrends_war_web, aes(date, hits)) +
  geom_line(color='darkseagreen3') +
  theme_minimal() +
  ggtitle("Google Trends - Evolving Interest in Search Word 'War'") +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        plot.title = element_text(hjust = 0.5)) +
  geom_vline(xintercept = as.POSIXct("2022-02-24"), linetype="dashed",
             color = "black", size=0.5) +
  annotate('label', x=as.POSIXct("2022-02-24"), y=80,
         label="Start Russian Invasion of Ukraine", vjust=2, color="black") +
```



```
geom_vline(xintercept = as.POSIXct("2023-10-07"), linetype="dashed",
           color = "black", size=0.5) +
annotate('label', x=as.POSIXct("2023-10-07"), y=80,
         label="Start Israel-Hammas War", vjust=2, color="black")
```

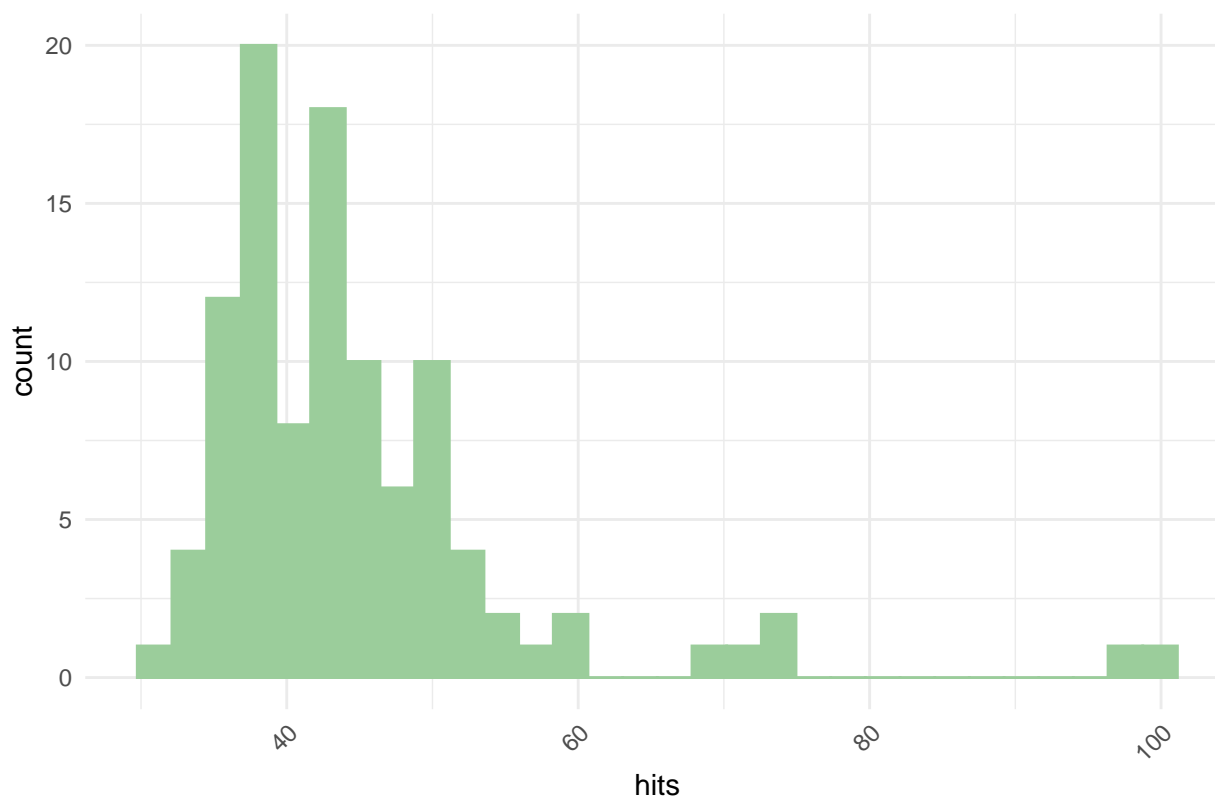
## Visualize Google Trends Data



```
# Histogram
ggplot(gtrends_war_web, aes(hits)) +
  geom_histogram(color='darkseagreen3', fill='darkseagreen3') +
  ggtitle("Search Word 'War' Distribution") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        plot.title = element_text(hjust = 0.5))
```

## `stat\_bin()` using `bins = 30`. Pick better value with `binwidth`.

## Search Word 'War' Distribution



## Stationarity test and adjustment

Ticker Data

```
# Check stationarity
sapply(ticker_data, adf.test)
```

```
##           XLK.Adjusted           XLF.Adjusted
## statistic  -1.952864          -2.839782
## parameter   4                  4
## alternative "stationary"       "stationary"
## p.value     0.5962104         0.228462
## method      "Augmented Dickey-Fuller Test" "Augmented Dickey-Fuller Test"
## data.name    "X[[i]]"         "X[[i]]"
##           XLV.Adjusted           XLY.Adjusted
## statistic  -3.79224            -2.573108
## parameter   4                  4
## alternative "stationary"       "stationary"
## p.value     0.0219477         0.3390348
## method      "Augmented Dickey-Fuller Test" "Augmented Dickey-Fuller Test"
## data.name    "X[[i]]"         "X[[i]]"
##           XLE.Adjusted           XLU.Adjusted
## statistic  -3.427279          -3.526365
## parameter   4                  4
## alternative "stationary"       "stationary"
```

```
## p.value      0.05372016      0.04313619
## method      "Augmented Dickey-Fuller Test" "Augmented Dickey-Fuller Test"
## data.name    "X[[i]]"      "X[[i]]"
```

Non-stationary are XLK, XLF, XLY, XLE. Make them stationary. Only log the others.

```
ticker_data_differenced <- NULL
ticker_data_differenced$XLK.Adjusted <- na.omit(diff(log(ticker_data$XLK.Adjusted)))
ticker_data_differenced$XLF.Adjusted <- na.omit(diff(log(ticker_data$XLF.Adjusted)))
ticker_data_differenced$XLY.Adjusted <- na.omit(diff(log(ticker_data$XLY.Adjusted)))
ticker_data_differenced$XLE.Adjusted <- na.omit(diff(log(ticker_data$XLE.Adjusted)))

# Already stationary ticker series
ticker_data_differenced$XLV.Adjusted <- log(ticker_data$XLV.Adjusted)
ticker_data_differenced$XLU.Adjusted <- log(ticker_data$XLU.Adjusted)

# For non differenced time series remove first row
ticker_data_differenced$XLV.Adjusted <- ticker_data_differenced$XLV.Adjusted[-1,]
ticker_data_differenced$XLU.Adjusted <- ticker_data_differenced$XLU.Adjusted[-1,]
```

Google Trends Data

```
adf.test(gtrends_war_web$hits)
```

```
##
## Augmented Dickey-Fuller Test
##
## data: gtrends_war_web$hits
## Dickey-Fuller = -3.5513, Lag order = 4, p-value = 0.0409
## alternative hypothesis: stationary
```

Not stationary and distribution has long tail on right → Log Diff. Although p value is slightly below 0.05

```
logged_diff_hits <- na.omit(diff(log(gtrends_war_web$hits)))

corresponding_dates <- gtrends_war_web[-1,]$date # +1 due to diff reduction

gtrends_war_web_differenced <- data.frame(
  date = corresponding_dates,
  hits = logged_diff_hits
)
gtrends_war_web_differenced
```

```
##      date      hits
## 1 2021-12-13 0.05715841
## 2 2021-12-20 -0.14953173
## 3 2021-12-27 0.09237332
## 4 2022-01-03 0.02898754
## 5 2022-01-10 0.13353139
## 6 2022-01-17 0.09531018
## 7 2022-01-24 0.10763066
## 8 2022-01-31 -0.13062018
```

## 9	2022-02-07	-0.04762805
## 10	2022-02-14	0.09309042
## 11	2022-02-21	0.77830499
## 12	2022-02-28	0.02020271
## 13	2022-03-07	-0.31471074
## 14	2022-03-14	-0.21292200
## 15	2022-03-21	-0.07020426
## 16	2022-03-28	0.07020426
## 17	2022-04-04	-0.14571181
## 18	2022-04-11	-0.06062462
## 19	2022-04-18	0.09909090
## 20	2022-04-25	-0.03846628
## 21	2022-05-02	0.01941809
## 22	2022-05-09	-0.08004271
## 23	2022-05-16	0.00000000
## 24	2022-05-23	-0.11000090
## 25	2022-05-30	-0.17768118
## 26	2022-06-06	0.13005313
## 27	2022-06-13	-0.10265415
## 28	2022-06-20	0.10265415
## 29	2022-06-27	-0.05001042
## 30	2022-07-04	0.09763847
## 31	2022-07-11	-0.12361396
## 32	2022-07-18	0.02597549
## 33	2022-07-25	-0.05264373
## 34	2022-08-01	0.10265415
## 35	2022-08-08	-0.10265415
## 36	2022-08-15	0.00000000
## 37	2022-08-22	0.00000000
## 38	2022-08-29	-0.02739897
## 39	2022-09-05	0.08004271
## 40	2022-09-12	0.12062799
## 41	2022-09-19	0.04445176
## 42	2022-09-26	-0.06744128
## 43	2022-10-03	0.06744128
## 44	2022-10-10	-0.02197891
## 45	2022-10-17	0.00000000
## 46	2022-10-24	-0.02247286
## 47	2022-10-31	0.16705408
## 48	2022-11-07	0.35282137
## 49	2022-11-14	-0.02739897
## 50	2022-11-21	-0.26933293
## 51	2022-11-28	-0.05608947
## 52	2022-12-05	-0.01941809
## 53	2022-12-12	-0.04000533
## 54	2022-12-19	0.02020271
## 55	2022-12-26	-0.06187540
## 56	2023-01-02	-0.08894749
## 57	2023-01-09	0.04546237
## 58	2023-01-16	0.02197891
## 59	2023-01-23	0.06317890
## 60	2023-01-30	-0.04167270
## 61	2023-02-06	-0.02150621
## 62	2023-02-13	-0.04445176

```
## 63 2023-02-20 0.10763066
## 64 2023-02-27 -0.13062018
## 65 2023-03-06 0.02298952
## 66 2023-03-13 -0.14660347
## 67 2023-03-20 0.07598591
## 68 2023-03-27 0.00000000
## 69 2023-04-03 0.02409755
## 70 2023-04-10 -0.04879016
## 71 2023-04-17 0.07232066
## 72 2023-04-24 0.04546237
## 73 2023-05-01 -0.02247286
## 74 2023-05-08 -0.04652002
## 75 2023-05-15 0.00000000
## 76 2023-05-22 -0.07410797
## 77 2023-05-29 -0.10821358
## 78 2023-06-05 0.10821358
## 79 2023-06-12 -0.08004271
## 80 2023-06-19 0.08004271
## 81 2023-06-26 -0.05264373
## 82 2023-07-03 -0.02739897
## 83 2023-07-10 0.00000000
## 84 2023-07-17 0.05406722
## 85 2023-07-24 -0.02666825
## 86 2023-07-31 -0.05556985
## 87 2023-08-07 0.08223810
## 88 2023-08-14 -0.11122564
## 89 2023-08-21 0.00000000
## 90 2023-08-28 0.13720112
## 91 2023-09-04 -0.08004271
## 92 2023-09-11 0.00000000
## 93 2023-09-18 0.00000000
## 94 2023-09-25 0.05406722
## 95 2023-10-02 0.10008346
## 96 2023-10-09 0.49643689
## 97 2023-10-16 -0.19105524
## 98 2023-10-23 -0.13102826
## 99 2023-10-30 -0.02020271
## 100 2023-11-06 -0.04167270
## 101 2023-11-13 -0.02150621
## 102 2023-11-20 -0.19105524
## 103 2023-11-27 0.12361396
```

Check that differenced time series have same length.

```
# Check length of time series
length(gtrends_war_web_differenced$date) == length(ticker_data_differenced$XLK.Adjusted)
```

```
## [1] TRUE
```

```
length(gtrends_war_web_differenced$date)
```

```
## [1] 103
```

```
length(ticker_data_differenced$XLK.Adjusted)
```

```
## [1] 103
```

```
min(gtrends_war_web_differenced$date)
```

```
## [1] "2021-12-13 GMT"
```

```
max(gtrends_war_web_differenced$date)
```

```
## [1] "2023-11-27 GMT"
```

```
df <- merge(gtrends_war_web_differenced, ticker_data_differenced)
```

Create final dataframe

```
# Make tickers in list to dataframe
```

```
ticker_data_differenced_df <- do.call(cbind.data.frame, ticker_data_differenced)
```

```
# Make date index to column for merging
```

```
ticker_data_differenced_df$date <- rownames(ticker_data_differenced_df)
```

```
# Make date in gtrends to character in order to merge
```

```
gtrends_war_web_differenced$date <- format(gtrends_war_web_differenced$date, format = "%Y-%m-%d")
```

```
# Merge
```

```
war_ticker_df <- left_join(gtrends_war_web_differenced, ticker_data_differenced_df)
```

```
## Joining, by = "date"
```

## 4. VAR & Causality Testing

TODO: - Check lag.max what to apply - Control variable?

```
# Create ticker list
```

```
ticker_cols <- colnames(war_ticker_df)[3:8]
```

```
for (Ticker in ticker_cols) {
```

```
  # Create data for VAR
```

```
  print(Ticker)
```

```
  data_for_var <- cbind(war_interest=war_ticker_df$hits, ticker=war_ticker_df[[Ticker]])
```

```
  # Run VAR model
```

```
  VAR_est <- VAR(data_for_var, ic = "AIC", lag.max = 24)
```

```
  coefs <- coeftest(VAR_est)
```

```
  summ <- summary(VAR_est)
```

```
  print(coefs)
```

```

print(summ)

# Run Granger Causality Test
causal <- causality(VAR_est, cause="war_interest")["Granger"]
print(causal)

# Impulse response functions
plot(irf(VAR_est, impulse="war_interest", response="ticker"))
}

```

```

## [1] "XLK.Adjusted"
##
## t test of coefficients:
##
##
##               Estimate Std. Error t value Pr(>|t|)
## war_interest:(Intercept)    0.0019004  0.0135260  0.1405  0.8885
## war_interest:war_interest.l1 0.0183628  0.1006158  0.1825  0.8556
## war_interest:ticker.l1      -0.2558441  0.3843173 -0.6657  0.5071
## ticker:(Intercept)          0.0012078  0.0034786  0.3472  0.7292
## ticker:war_interest.l1      -0.0343895  0.0258762 -1.3290  0.1869
## ticker:ticker.l1            -0.0464416  0.0988381 -0.4699  0.6395
##
##
## VAR Estimation Results:
## =====
## Endogenous variables: war_interest, ticker
## Deterministic variables: const
## Sample size: 102
## Log Likelihood: 258.28
## Roots of the characteristic polynomial:
## 0.1133 0.0852
## Call:
## VAR(y = data_for_var, lag.max = 24, ic = "AIC")
##
##
## Estimation results for equation war_interest:
## =====
## war_interest = war_interest.l1 + ticker.l1 + const
##
##               Estimate Std. Error t value Pr(>|t|)
## war_interest.l1  0.01836    0.10062   0.183   0.856
## ticker.l1        -0.25584    0.38432  -0.666   0.507
## const            0.00190    0.01353   0.141   0.889
##
##
## Residual standard error: 0.1366 on 99 degrees of freedom
## Multiple R-Squared: 0.004734, Adjusted R-squared: -0.01537
## F-statistic: 0.2355 on 2 and 99 DF, p-value: 0.7907
##
##
## Estimation results for equation ticker:
## =====

```

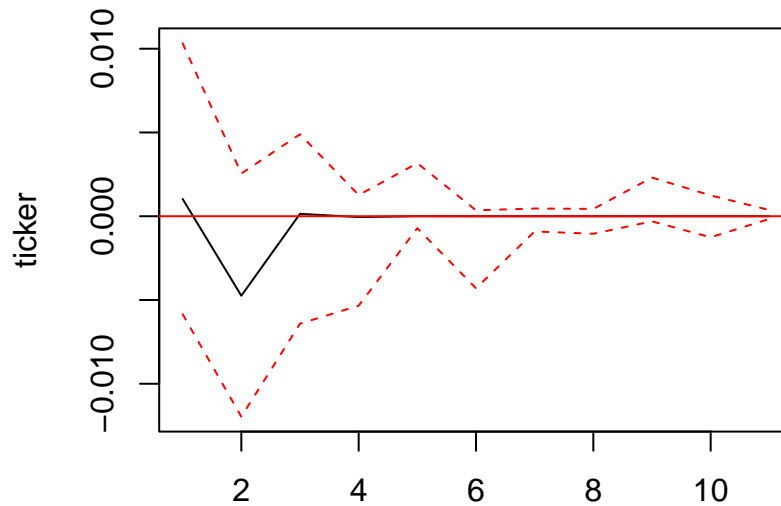
```

## ticker = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1 -0.034389   0.025876  -1.329   0.187
## ticker.l1       -0.046442   0.098838  -0.470   0.639
## const           0.001208   0.003479   0.347   0.729
##
##
## Residual standard error: 0.03512 on 99 degrees of freedom
## Multiple R-Squared: 0.01998, Adjusted R-squared: 0.0001809
## F-statistic: 1.009 on 2 and 99 DF,  p-value: 0.3683
##
##
## Covariance matrix of residuals:
##           war_interest    ticker
## war_interest    0.0186527 0.0001405
## ticker           0.0001405 0.0012337
##
## Correlation matrix of residuals:
##           war_interest    ticker
## war_interest    1.00000 0.02928
## ticker           0.02928 1.00000
##
##
## $Granger
##
## Granger causality H0: war_interest do not Granger-cause ticker
##
## data:  VAR object VAR_est
## F-Test = 1.7662, df1 = 1, df2 = 198, p-value = 0.1854

```



### Orthogonal Impulse Response from war\_interest



95 % Bootstrap CI, 100 runs

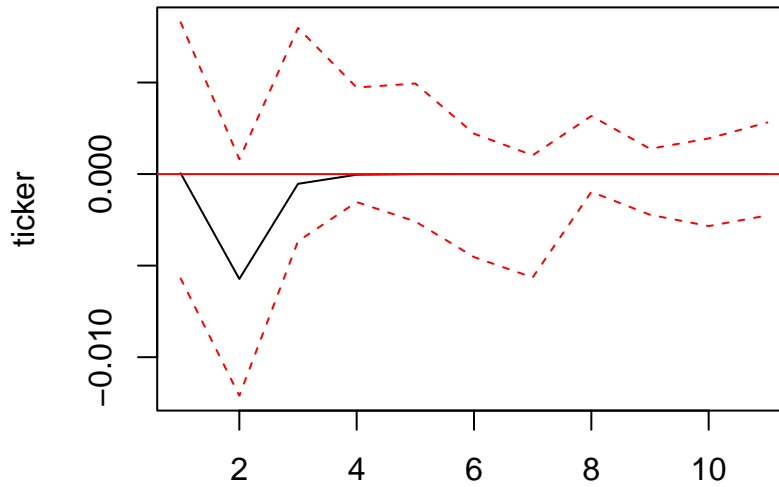
```
## [1] "XLF.Adjusted"
##
## t test of coefficients:
##
##               Estimate Std. Error t value Pr(>|t|)
## war_interest:(Intercept)    0.00174206  0.01355560   0.1285  0.89800
## war_interest:war_interest.l1 0.01680025  0.10081122   0.1667  0.86798
## war_interest:ticker.l1      0.03166530  0.43553251   0.0727  0.94219
## ticker:(Intercept)         -0.00023234  0.00306855  -0.0757  0.93980
## ticker:war_interest.l1     -0.04189318  0.02282041  -1.8358  0.06939
## ticker:ticker.l1           0.07606430  0.09859051   0.7715  0.44224
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## VAR Estimation Results:
## =====
## Endogenous variables: war_interest, ticker
## Deterministic variables: const
## Sample size: 102
## Log Likelihood: 270.802
## Roots of the characteristic polynomial:
## 0.05103 0.05103
## Call:
## VAR(y = data_for_var, lag.max = 24, ic = "AIC")
##
```

```

##
## Estimation results for equation war_interest:
## =====
## war_interest = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1 0.016800   0.100811   0.167   0.868
## ticker.l1       0.031665   0.435533   0.073   0.942
## const          0.001742   0.013556   0.129   0.898
##
##
## Residual standard error: 0.1369 on 99 degrees of freedom
## Multiple R-Squared: 0.0003321, Adjusted R-squared: -0.01986
## F-statistic: 0.01645 on 2 and 99 DF, p-value: 0.9837
##
##
## Estimation results for equation ticker:
## =====
## ticker = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1 -0.0418932 0.0228204 -1.836 0.0694 .
## ticker.l1       0.0760643 0.0985905 0.772 0.4422
## const          -0.0002323 0.0030685 -0.076 0.9398
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.03098 on 99 degrees of freedom
## Multiple R-Squared: 0.03869, Adjusted R-squared: 0.01927
## F-statistic: 1.992 on 2 and 99 DF, p-value: 0.1418
##
##
##
## Covariance matrix of residuals:
##           war_interest  ticker
## war_interest  1.874e-02 6.103e-06
## ticker        6.103e-06 9.600e-04
##
## Correlation matrix of residuals:
##           war_interest  ticker
## war_interest  1.000000 0.001439
## ticker        0.001439 1.000000
##
##
## $Granger
##
## Granger causality H0: war_interest do not Granger-cause ticker
##
## data:  VAR object VAR_est
## F-Test = 3.3701, df1 = 1, df2 = 198, p-value = 0.06789

```

# Orthogonal Impulse Response from war\_interest



95 % Bootstrap CI, 100 runs

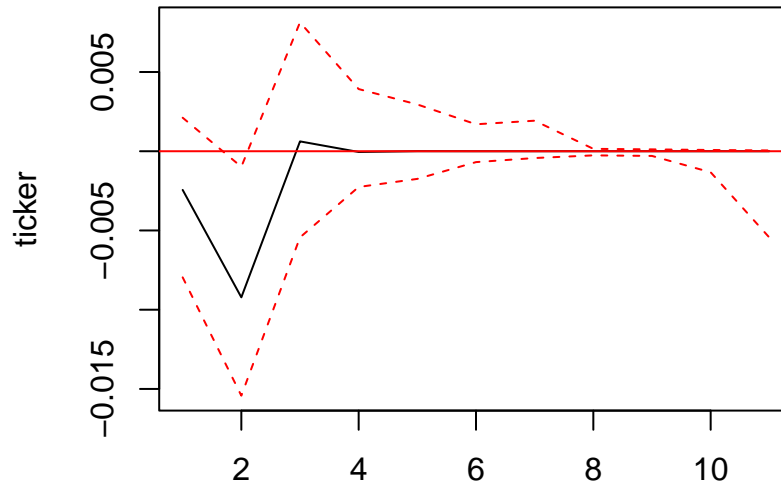
```
## [1] "XLY.Adjusted"
##
## t test of coefficients:
##
##               Estimate Std. Error t value Pr(>|t|)
## war_interest:(Intercept)    0.0017438  0.0135681  0.1285  0.89800
## war_interest:war_interest.l1 0.0169898  0.1010904  0.1681  0.86687
## war_interest:ticker.l1      0.0114933  0.3598942  0.0319  0.97459
## ticker:(Intercept)         -0.0013380  0.0036460 -0.3670  0.71443
## ticker:war_interest.l1     -0.0688594  0.0271651 -2.5348  0.01282 *
## ticker:ticker.l1           -0.0844315  0.0967112 -0.8730  0.38476
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## VAR Estimation Results:
## =====
## Endogenous variables: war_interest, ticker
## Deterministic variables: const
## Sample size: 102
## Log Likelihood: 253.528
## Roots of the characteristic polynomial:
## 0.07591 0.008471
## Call:
## VAR(y = data_for_var, lag.max = 24, ic = "AIC")
##
```

```

##
## Estimation results for equation war_interest:
## =====
## war_interest = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1 0.016990  0.101090  0.168  0.867
## ticker.l1       0.011493  0.359894  0.032  0.975
## const          0.001744  0.013568  0.129  0.898
##
##
## Residual standard error: 0.1369 on 99 degrees of freedom
## Multiple R-Squared: 0.0002891, Adjusted R-squared: -0.01991
## F-statistic: 0.01431 on 2 and 99 DF, p-value: 0.9858
##
##
## Estimation results for equation ticker:
## =====
## ticker = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1 -0.068859  0.027165 -2.535  0.0128 *
## ticker.l1       -0.084432  0.096711 -0.873  0.3848
## const          -0.001338  0.003646 -0.367  0.7144
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.03678 on 99 degrees of freedom
## Multiple R-Squared: 0.06513, Adjusted R-squared: 0.04624
## F-statistic: 3.448 on 2 and 99 DF, p-value: 0.03566
##
##
## Covariance matrix of residuals:
##           war_interest  ticker
## war_interest  0.018736 -0.000334
## ticker       -0.000334  0.001353
##
## Correlation matrix of residuals:
##           war_interest  ticker
## war_interest  1.00000 -0.06634
## ticker       -0.06634  1.00000
##
##
## $Granger
##
## Granger causality H0: war_interest do not Granger-cause ticker
##
## data:  VAR object VAR_est
## F-Test = 6.4254, df1 = 1, df2 = 198, p-value = 0.01202

```

# Orthogonal Impulse Response from war\_interest



95 % Bootstrap CI, 100 runs

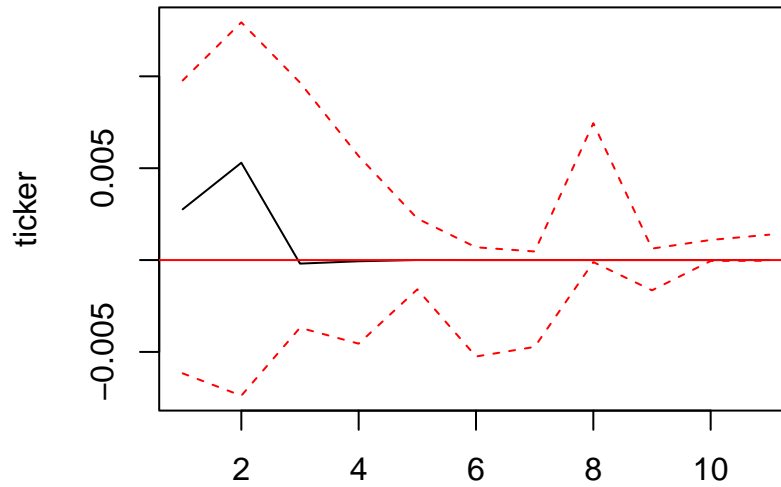
```
## [1] "XLE.Adjusted"
##
## t test of coefficients:
##
##               Estimate Std. Error t value Pr(>|t|)
## war_interest:(Intercept)    0.0034254  0.0135124   0.2535  0.8004
## war_interest:war_interest.l1 0.0248357  0.1002100   0.2478  0.8048
## war_interest:ticker.l1      -0.3667610  0.2898420  -1.2654  0.2087
## ticker:(Intercept)          0.0053365  0.0046250   1.1538  0.2513
## ticker:war_interest.l1       0.0401130  0.0342994   1.1695  0.2450
## ticker:ticker.l1            -0.0541658  0.0992058  -0.5460  0.5863
##
##
## VAR Estimation Results:
## =====
## Endogenous variables: war_interest, ticker
## Deterministic variables: const
## Sample size: 102
## Log Likelihood: 230.441
## Roots of the characteristic polynomial:
## 0.1156 0.1156
## Call:
## VAR(y = data_for_var, lag.max = 24, ic = "AIC")
##
##
## Estimation results for equation war_interest:
```

```

## =====
## war_interest = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1  0.024836   0.100210   0.248   0.805
## ticker.l1        -0.366761   0.289842  -1.265   0.209
## const           0.003425   0.013512   0.253   0.800
##
##
## Residual standard error: 0.1358 on 99 degrees of freedom
## Multiple R-Squared: 0.01619, Adjusted R-squared: -0.003684
## F-statistic: 0.8146 on 2 and 99 DF, p-value: 0.4458
##
##
## Estimation results for equation ticker:
## =====
## ticker = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1  0.040113   0.034299   1.169   0.245
## ticker.l1        -0.054166   0.099206  -0.546   0.586
## const           0.005336   0.004625   1.154   0.251
##
##
## Residual standard error: 0.04648 on 99 degrees of freedom
## Multiple R-Squared: 0.01582, Adjusted R-squared: -0.004067
## F-statistic: 0.7954 on 2 and 99 DF, p-value: 0.4542
##
##
##
## Covariance matrix of residuals:
##           war_interest  ticker
## war_interest  0.0184380 0.0003749
## ticker        0.0003749 0.0021601
##
## Correlation matrix of residuals:
##           war_interest  ticker
## war_interest  1.00000 0.05941
## ticker        0.05941 1.00000
##
##
## $Granger
##
## Granger causality H0: war_interest do not Granger-cause ticker
##
## data:  VAR object VAR_est
## F-Test = 1.3677, df1 = 1, df2 = 198, p-value = 0.2436

```

### Orthogonal Impulse Response from war\_interest



95 % Bootstrap CI, 100 runs

```
## [1] "XLV.Adjusted"
##
## t test of coefficients:
##
##               Estimate Std. Error t value Pr(>|t|)
## war_interest:(Intercept)    1.863990   2.038020   0.9146  0.362620
## war_interest:war_interest.l1  0.011824   0.100534   0.1176  0.906615
## war_interest:ticker.l1     -0.382921   0.419051  -0.9138  0.363051
## ticker:(Intercept)         1.212202   0.318124   3.8105  0.000241 ***
## ticker:war_interest.l1     -0.011666   0.015693  -0.7434  0.458995
## ticker:ticker.l1           0.750711   0.065412  11.4767 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## VAR Estimation Results:
## =====
## Endogenous variables: war_interest, ticker
## Deterministic variables: const
## Sample size: 102
## Log Likelihood: 309.6
## Roots of the characteristic polynomial:
## 0.7567 0.005827
## Call:
## VAR(y = data_for_var, lag.max = 24, ic = "AIC")
##
```

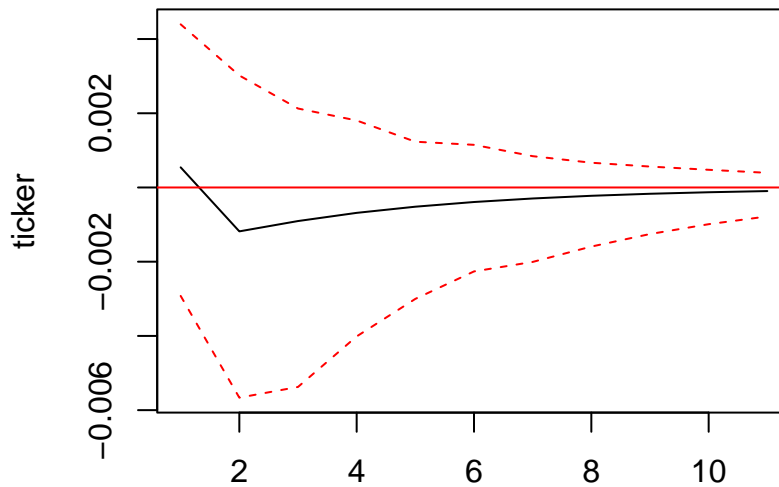
```

##
## Estimation results for equation war_interest:
## =====
## war_interest = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1  0.01182    0.10053   0.118   0.907
## ticker.l1        -0.38292    0.41905  -0.914   0.363
## const           1.86399    2.03802   0.915   0.363
##
##
## Residual standard error: 0.1363 on 99 degrees of freedom
## Multiple R-Squared: 0.00864, Adjusted R-squared: -0.01139
## F-statistic: 0.4314 on 2 and 99 DF, p-value: 0.6508
##
##
## Estimation results for equation ticker:
## =====
## ticker = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1 -0.01167    0.01569  -0.743 0.458995
## ticker.l1        0.75071    0.06541  11.477 < 2e-16 ***
## const           1.21220    0.31812   3.810 0.000241 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.02128 on 99 degrees of freedom
## Multiple R-Squared: 0.5743, Adjusted R-squared: 0.5657
## F-statistic: 66.78 on 2 and 99 DF, p-value: < 2.2e-16
##
##
## Covariance matrix of residuals:
##           war_interest  ticker
## war_interest  1.858e-02 7.394e-05
## ticker        7.394e-05 4.527e-04
##
## Correlation matrix of residuals:
##           war_interest  ticker
## war_interest  1.00000 0.02549
## ticker        0.02549 1.00000
##
##
## $Granger
##
## Granger causality H0: war_interest do not Granger-cause ticker
##
## data:  VAR object VAR_est
## F-Test = 0.55266, df1 = 1, df2 = 198, p-value = 0.4581

```



### Orthogonal Impulse Response from war\_interest



95 % Bootstrap CI, 100 runs

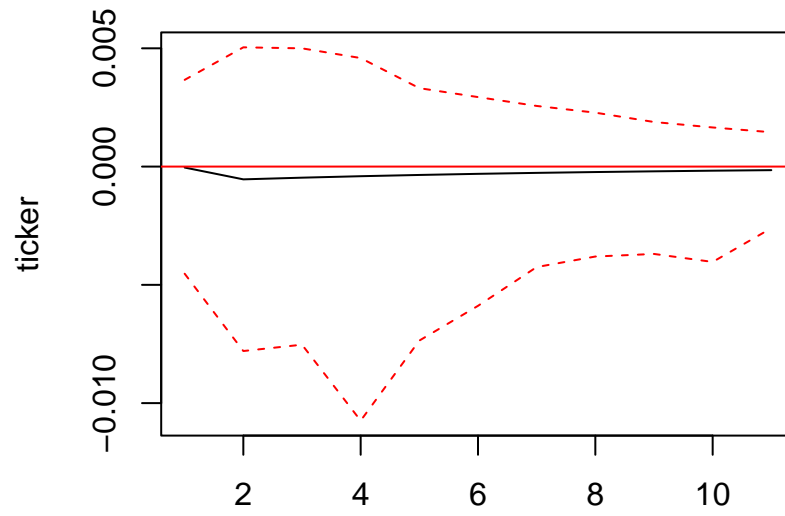
```
## [1] "XLU.Adjusted"
##
## t test of coefficients:
##
##               Estimate Std. Error t value Pr(>|t|)
## war_interest:(Intercept)    1.3418463  1.0308317   1.3017  0.1960
## war_interest:war_interest.l1  0.0028875  0.1005288   0.0287  0.9771
## war_interest:ticker.l1     -0.3195804  0.2458026  -1.3002  0.1966
## ticker:(Intercept)          0.5595920  0.2148088   2.6051  0.0106 *
## ticker:war_interest.l1     -0.0037225  0.0209486  -0.1777  0.8593
## ticker:ticker.l1           0.8664395  0.0512213  16.9156 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## VAR Estimation Results:
## =====
## Endogenous variables: war_interest, ticker
## Deterministic variables: const
## Sample size: 102
## Log Likelihood: 280.967
## Roots of the characteristic polynomial:
## 0.8678 0.001512
## Call:
## VAR(y = data_for_var, lag.max = 24, ic = "AIC")
##
```

```

##
## Estimation results for equation war_interest:
## =====
## war_interest = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1  0.002887   0.100529   0.029   0.977
## ticker.l1        -0.319580   0.245803  -1.300   0.197
## const           1.341846   1.030832   1.302   0.196
##
##
## Residual standard error: 0.1357 on 99 degrees of freedom
## Multiple R-Squared: 0.01706, Adjusted R-squared: -0.002795
## F-statistic: 0.8592 on 2 and 99 DF, p-value: 0.4266
##
##
## Estimation results for equation ticker:
## =====
## ticker = war_interest.l1 + ticker.l1 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## war_interest.l1 -0.003722   0.020949  -0.178   0.8593
## ticker.l1        0.866440   0.051221  16.916 <2e-16 ***
## const           0.559592   0.214809   2.605  0.0106 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.02828 on 99 degrees of freedom
## Multiple R-Squared: 0.7455, Adjusted R-squared: 0.7404
## F-statistic: 145 on 2 and 99 DF, p-value: < 2.2e-16
##
##
## Covariance matrix of residuals:
##           war_interest    ticker
## war_interest  1.842e-02 -5.529e-06
## ticker        -5.529e-06  7.999e-04
##
## Correlation matrix of residuals:
##           war_interest    ticker
## war_interest  1.00000 -0.00144
## ticker        -0.00144  1.00000
##
##
## $Granger
##
## Granger causality H0: war_interest do not Granger-cause ticker
##
## data:  VAR object VAR_est
## F-Test = 0.031576, df1 = 1, df2 = 198, p-value = 0.8591

```

Orthogonal Impulse Response from war\_interest



95 % Bootstrap CI, 100 runs

## 5. Results & Discussion