

# **Analysis of Stock Market Reactions to COVID-19 Pandemic**

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## **Abstract**

The purpose of this study is to determine whether the COVID-19 pandemic has affected different aspects of the stock market at different magnitudes. During the current pandemic, certain industries seem to perform better than others, raising the question of whether all stock market sectors are affected equally by the coronavirus recession. In addition, past stock market trends have shown that in the case of an economic drop, small cap stocks tend to be more affected than large cap stocks. To determine whether these observations have any statistical significance during the COVID-19 economic chaos, this study looks at whether different sectors of the stock market and stocks of varying sizes are affected differently by the global pandemic. For the first analysis, data was collected by randomly sampling ten stocks from each sector. Following data collection, the average percent decrease of stock price for each sector's stocks was compared. It was determined that there was a statistically significant difference between the average percent decrease of stock prices in different sectors. Results of this test suggest that the COVID-19 pandemic affected some sectors more than others. For the second portion of this analysis, data was collected on the ten largest cap and ten smallest cap stocks of each sector. The average percent decrease of the ten largest and smallest cap stocks were compared. Six out of eleven sectors were found to be statistically significant, implying that there is a discrepancy between the average percent decrease of stock price between the large and small cap stocks. This result suggests that in more than half of the sectors, larger-cap stocks were affected at a different percentage than smaller cap stocks, specifically that the smaller cap stocks were hit harder than the larger cap stocks.

## **Keywords**

Stock market, economy, market cap, statistics, COVID-19 pandemic.

## **1. Introduction**

Following the outbreak of the novel coronavirus disease (COVID-19) in the United States, there was no doubt that the economy was shaken to what Forbes called, "A Market Gone Wild." Major companies have filed for bankruptcy and "global financial market risks have increased substantially in response to the pandemic" (Zhang, Hu & Ji, 2020). Even so, it is important to take into account that previous trends in similar scenarios have shown "that often markets will react adversely to these such incidents in the short run but that in the long run, markets eventually correct themselves and increase" (Yan, Tu, Stuart & Zhang, 2020). Additionally, it is generally assumed that while "in the year prior to the business cycle peak, however, small caps tend to lag," small-cap firms outperform large caps after an economic trough (Switzer, 2020).

However, due to the nature of the COVID-19 pandemic, the economy has seemingly been targeted in a manner that differs from previous similar occurrences. Comparable outbreaks such as SARS in 2003 cannot be used for predictions, as the economic landscape in China, and the rest of the world for that matter, have changed drastically in the past seventeen years (Fernandes 2020). Recent analysis has pointed to signs suggesting that "compared with other outbreaks, COVID-19 is having an unprecedented impact on markets" and that "investors' expectations did not decline as dramatically as in the earlier calculation" (Baker, Bloom, Davis, Kost, Sammon & Viratyosin, 2020; Gormsen & Koijen, 2020). Certain sectors such as the health care sector may be expected to see less of a decrease in stock price due to its inevitable necessity, while the energy sector may be presumed to drop in stock price due to its decreasing demand. However, it is important to note that the 2020 Russia-Saudi Arabia oil war occurred on March 8th, around the same time as the COVID-19 recession's peak, which was also a factor in the recent economic decline, particularly in the energy sector (Levisohn, 2020).

Stocks within the same sector appear to have been affected differently as well. Switzer's paper on large and small cap stocks implies that generally, small cap stocks would be more likely to lag during an economic trough such as the current pandemic. Despite being in the same sector, Amazon's stock price has shot up while Six Flags, which

has closed down all its parks during its prime season due to the pandemic, has reached lows, with over a 70% decrease. From a consumer perspective, it is apparent that not all industries are equal when it comes to combating the economic decline that has accompanied the global pandemic.

Despite varying conclusions from a number of different studies, there is no doubt that most stocks saw some form of decrease in their number of shares purchased. However, differing demand rates for certain products and industries raises the question of whether or not all stocks were affected at an equal percentage. Therefore, the main purpose of this project is to analyze two economic categories of interest - market caps and sectors - and determine whether there is a statistically significant difference between the average percent decrease of these categories.

## **2. Methods**

In order to target changes in both market caps and sectors, the analysis and data collection for this project were split into two parts. The first portion of this project used the 11 main sectors of the economy - Energy, Materials, Industrials, Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, Telecommunication Services, Utilities, and Real Estate - to look at whether certain sectors of the market had been hit harder than others. The second half of this project consists of using the percent decrease of stock price from the ten largest cap stocks and the ten smallest cap stocks to determine whether larger stocks in each sector thrive better than the smaller stocks. In other words, the first half of the project looked at different types of stock while the second half of the project analyzed different sizes of stock.

### **2.1 Hypothesis**

Due to a high demand for certain products, it was hypothesized that for the first half of this study, there would be a statistically significant discrepancy between the average percent decrease of stock price between different sectors. For the second half of this study, due to past observations of the economy and common trends in the stock market, it was hypothesized that larger stocks would perform better than smaller stocks during COVID-19 pandemic.

### **2.2 Data Collection**

Because the purpose of this study was to analyze stocks in specific sectors, stratified sampling was utilized for both parts of this study. This method was used instead of random sampling in order to prevent a sample with a disproportionate amount of stocks from each sector. Instead, by using stratified sampling and choosing a set amount of stocks from their respective sectors, an equal number of stocks would be chosen per sector and prevent any sampling bias that may occur with random sampling. For the first half of this study, a random sample of stocks was chosen from each sector to use as a sample for comparing averages. The number of individual stocks in each sector on <https://finance.yahoo.com/> was first determined. Then, from the total number of stocks, a random number generator was used to choose ten numbers in the list. Using the ten randomly generated numbers from the list, the associated stocks were taken. In total, 110 stocks were hand-picked. The highest price between February and April was chosen for each stock. This time frame was used because it falls directly before the coronavirus related stock market crash in late March to early April. Next, the lowest price between February and May was also chosen for all stocks. This time frame includes the months of March and April, when most stocks saw their lowest numbers. Next, the percentage decrease of stock price for each stock was calculated by subtracting the highest price from the lowest price and dividing this negative difference by the former, higher price. This calculation was performed for all 110 stocks. After the percent decrease from the 110 stocks was calculated, a one-way ANOVA test and Tukey HSD test were used to compare the average percent decrease between sectors. For the second half of the study, the ten largest and smallest cap stocks were taken from each sector to be compared. This was done by taking the first and last ten stocks from the Yahoo Finance sector list, which was listed from greatest to smallest stocks. This resulted in a total of 220 stocks. Following data collection, the same procedure for calculating percent decrease of stock price was performed for all 220 stocks.

## **3. Data and Statistical Analysis**

For part one of analysis, all data used - percent decrease of stock price - was measured on a ratio scale, and there were eleven groups of stocks (ten stocks per sector) in total. Therefore, because the data was parametric and more than two groups were being compared, a one-way ANOVA test and Tukey HSD test on <https://scistatcalc.blogspot.com/> were used to compare the average percent decrease of stock price between sectors.

For part two, all data used - percent decrease of stock price - was measured on a ratio scale, and there were two groups of stocks per sector. A separate test was done for each sector to look at the differences between large and small cap stocks in that particular sector. Therefore, because the data was measured on a ratio scale and each test had exactly two groups of data to be compared, an unpaired two-sample t-test on <http://vassarstats.net/> was used to compare the average percent decrease between larger stocks and smaller stocks in each sector. The reason why an unpaired t-test was chosen over a paired t-test is because there was no dependent relationship between the two groups. Thus, by utilizing an unpaired t-test, the comparison was more representative of large and small cap stocks as a whole, instead of singling out specific pairs of stocks.

### 3.1 Data Presentation

Figure 1 displays the graphs of the consumer staples sector and the energy sector to provide a visual comparison of two different sectors. The blue graph shows the percent decrease of stock price for the ten randomly sampled stocks from the consumer staples sector, while the green graph shows the percent decrease from the energy sector. From looking at the graph alone, it appears the energy sector was certainly affected more than the consumer staples sector. However, it is important to take the Russia-Saudi Arabia Oil War into consideration, which may have had an impact on the economy, especially the energy sector. While there appear to be obvious differences in percent decrease, statistical testing is needed to determine whether these differences are statistically significant.

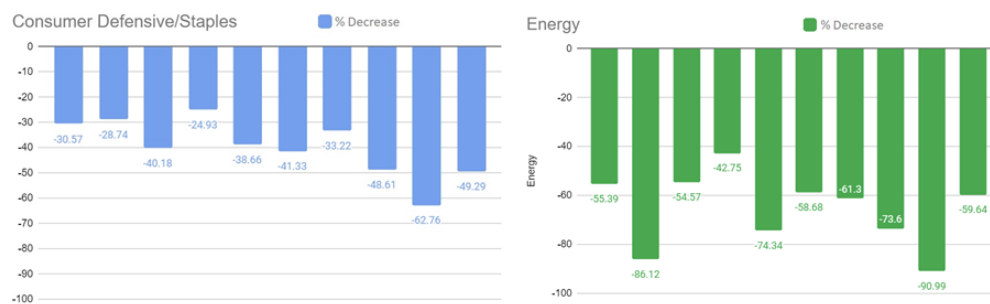


Figure 1: Randomly chosen consumer staples data

Figure 2 below shows the percent decrease for the ten largest and smallest cap stocks collected from the industrial sector. From looking at this graph alone, it appears that the smaller cap stocks were affected at a greater rate than the larger cap stocks. However, this does not guarantee statistical significance and requires statistical testing. The same data collection was performed for all eleven sectors.

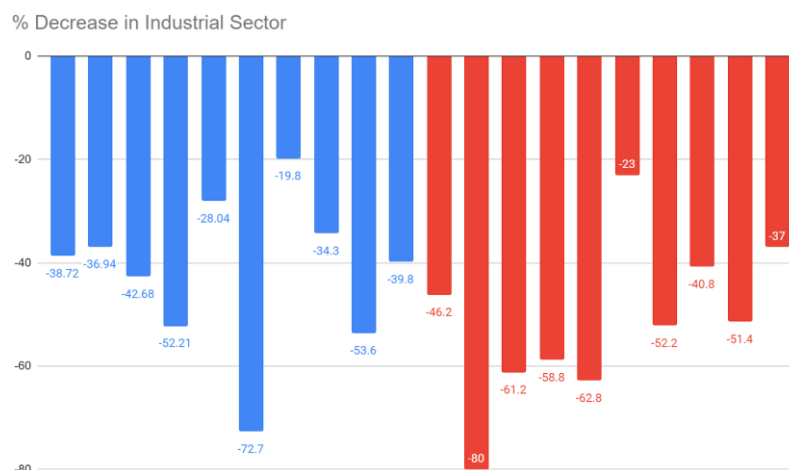


Figure 2: Largest and smallest stocks in industrial sector data

### 3.2 Statistical Analysis

Because there are eleven sets of randomly chosen data points from all eleven sectors, the ANOVA test was used to compare the average percent decrease between groups. The Tukey HSD test was then used to follow up on the ANOVA test and determine exactly which groups displayed statistical significance. Figure 3 shows the results obtained from the ANOVA test.

Degrees of freedom: df1 is 10, df2 is 99
Sum of Squares for Treatment (SSTR) is 8899.696
Sum of Squares for Error (SSE) is 22440.850
Total sum of squares (SST = SSE + SSTR) is 31340.546
Mean Square Treatment (MSTR = SSTR/df1) is 889.970
Mean Square Error (MSE = SSE/df2) is 226.675
F (= MSTR/MSE) is 3.926
Probability of calculated F is 0.0001607906
F critical (5% one-tailed) 1.928

Figure 3: ANOVA test results

This test was determined to be highly statistically significant with a p-value (probability of calculated F) of 0.000168 which is less than 0.01, and an F value of 3.926, which is higher than its critical value, 1.928. Therefore, it can be concluded that there *is* a significant difference in average percent decrease of stock price between sectors. However, in order to determine which pairs of sectors actually displayed a significant difference in means, a follow up test, the Tukey HSD test, was conducted as well. Figure 4 shows all the significant pairs of sectors.

** Mean of groups 1 and 9 differ: 25.90900 > 21.80289
** Mean of groups 3 and 9 differ: 22.74700 > 21.80289
** Mean of groups 4 and 9 differ: 32.22100 > 21.80289
** Mean of groups 4 and 10 differ: 26.25000 > 21.80289
** Mean of groups 5 and 9 differ: 23.37800 > 21.80289
** Mean of groups 6 and 9 differ: 25.83300 > 21.80289

Figure 4: Tukey HSD test results

Table 1: Mean % decrease in stock price

Sector	Mean % Decrease
Consumer Staples (Group 1)	-39.829
Consumer Discretionary (Group 2)	-52.544
Communication services (Group 3)	-42.991
Utilities (Group 4)	-33.517
Technology (Group 5)	-42.360
Health Care (Group 6)	-39.905

Financial Services (Group 7)	-48.330
Industrial Services (Group 8)	-51.545
Energy (Group 9)	-65.738
Real Estate (Group 10)	-59.767
Basic Materials (Group 11)	-50.179

This test shows that there are six pairs of groups - consumer staples and energy, communication and energy, utilities and energy, utilities and real estate, technology and energy, health care and energy - that have statistically significant results. For all pairs, the second group of data had a lower mean, suggesting that the virus had a larger economical impact on that sector. For example, looking at the discrepancy between groups 1 and 9, or the consumer staples and energy sectors, the test statistic was higher than the Honestly Significant Difference (HSD) of 21.80289, suggesting a statistically significant difference in means. Because the mean for the energy sector is -65.738 and the mean for the consumer staples sector is -39.829, the lower mean of the energy sector implies that it was hit harder by the coronavirus economic impact. Five out of the six significant results suggested that the energy sector was hit harder than the sector it was being compared to. This implies that stocks in the energy sector saw the most economic impact during the coronavirus. It should be noted that the Russia-Saudi Arabia oil war occurred on March 8th, 2020, around the same time as the emergence of COVID-19 in the United States. The presence of this economic war was likely a factor in the economic recession, especially in the energy sector. Therefore, it cannot be guaranteed that the coronavirus was the sole cause of the decline in the energy sector. For the second half of the analysis, because the average of two parametric groups - small cap and large cap stocks - was being compared, a two-sample t-test was used to compare the average percent decrease of stock price between the ten largest and ten smallest cap stocks in each sector. Using the industrial sector as an example, figure 5 shows the results from statistical analysis.

<i>Data Summary</i>			
	A	B	Total
n	10	10	20
$\sum X$	-418.790000	-513.4	-932.19
$\sum X^2$	19508.33010	28610.6	48118.9301
SS	1969.8237	2252.644	4670.0203
mean	-41.879	-51.34	-46.6095

<i>Results</i>					
Mean <sub>a</sub> —Mean <sub>b</sub>	t	df	P	one-tailed	0.092244
9.461	+1.38	18		two-tailed	0.184488

Figure 5: Statistical results for industrial sector

In this test, the t-value was determined to be 1.38. The critical value for a test with 18 degrees of freedom is 2.101. Because the t-value is below the critical value, this result is considered to be insignificant. The p-value, or probability of this result being due to chance, is 0.184488, which is greater than 0.05, and as a result, *not* statistically significant. Therefore, the null hypothesis stands and there is *no* discrepancy between the average percent decrease of the 10 largest and 10 smallest cap stocks in the industrial sector.

This same test was performed for all other sectors and if the p-value was less than 0.05, the result was deemed significant, and if the p-value was less than 0.01, the result was deemed highly significant. Table 2 displays the results from this analysis.

Table 2: Two-sample t-test results

Sector	Mean A (Larger Stocks)	Mean B (Smaller Stocks)	P-value	Significance
Technology	-31.353	-54.68	<0.0001	Highly Significant
Health Care	-27.462	-52.4	<0.0001	Highly Significant
Consumer Discretionary	-35.094	-59.06	0.00125	Highly Significant
Real Estate	-28.785	-50.18	0.016	Significant
Communication	-28.936	-43.26	0.02	Significant
Financials	-23.536	-40.65	0.021	Significant
Consumer Staples	-29.832	-42.22	0.0597	Not significant
Basic Materials	-35.26	-45.06	0.0695	Not significant
Industrials	-41.879	-51.34	0.18	Not significant
Energy	-51.872	-59.92	0.317	Not significant
Utilities	-35.119	-32.45	0.37	Not significant

In six out of eleven sectors - technology, real estate, communications, consumer discretionary, financials, and health care - percent changes between larger and smaller cap stocks were statistically significant. For all significant sectors, mean B is smaller, or lower, than mean A. In all sectors including the non-significant ones, mean B was lower than mean A in all sectors except for utilities. In other words, for 10 out of 11 sectors, the mean percent decrease of stock price for the smaller cap stocks was larger than those of the larger cap stocks, implying that small cap stocks were hit harder than large cap stocks; of all the sectors six of those results were statistically significant. In order to determine why the utilities Sector deviated from the majority, we can compare one of the highly significant sectors, consumer discretionary, with the utilities sector. Between these two sectors specifically, consumer discretionary is far more likely to be affected by consumer choice of brands for want-based products. Some of the largest stocks in this sector include Nike, Tesla, Toyota, just to name a few. These companies focus heavily on branding for their non-essential, luxury products that are strongly reliant on seasonal merchandise, current trends. Amidst the COVID-19 pandemic, small brands in this sector without a large market value would be at a higher risk of bankruptcy. Nike for example, can ensure continued consumer business through paid ads, promotion of online shopping, and other expensive marketing tactics, while smaller companies, who do not have access to these resources, are unable to keep their demand high. Utilities companies on the other hand, are typically need-based; everyone needs utilities, regardless of the coronavirus - they are essential. Furthermore, they are far less focused on branding; that is to say that with utilities, consumer choice is significantly less impactful on the company's market value. This is because utility choice is heavily dependent on location, rather than consumer selection. For example, nearly the entire state of California relies on PG&E for electricity. Because this option is universal to certain locations, the demand for utilities is less affected by COVID-19 and it is fathomable that by chance, large cap stocks were affected slightly more than small cap stocks.

#### **4. Conclusion**

The purpose of this study was to determine whether different stock sectors and different stock market caps were affected at different magnitudes during the COVID-19 pandemic. It was found that there was a statistically significant difference in the average percent decrease of stock prices between sectors and that *some* of the sectors - consumer staples and energy, communication and energy, utilities and energy, utilities and real estate, technology and energy, health care and energy - had statistically significant differences in average percent decrease of stock prices. Because the energy sector had the largest average percent decrease of stock prices, it is implied that the energy sector was hit the hardest by the COVID-19 market crash. It is important to note that the emergence of the coronavirus in the United States happened near the start of the Russia-Saudi Arabia oil war. The presence of this economic conflict may have been a factor in the stock market's decline, particularly for the energy sector. Therefore, we cannot guarantee that the largest decrease in the energy sector is completely caused by the COVID-19 pandemic. Nonetheless, this statistical result supports the original hypothesis stating that there would be a statistically significant difference between the average percent decrease of stock prices between different sectors. Possible discrepancies of average percent decrease of stock price between larger and smaller cap stocks were also analyzed using a two-sample t-test. Six out of eleven sectors were found to be statistically significant, suggesting that in many stocks, large and small cap stocks were affected at different rates. The smaller cap stocks had a greater percent decrease of stock price, suggesting that they were affected more than large cap stocks. Therefore, it can be concluded that the COVID-19 pandemic had a greater economic effect on smaller stocks.

#### **5. Future Research**

For this study, differences in average percent decrease of stock price in sectors and market caps were analyzed. However, several possible factors may have impacted the accuracy of the results. The number of data points - randomly chosen stocks per sector - was lacking. Repetitions of this study should have at least thirty randomly chosen stocks per sector to minimize sampling error and produce a more representative sample. Options for follow up studies would include analyzing the recovery rate of stocks. The same categories of interest analyzed in this study, sectors and market caps, would apply to the follow up research as well. Instead of calculating the percent decrease of stock price for each stock, the percent increase of stock price would be calculated and the same statistical tests would be performed to compare the average percent increase. Data following the COVID-19 pandemic peak would be interesting from a consumer standpoint because it is undeniable that certain companies have benefited from the COVID-19 pandemic, which has affected and sped up their stocks' recovery rate. A recent study on the performance of sectoral indices in China during the coronavirus found that "the energy and financials sectors set for the comparatively weakest rebound, while information technology, telecommunication sectors and consumer staples exhibited the strongest strength in rebound" (Liew & Puah, 2020). In fact, it should be noted that a common theme in stocks from a sector that had higher performance overall was that the current price for the stock is actually higher than before the pandemic. In addition to looking further into this phenomenon, this follow up study would also test Switzer's hypothesis that smaller cap stocks perform better than large cap stocks in the year following an economic trough.

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## **Biography**

**Lily Sun** is a USFSA certified Senior Gold Medalist in singles skating. She is a 3 time national competitor in figure skating and a national bronze medalist. Lily is a Digital Marketing Intern for Generation She, Vice President of the Empathetic Leaders Movement, Co-Founder of SISTER, Head of Media for She Helps Her, and Editor in Chief for Women in Politics.