

# *Explaining US Stock Market Directions using Technical Indicators and Investor Sentiment*

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## **Abstract**

This paper provides a stock market forecasting model that utilizes technical indicators and investor sentiment as part of the analysis. We create and apply a logit model with 0 and 1 representing bull and bear markets as the Y variable, and utilize technical indicators to measure the proxy of investor sentiment as well as the momentum. We believe that this model could be helpful for predicting stock market direction to help clients make the best investment decisions in trading strategies.

# Introduction

Forecasting stock market price movement is a well-researched and an alluring topic within the machine learning and financial realm. Given its complexity, the attraction of minimizing risk and increasing odds has brought much attention towards finding the best approach. What's less researched is the direction of the stock price, which is the focus of my research. There are three key components: Technicals, Sentiment, and Market Direction. Technicals, Sentiment, and Market Direction are interconnected. The direction of the stock price is determined by technical indicators which are driven by investors' sentiment. Technical analysis is an analysis methodology for forecasting the direction of prices through the study of past market data, primarily price and volume. Market sentiment is the general prevailing attitude of investors as to anticipated price development in a market. A predictive system that could accurately forecast the direction of a stock price movement helps investors to make rational decisions, to improve profitability, and risk management. The reason we are investigating the direction of the market rather than the magnitude is that providing information on bull and bear states to clients, investors, researchers, and practitioners is the top priority. With information on the market direction, they will be able to make rational investment decisions based on the most recent market performance, i.e. whether there will be a peak to sell their current shares to make profits, or if the market will reach the lowest point in the following weeks which could potentially be a signal to buy stock shares. One important question to ask is: does sentiment play a role in technical indicators' ability to forecast market direction? Our contribution to the current literature review is that we utilize 45 different industries with daily returns and daily price index as our dataset to make further analysis on bull/bear state, duration, amplitude of the bull/bear,

etc, whereas current literature usually only applies SP500 and make analysis based on regression results from SP500. That's one of the largest contributions of my research to the current literature. Another innovation involves the use of DVI as our technical analysis. DVI has not been widely used as a technical indicator by other literature available online to predict stock market direction, price movement, as well as volatility spillover. DVI is one type of oscillator. The current DVI is a combination of two different indicators: 1) DVIM- DVI Magnitude which measures the distance price has traveled over multiple intermediate time frames and 2) DVI Stretch which measures the net up or down days over multiple time frames. Both indicators are complementary and combine to produce a superior composite- the DVI- in most cases. The DVI line is very smooth and is designed to help identify areas of higher or lower value rather than peaks or valleys as it stays in oversold or overbought territory for longer periods. This makes it ideal for combination with intermediate trend systems, or filtering DV2, DVSC, or DVO trades.

## **Literature Review**

Technical indicators, investor sentiment, and market directions are interrelated. The link between them is that technical indicators could be used to measure the momentum of the investor sentiment. These two reinforce one another to predict the direction of the stock market by probit models. Technical analysis is the interpretation of the price action of a company's underlying stock (or any tradable financial instrument). It identifies historically relevant price patterns and behaviors to help forecast the potential direction of the stock. Some methodologies from other literature focus only on the price of the shares, not the operations of the company. By using historical price data, technical analysis attempts to interpret the supply and demand that moves

share prices. Technical analysis visually tracks the activity of the dinosaurs using various charts and indicators to pinpoint price areas of strong interest both in terms of buying and selling.

History tends to repeat itself as evidenced by price patterns. Technical analysis will help people make better-informed decisions as to how much risk to employ for how much potential reward.

Stocks represent the underlying company's business and operations. However, the perception and future valuation of the company and its performance are reflected in its stock price. There is often a divergence between the two. Technical analysis also helped to determine where the divergence lies and how many opportunities may exist.

Shu Feng, Na Wang and Edward J. Zychowicz, (2017) found out that sentiment could be optimistic, pessimistic, or neutral. When sentiment is neutral (i.e., not overly optimistic or overly pessimistic), the marginal benefits of further analysis of price action (i.e., technical analysis) may be relatively small. (extract out the fundamentals, and use technical analysis on the noise). High-sentiment-induced overpricing in which prices are decoupled from intrinsic value—technical analysis focusing on price patterns and trading volume might be relatively more beneficial. Following the argument used in Stambaugh, Yu, and Yuan [2012] and Shen and Yu [2013], high investor sentiment drives asset overpricing, and the impediments to short-selling play a significant role in limiting the ability of rational traders to exploit overpricing. In contrast, the asset prices should be close to their fundamental value during the low-sentiment periods, because underpricing can be countervailed by arbitrageurs taking long positions. The market tends to be more efficient during the low-sentiment periods compared to the high-sentiment periods, and people could expect technical analysis to be more effective when applied during the high-sentiment periods. Popular technical indicators perform relatively more effectively when

sentiment is high, and this finding holds with different performance measures and after applying several robustness checks.

In addition, there are documents that the sentiment effect is more pronounced when applying the technical indicators to small stocks in comparison to large stocks. Antoniou, Doukas, and Subrahmanyam [2013], who show that the well-known momentum effect is stronger during periods of high sentiment and substantially weaker when sentiment is low. Market participants may underreact more strongly to new information when it contradicts their sentiment because of cognitive dissonance, and that subsequent momentum effects may be stronger in high-sentiment periods because arbitraging loser stocks is more difficult because of short-selling constraints.

Stock technical indicators (STIs) are statistical calculations based on the price, volume, or significance for a share, security, or contract. This does not depend on fundamentals of a business, like earnings, revenue, or profit margins. The active stock traders and technical analysts commonly use STIs to analyze short-term and long-term price movements and to identify entry and exit points. Technical indicators can be useful while predicting the future prices of assets so they can be integrated into automated trading systems. There are two basic types of technical indicators: Overlays and Oscillators.

Han, Yang, and Zhou [2013] suggest that in market environments in which fundamental information such as earnings and economic outlook are less precise, there may be a heavier reliance on technical approaches. They contend that under such conditions technical analysis may be a more effective mode of analysis for investors and traders.

There are some difficulties such as optional combinations of indicators or tuning their parameters; several efforts have been made. There is no sophisticated well-established technique that allows the system's developers to easily select appropriate parameters. Models could cause inaccuracy in predicting the direction of stock market returns by using technical indicators. Current literature has limited categories of regimes (bull, bear market). The direction of the market is less researched in current literature and academic papers. Methods to test models are limited. Few papers are showing strong connections between sentiment and the market direction. To make further improvements and innovation, we will enlarge threshold size and type (i.e. 2 regimes, 3 regimes, 5 regimes, 7 regimes). Using a rule-based system, we identify the regimes. (eg: bull and bear markets).

## **Methodology**

There are two dating algorithms for BB detection. Implements two algorithms of detecting Bull and Bear markets in stock prices: the algorithm of Pagan and Sossounov (2002, <[doi:10.1002/jae.664](https://doi.org/10.1002/jae.664)>) and the algorithm of Lunde and Timmermann (2004, <[doi:10.1198/073500104000000136](https://doi.org/10.1198/073500104000000136)>). The algorithms provide the dating of the Bull and Bear states of the market, the descriptive statistics of the states, as well as plots of the results for every 45 industries.

In technical analysis, an investor measures oscillators on a percentage scale from 0 to 100, where the closing price is relative to the total price range for a specified number of bars in a given bar chart. In order to achieve this, one deploys various techniques of manipulating and smoothing

out multiple moving averages. When the market trades in a specific range, the oscillator follows the price fluctuations and indicates an overbought condition when it exceeds 70 to 80% of the specified total price range, signifying a selling opportunity. An oversold condition exists when the oscillator falls below 30 to 20%, which signifies a buying opportunity. The formula for a CCI technical indicator formula is that:

$$CCI_i = \frac{TP_i - SMA_{period}(TP_i)}{0.015 * \frac{\sum_{j=i-p+1}^i |TP_i - SMA_{period}(TP_i)|}{period}}$$

Where TP is a Typical Price calculated as:

$$TP_i = \frac{High_i + Low_i + Close_i}{3}$$

Simple Moving Average is each point is calculated according to the following formula:

$$SMA_i = \frac{\sum_{k=i-n}^i x_k}{n}$$

DVI is one type of oscillator. A stochastic Oscillator indicator is created, which is calculated according to the following formula:

$$\%K = \frac{C - L(pK)}{H(pK) - L(pK)} * 100\%$$

where pK is the first period that is set through the stochastic method, which is a period for the %K value:

$$\%D = MA(\%K, p3)$$

where p3 is the third period that is set through the stochastic method, which is a period for the %D value.

$$\%K = \left( \frac{C - L14}{H14 - L14} \right) \times 100$$

C = The most recent closing price

L14 = The lowest price traded of the 14 previous trading sessions

H14 = The highest price traded during the same 14-day period

%K = The current value of the stochastic indicator

The reason I choose DVI is that The DV Intermediate oscillator (DVI) is a very smooth momentum oscillator that can be used as a trend indicator. The DVI combines smoothed returns over different time windows and the relative number of up versus down days (stretch) over different time windows. Its indicator oscillates between 0 and 1. The DVI is the DVO of intermediate oscillators and was designed to take both 1) the magnitude of returns over different time windows smoothed and 2) the stretch—or the relative number of up versus down days into account over different time windows to produce superior results. The versatility of the DVI is what makes it unique and it often gives both uncorrelated and longer signals relative to the

DV2/DVSC/DVO and the Double Stochastic. The fact that the signals are smoother allows us to combine trend-following methods with mean-reversion without having to make too many trades to adjust. The DVI is superior at identifying overbought levels above the 200ma. We can construct a simple system that buys above the 200ma and sells when the  $DVI > .5$ , and short below the 200ma and covers when the  $DVI < .5$ .

The sentiment reflects technical indicators and technical indicators could be used to explain the market direction. We construct a logit model with 0 and 1 to bull and bear on the left-hand side. We utilize DVI and CCI (two technical indicators) as the proxy for measuring investor sentiment.

The formula for the logit model:

$$\ell = \log_b \frac{p}{1-p} = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

The DVI indicator oscillates between 0 and 1. The basic strategy to trade it, is to enter short if the close is above 0.5, and a long otherwise.

The returns are positive (losing trades) for DVI measurements higher than 0.9. That suggests that once the value passes 0.9, exiting a short, or even entering a long, may improve the returns. Even the prior bar (at DVI of 0.8) is not large on the 1-day portion – it could be a signal to exit shorts even earlier.

For the Soda industry, the DVI value for 12/04/1969 is 0.84 based on the R DVI output. This implies that we could sell the stock shares because a DVI value that is larger than 0.5 implies that it would be rational to exit short to secure the returns and profits. The DVI value for 09/16/1970 is 0.36. This implies that people could buy more stock shares and there are some opportunities to have higher returns. For the Beer industry, the DVI value for 12/04/1969 is 0.36. This is the right time to buy more stock shares because there will be an increase in prices in the near future. For the health industry, the DVI value for 12/04/1969 is 0.44. Since the threshold is 0.5, this is the right time to increase the number of stock shares to make profits. For the drug industry, the DVI value for 12/04/1969 is 0.48. This provides the same information and buying strategy to clients as the health industries.

## **Data Analysis and Empirical Results**

The first step is to clean the dataset from Ken French's website by deleting the dates that do not contain values for returns for all 45 industries. We assume the starting price index is 100 for all 45 industries and then convert all returns to the price index for each date. Summary statistics following are for the Agric, Beer, and Soda industry.

Summary statistics for daily price index of Agric Industry

<i>Agric</i>	
Mean	32358.12
Standard Error	358.8112
Median	4178.982
Mode	89.20247
Standard Deviation	41028.61
Sample Variance	1.68E+09
Kurtosis	-1.07764
Skewness	0.807074
Range	129737.9
Minimum	48.3628
Maximum	129786.3
Sum	4.23E+08
Count	13075

Summary statistics for daily price index of Beer Industry

<i>Beer</i>	
Mean	73963.4
Standard Error	1291.453
Median	3904.24
Mode	88.75219
Standard Deviation	147672.5
Sample Variance	2.18E+10
Kurtosis	4.462715
Skewness	2.30744
Range	816629.5
Minimum	50.51937
Maximum	816680
Sum	9.67E+08
Count	13075

Figure: Summary statistics for daily price index of Soda Industry

<i>Soda</i>	
Mean	114753.8
Standard Error	1952.888
Median	5814.922
Mode	87.55496
Standard Deviation	223304.9
Sample Variance	4.99E+10
Kurtosis	10.78335
Skewness	3.023608
Range	1615883
Minimum	62.39652
Maximum	1615945
Sum	1.5E+09
Count	13075

Figure Soda

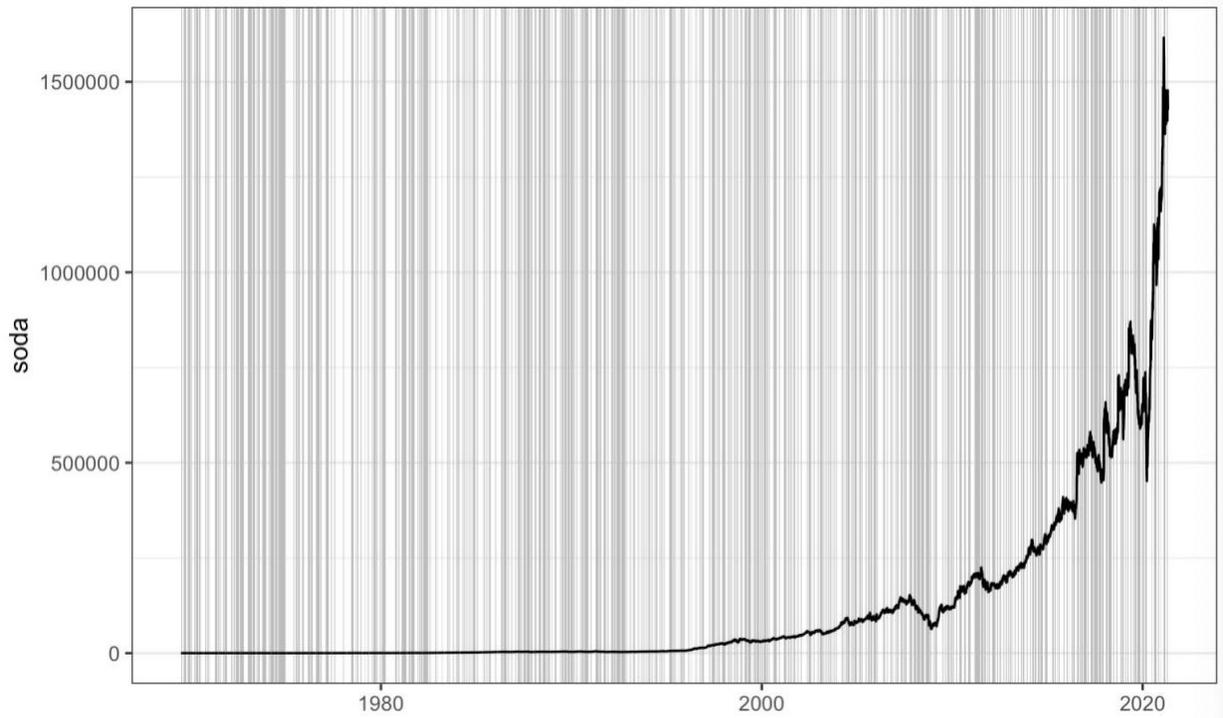


Figure Beer

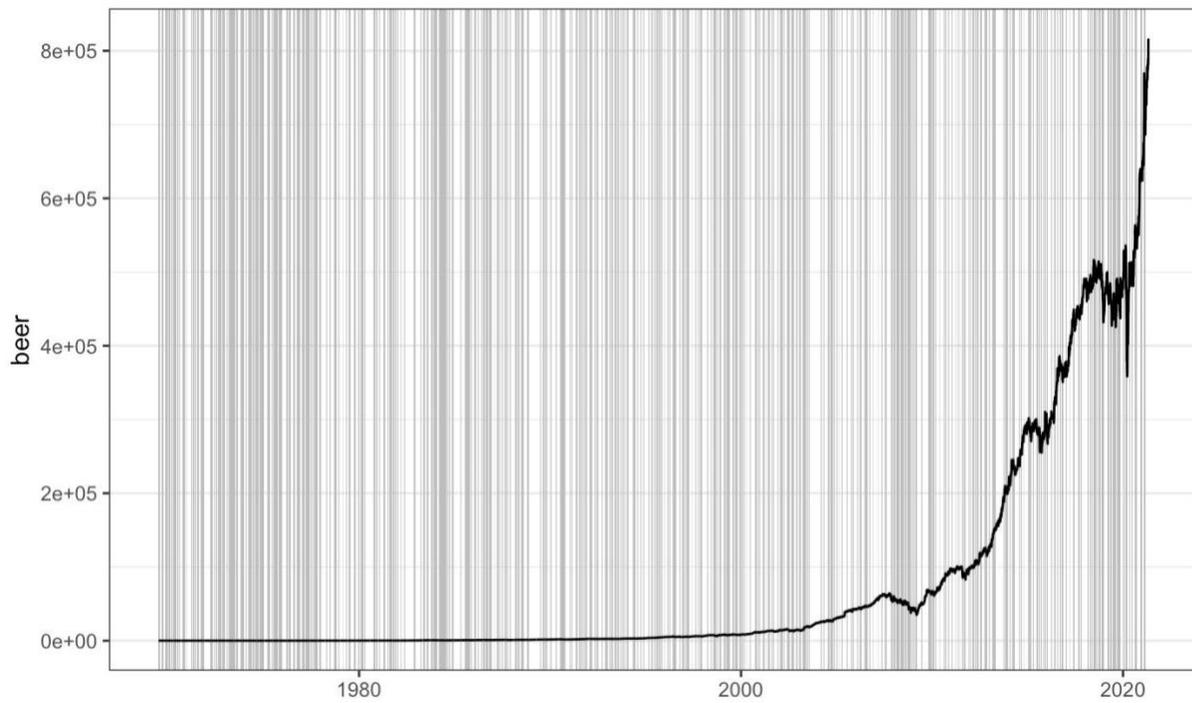


Figure Smoke

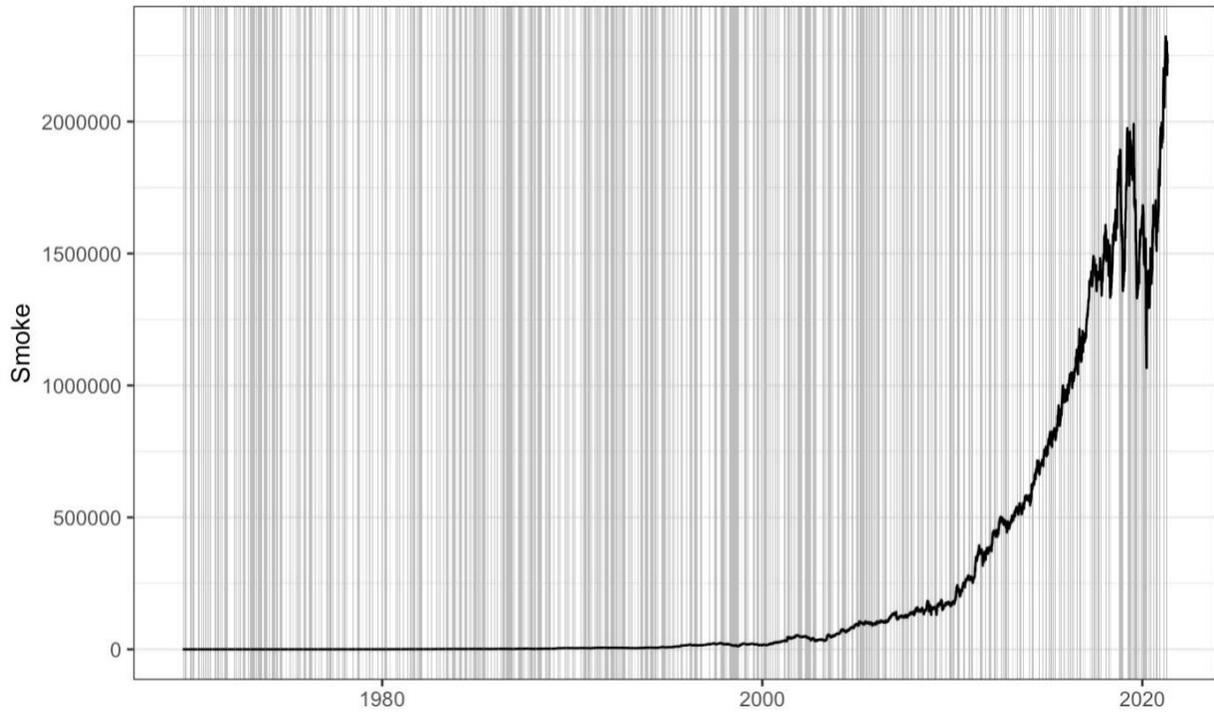


Figure Health

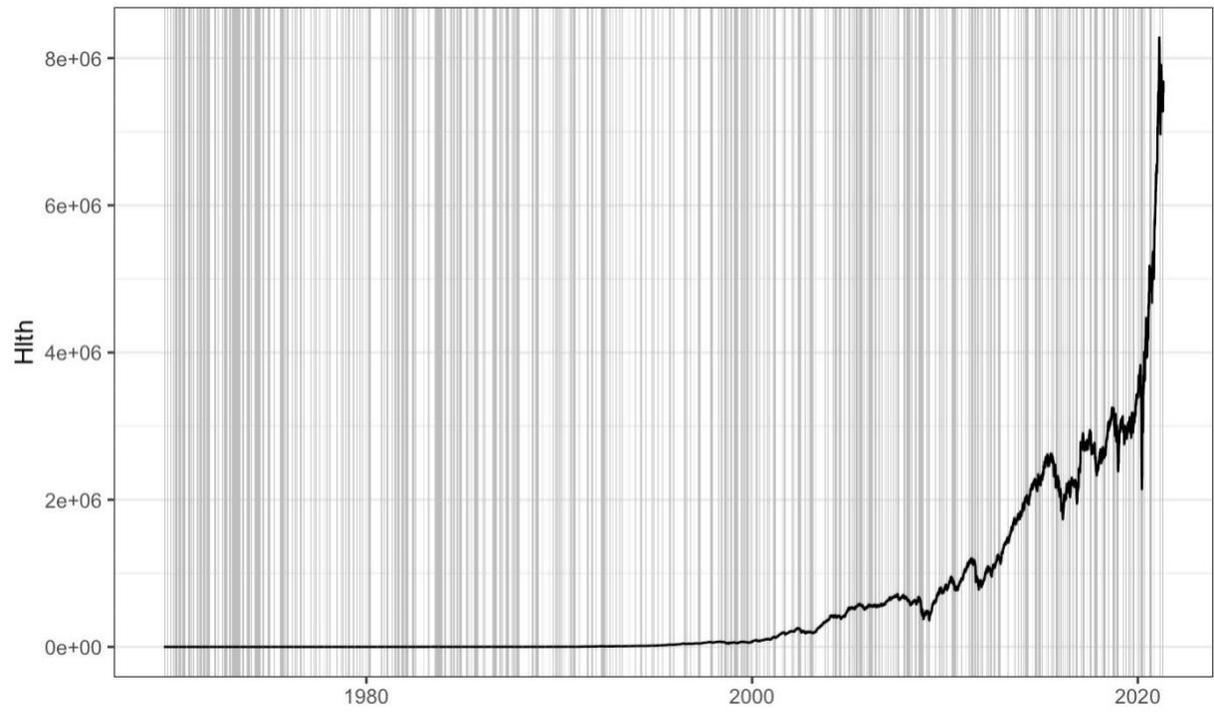


Figure MedEq

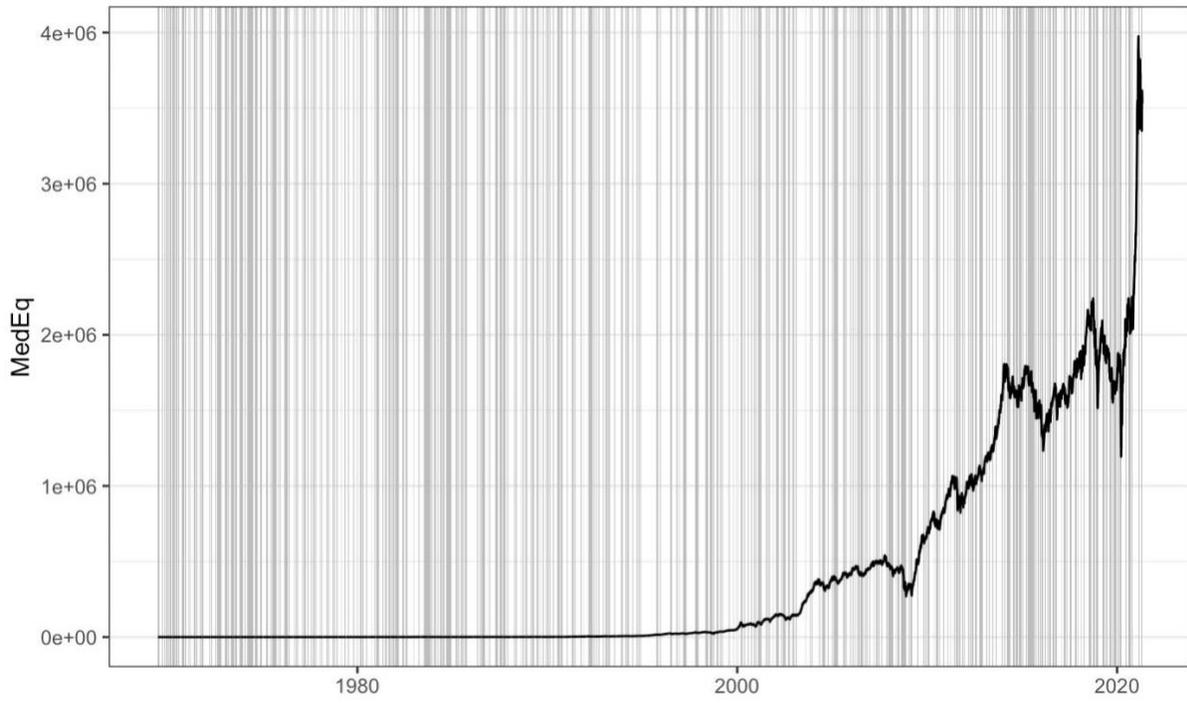
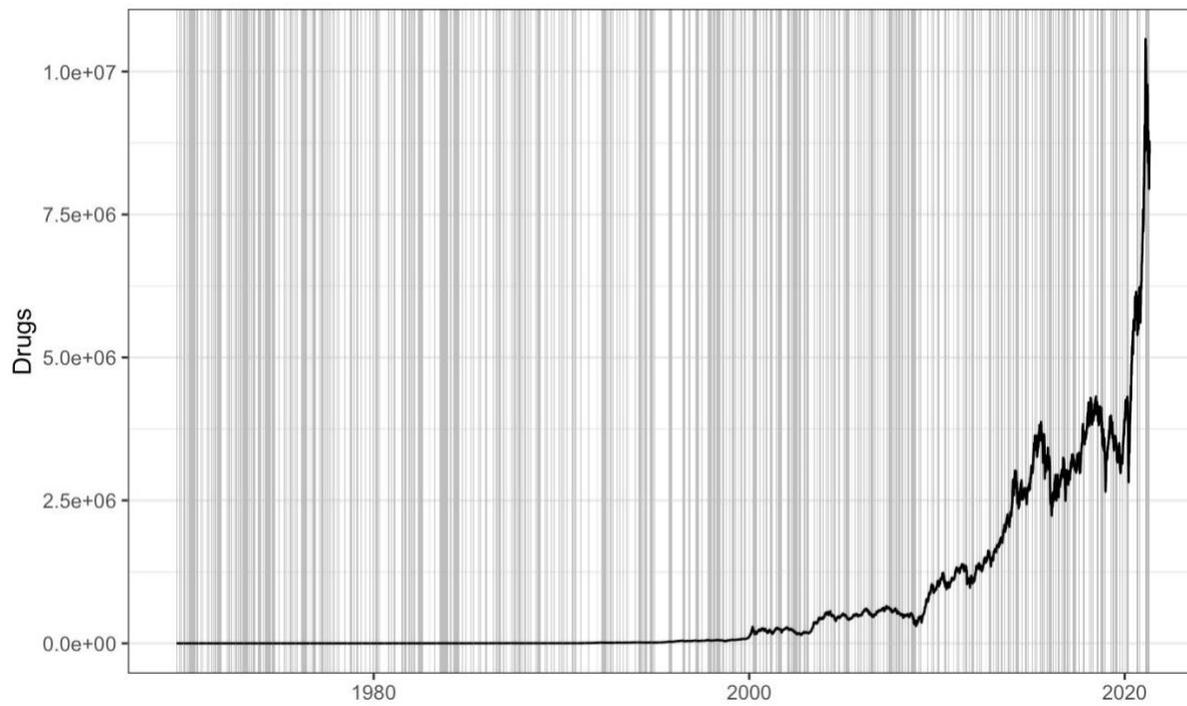


Figure Drugs



From the graphs above, the shadowed regions are the bear markets and the unshadowed regions are the bull markets. For instance, for the drug industry, the year 2020 falls in the category of a bull market. There are many possible explanations for this. One of them might be that there was a global public health issue like COVID-19 spreading to the whole nation. More and more money was invested in this field. Producing face masks to prevent the spread of the coronavirus, investing money into medicine industries to produce and innovate possible medicines to cure the coronavirus. Additionally, the whole nation was inventing the COVID vaccine and providing it to citizens. All of these factors are possible factors triggering a bull market for the drug and medicine industries.

Based on the table below, we created column names as start date bear, end date bear, start date bull, end date bull, amplitude bear, amplitude bull, duration bear, and duration bull. We assign a vector of 0s and 1s to each date as a bull or bear market based on the R output. For instance, for the beer industry, as we can tell from the table below, from July 1969 to August 1969, this was a bull market. The duration of this bull market is 23. The Amplitude is 10. This suggests that

From Sep 1969 to Oct 1969, this was a bear market. The duration is 22. The amplitude is -4. This suggests that the current bear market would last for a long time since 22 is a large number for duration value. Then, the market direction will reverse back to bull, which means that there are new opportunities for investors to buy stocks. From March 2018 to April 2018, this was a bull market. The duration is 16. The amplitude is 4. The value of duration is 16. This is not a considerable number. Therefore, it suggests that the market direction will soon return to bear market, which means that it is the right time for investors to sell their stock shares to secure the

number of profits they have already earned during the bull market period. The maximum duration for the bull market of the beer industry is 151. The minimum duration for the bull of the beer industry is 5. The maximum amplitude for the bull market of the beer industry is 41. The amplitude for the bull market of the beer industry is 1. However, for the bear market of the beer industry, the maximum duration is 79. The minimum duration is 4. The maximum amplitude is 24. The minimum amplitude is -32.

#### Beer industries Bull and Bear Analysis Result 1

	startdatebull	enddatebull	Durationbull	Amplitudebull	bull
1	Jul_1969	Aug_1969	23	10	1
2	Oct_1969	Nov_1969	30	13	1
3	Dec_1969	Jan_1970	18	6	1
4	Feb_1970	Mar_1970	17	6	1
5	Mar_1970	Apr_1970	11	3	1
6	Jun_1970	Jun_1970	5	3	1
7	Jul_1970	Jul_1970	18	6	1
8	Aug_1970	Oct_1970	33	14	1
9	Nov_1970	Dec_1970	10	5	1
10	Dec_1970	Mar_1971	62	25	1
11	Apr_1971	Apr_1971	7	2	1
12	May_1971	Jun_1971	13	3	1
13	Jun_1971	Jul_1971	7	3	1
14	Aug_1971	Sep_1971	24	5	1
15	Nov_1971	Mar_1972	72	41	1
16	May_1972	May_1972	12	3	1
17	Jun_1972	Jul_1972	12	5	1
18	Jul_1972	Aug_1972	13	5	1
19	Oct_1972	Nov_1972	12	6	1
20	Dec_1972	Jan_1973	15	4	1
21	Feb_1973	Feb_1973	9	3	1

Beer industries Bull and Bear Analysis Result 2

startdatebear	enddatebear	Durationbear	Amplitudebear	bear
Sep_1969	Oct_1969	22	-4	0
Nov_1969	Dec_1969	24	-11	0
Jan_1970	Feb_1970	16	-4	0
Mar_1970	Mar_1970	10	-5	0
Apr_1970	Jun_1970	51	-18	0
Jun_1970	Jul_1970	11	-6	0
Aug_1970	Aug_1970	11	-6	0
Oct_1970	Nov_1970	35	-10	0
Dec_1970	Dec_1970	6	-1	0
Mar_1971	Apr_1971	16	-3	0
Apr_1971	May_1971	21	-5	0
Jun_1971	Jun_1971	15	-5	0
Jul_1971	Aug_1971	22	-9	0
Sep_1971	Nov_1971	51	-12	0
Mar_1972	May_1972	46	-10	0
May_1972	Jun_1972	15	-3	0
Jul_1972	Jul_1972	14	-4	0
Aug_1972	Oct_1972	46	-8	0
Nov_1972	Dec_1972	34	-6	0
Jan_1973	Feb_1973	12	-3	0
Feb_1973	Mar_1973	7	-3	0

### Beer industries Bull and Bear Analysis Result 3

	▲ startdatebull ⇅	enddatebull ⇅	Durationbull ⇅	Amplitudebull ⇅	bull ⇅
277	Mar_2018	Apr_2018	16	4	1
278	May_2018	May_2018	12	2	1
279	May_2018	Jun_2018	19	7	1
280	Aug_2018	Aug_2018	5	4	1
281	Sep_2018	Sep_2018	9	4	1
282	Oct_2018	Nov_2018	9	4	1
283	Dec_2018	Mar_2019	46	13	1
284	Apr_2019	Apr_2019	18	5	1
285	Jun_2019	Jun_2019	7	4	1
286	Jun_2019	Jul_2019	9	7	1
287	Aug_2019	Sep_2019	19	14	1
288	Oct_2019	Oct_2019	7	5	1
289	Nov_2019	Jan_2020	45	8	1
290	Jan_2020	Feb_2020	18	5	1
291	Mar_2020	Apr_2020	27	41	1
292	May_2020	Jun_2020	18	5	1
293	Jul_2020	Jul_2020	12	9	1
294	Aug_2020	Aug_2020	9	8	1
295	Sep_2020	Dec_2020	47	20	1
296	Jan_2021	Feb_2021	25	21	1
297	Mar_2021	Apr_2021	40	16	1

Beer industries Bull and Bear Analysis Result 4

startdatebear	enddatebear	Durationbear	Amplitudebear	bear
Apr_2018	May_2018	12	-4	0
May_2018	May_2018	4	-1	0
Jun_2018	Aug_2018	31	-5	0
Aug_2018	Sep_2018	18	0	0
Sep_2018	Oct_2018	24	-4	0
Nov_2018	Dec_2018	31	-14	0
Mar_2019	Apr_2019	22	-7	0
May_2019	May_2019	22	-9	0
Jun_2019	Jun_2019	11	-2	0
Jul_2019	Aug_2019	25	-9	0
Sep_2019	Oct_2019	19	-6	0
Oct_2019	Nov_2019	17	-8	0
Jan_2020	Jan_2020	6	-1	0
Feb_2020	Mar_2020	20	-32	0
Apr_2020	May_2020	10	-3	0
Jun_2020	Jul_2020	21	-5	0
Jul_2020	Aug_2020	7	-1	0
Aug_2020	Sep_2020	26	-4	0
Dec_2020	Jan_2021	22	-1	0
Feb_2021	Mar_2021	16	-11	0

Based on the models and regression output, it explains questions like how do technical indicators help to explain bull and bear markets. The way we set up the model is that we create a column of the start date, end date, regime type, and DVI values. Then, we run the logit regression to make regime type 1 representing bull market, 0 representing bear market as our Y variable, which is a binary variable. Since the DVI is used to measure the proxy of investor sentiment, we make that as the X variable on the right-hand side of the model.

Below is the output for the Beer industry, one unit increase in the DVI indicator will increase the odds of becoming a bull market by 13.89%.

Call:

```
glm(formula = Regimetype ~ dvi, family = binomial(link = "logit"),
     data = mydata)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.170	-1.146	-1.123	1.205	1.233

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-0.1572	0.1905	-0.825	0.409
dvi	0.1389	0.2805	0.495	0.621

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 670.30 on 483 degrees of freedom

Residual deviance: 670.05 on 482 degrees of freedom

(12591 observations deleted due to missingness)

AIC: 674.05

Number of Fisher Scoring iterations: 3

Below is the output for the Soda industry, one unit increase in DVI indicator will increase the odds of becoming a bull market by 12.9%.

```
Call:
glm(formula = Regimetype ~ dvi, family = binomial(link = "logit"),
     data = mydata)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.188	-1.166	-1.145	1.184	1.210

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-0.1030	0.1903	-0.541	0.588
dvi	0.1290	0.2730	0.473	0.636

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 712.49 on 513 degrees of freedom  
Residual deviance: 712.26 on 512 degrees of freedom  
(12561 observations deleted due to missingness)  
AIC: 716.26

Number of Fisher Scoring iterations: 3

Below is the output for the Drugs industry, one unit increase in DVI indicator will increase the odds of becoming a bull market by 17.39%.

Call:

```
glm(formula = Regimetype ~ dvi, family = binomial(link = "logit"),  
     data = mydata)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.187	-1.151	-1.128	1.199	1.228

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-0.1525	0.1877	-0.812	0.417
dvi	0.1739	0.2805	0.620	0.535

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 648.48 on 467 degrees of freedom  
Residual deviance: 648.09 on 466 degrees of freedom  
(12607 observations deleted due to missingness)  
AIC: 652.09

Number of Fisher Scoring iterations: 3

Below is the output for the MedEq industry, one unit increase in DVI indicator will decrease the odds of becoming a bull market by 6.27%.

```
Call:
glm(formula = Regimetype ~ dvi, family = binomial(link = "logit"),
     data = mydata)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.146	-1.138	-1.125	1.217	1.230

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-0.06102	0.19928	-0.306	0.759
dvi	-0.06270	0.29514	-0.212	0.832

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 619.98 on 447 degrees of freedom  
Residual deviance: 619.93 on 446 degrees of freedom  
(12627 observations deleted due to missingness)  
AIC: 623.93

Number of Fisher Scoring iterations: 3

## **Conclusion**

We utilize the forecasting model using technical indicators and investor sentiment to explain the stock market direction. Applying daily price index and return values from 1969 to 2021 helps us identify the bull and bear states in a much more innovative way. Utilizing technical indicators like DVI and CCI to measure the proxy of investor sentiment provides investors and clients reliable information on when and where is the selling and buying point to help them make rational investment decisions to make profits from the stock market. Our analysis on the values of DVI for the industries, the duration, and the amplitude of the bull and bear states offer the best possible solutions to both short-term and long-term investment decisions.

## **Acknowledgment**

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