Using the Beta Coefficient to compare how different S&P500 industries' price volatility has changed during the COVID-19 pandemic.

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Author contributions.

A.H. proposed the research question, designed the study, conducted the survey, wrangled the data, analysed the results, drafted and edited the paper.

Abstract.

I analyse stock volatility of every CIGS sub-industry during the COVID-19 pandemic and compare it to the same time last year. The method used was to compare the average movement within each industry to the rest of the market using regression analysis to determine the Beta Coefficient of individual industry with regards to all stocks not in that industry. This paper has found that all stocks with a previous negative correlation to the market now have become positive, including the 'safe haven' from market volatility, Gold. Stocks that once had a near-perfect correlation to the market have also strayed from their norms becoming more volatile, such as Real Estate, and Restaurants. A large number of industries moved with the market similar to last year, while others became less correlated. Overall there was a large percentage of industries that either increased or decreased in market correlation and volatility. This paper provides valuable insights to anyone making financial decisions based on risk and gives a clear view of how different industries react to COVID-19 as well the events associated with the pandemic.

Keywords.

python, NumPy, pandas, COVID-19, finance, SPY, regression, analysis, markets, Nasdaq

Introduction.

The COVID-19 pandemic has seen a sharp increase in the volatility of the stock market (Z. Ye, I. Florescu, 2020) with the S&P 500 seeing some of the sharpest price swings since the 1987 stock market crash, also known as Black Monday (NASDAQ, 2020). Every day new COVID-19 developments are released, causing mass uncertainty in the market.

With this paper, I provide a detailed analysis of the Beta Coefficient for each sub-industry within the Global Industry Classification Standard (GICS). This will determine how industries' volatility compares to the rest of the market during the unprecedented lockdown, social distancing, and states of emergency.

This will allow for investors, policymakers, financial analysts, as well as other economic researchers to better understand how each industry behaves to allow for a more informed decision-making process in the future.

How will this help the public?

Economic policy can be directed to mitigate volatility and ensure better returns from more vulnerable industries. Policymakers will be more informed when allocating resources such as social and corporate welfare and run a more in-depth cost-benefit analysis to determine where tax-payers' money should go (Tarhan, 1993).

Furthermore, the average retirement 401(k) balance was $106,000 in Q2 2019, with 196,000 Americans holding over $1m in their retirement fund (Fidelity Investments, 2019). Fund managers could use this research to better allocate people's money that suits their clients' desired risk regarding their portfolio's performance.

The Standard & Poor 500 index was studied, which covers about 80% of the available market capitalisation (S&P 500, 2020) within the NASDAQ. As the inclusion of stocks in the S&P500 are dynamic, historical data is used for comparison for each time period.

The null hypothesis is that the standard deviation of change in volatility is equal to 0. Meaning that there was no change in volatility between 2019 and 2020. I hypothesise large volatility changes for most industries.

[1] The original research question was "*How has the volatility between different GICS sectors within the S&P500 changed during the COVID-19 pandemic, compared to the same time last year?*"

Method.

Categorising stocks into particular industries.

GICS is arguably the most widely used standard, with the advantage of being consistent across different applications for effectively grouping stocks with similar operating characteristics (Hrazdil, Trottier, & Zhang, 2013).

I scraped a data table (List of S&P 500 companies, 2020) (S&P 500, 2020) to create a data frame using the Pandas

python library for each stock included in the S&P500. I then filtered the data to distinguish stocks based on their GICS sub-industry classification. In total 126 sub-industries categorise 504 stocks.

Downloading the data.

For each stock's unique ticker, Yahoo Finance API was used to download the price history for the specified date range. The percentage change between each Adjusted Close was calculated for each ticker in that industry, then the mean of these percentages was taken. As seen in Fig.1 and Fig.2.
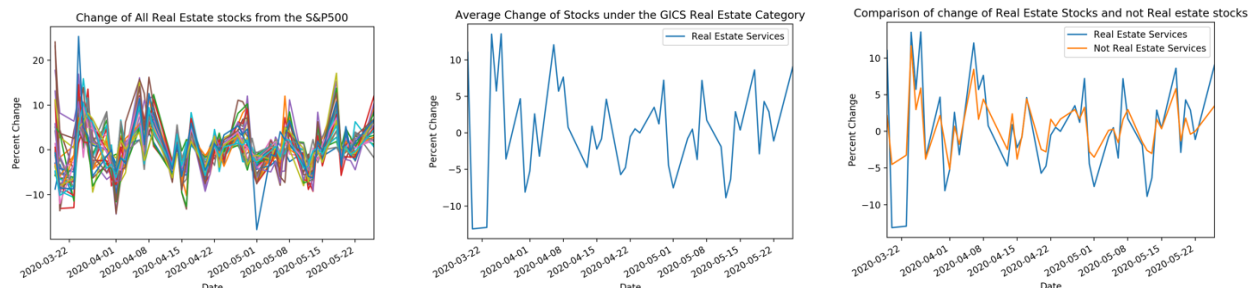

Fig. 1 shows the % change for each Real Estate Stock. **Fig. 2** shows the mean of all Real Estate stock's change. **Fig.3** shows the mean percent change for S&P500 excluding Real Estate.

Separating the population.

Once the percentage of change between the Adjusted Close price for each stock was calculated (we will refer to this as *P*) the sum of each row in *P* was divided by the size of *P* (e.g. 'Real Estate' has 31 individual stocks) in that category to determine the mean of percentage changes between Adjusted Close.

The same was done for every stock that was not a part of the category, this will be referred to as *P'* and will be used as the benchmark to analyse against, as seen in Fig.3. The reason for comparing an industry to all the other stocks excluding the current industry was because some industries, such as real estate, take a bigger proportion of the S&P meaning they, as previously mentioned, would contribute a greater weight creating bias.

Regression Analysis.

The beta coefficient β of a stock is used to measure how volatile it is against the market during a particular time-series. β x 100 shows the overall percentage of the volatility of the stock with regards to the overall market. If β>1 then the stock is more volatile than the market, and vice versa. If β<0, it is negatively correlated to the market (Corporate Finance Institute, 2015). The beta coefficient was calculated through an ordinary least squares regression model. The standard deviation was calculated on each Δβ, as to determine how much the industries deviate from the mean. The mean of Δβ is always expected to be 0, as the average beta coefficient will always be 1, as β=1 indicates an exact correlation to overall market performance. Thus, any positive Δβ for one stock means a negative Δβ for another.

$$\text{Beta coefficient } (\beta) = \frac{Covariance(R_P, R_{P'})}{Variance\ (R_{P'})}$$

R_P = Return of an industry
$R_{P'}$ = Return of everything not within the industry.

Results.

Beta Coefficient (β) of different GICS Sub-Industries in 2019 and 2020
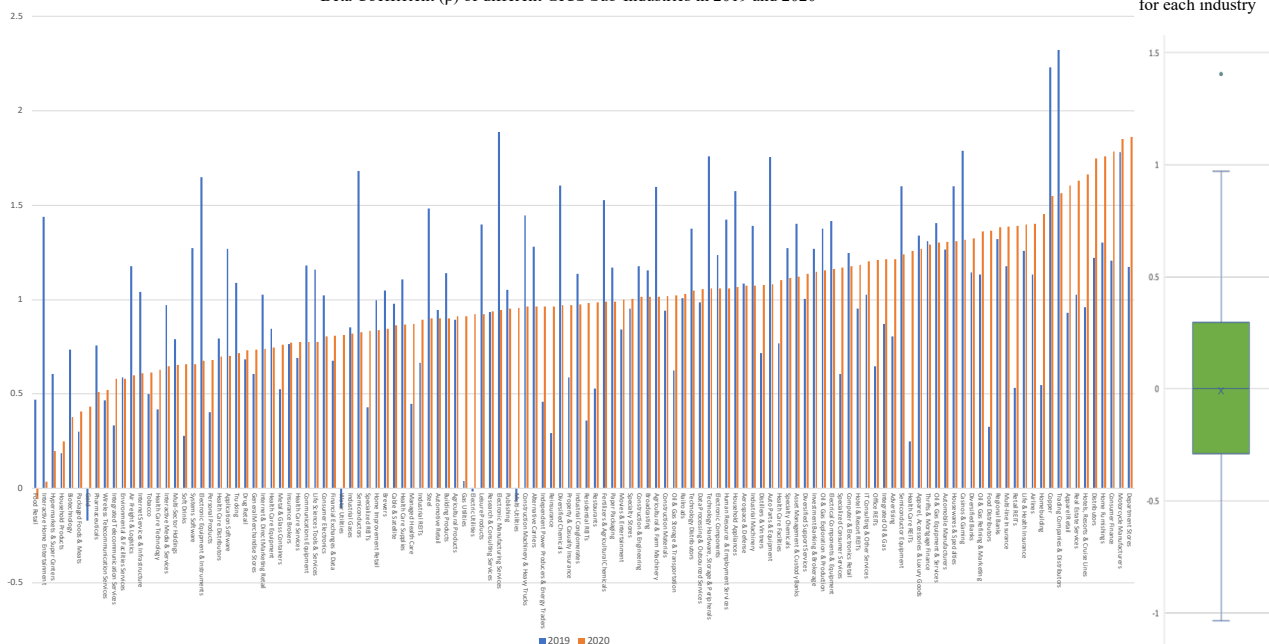
Δβ between 2019 & 2020 for each industry

2019   2020

Fig.4 shows the beta coefficient for all 126 sub-industries within the S&P500. Sorted by 2020 Beta Coefficient.

Blue lines indicate the volatility for the same period in 2019.
Date Range for Fig.3: 19/03/2020 through 26/05/2020
Pricing time for Fig.3: Adjusted Close

Some industries in Fig.4 showed large $\Delta\beta$, while others stayed similar. With 28.6% of industries having $|\Delta\beta|>.5$ Multi-Utilities, Gold, and Water Utilities volatility turned from going against the market with $\beta < 0$ indicating a negative relationship, to going with market behaviour as indicated by $\beta > 0$. Food Retail had the inverse behaviour. Interactive Home Entertainment was the only outlier, with $\Delta\beta$ being ~1.4.

$\sigma(\Delta\beta) = 0.4609$, and the inter-quartile range of $\Delta\beta$ was ~2, as seen in Fig.5. Disproving the null hypothesis.

Discussion.

Industries with higher than market volatility.

High volatility on prices for industries such as Department Stores and Home Furnishings could indicate that these are the most affected by uncertainty, communication regarding policy could be a factor leading to volatile speculation (Hayo, Kutan, & Neuenkirch, 2012). High volatility could also indicate that the stocks are more so affected during announcements such as lockdown, stimulus, social distancing laws, and supply chain strain. Supply chains are expected to be impacted well beyond the pandemic (Ivanov, 2020) which could also explain why manufacturers have seen increased volatility.

What could be causing industries to have no association with the overall market?

Air Freight and Logistics' stocks aren't moving with the market as much as in 2019. This could be attributed to cheaper fuel (Albulescu, 2020) and a larger supply of planes due to reduced air travel being a positive for the industry. Whilst reduced consumerism (Baker, Farrokhnia, Pagel, Yannelis. 2020) could be seen as negative. Having $\beta = 0$ could be an indication that the market sees most COVID-19 market events as positive or negative.

Another noticeable low volatility industry is Interactive Home Entertainment, this could be attributed to stay-at-home boredom increasing the necessity of at-home entertainment services (Taylor, 2020), but the lack of a negative Beta could indicate that as consumers are earning less money due to record unemployment (Coibion, Gorodnichenko, & Weber, 2020), and with lockdowns already being reduced (Garnett, 2020) households may soon view at-home entertainment as a luxury expense. Studies in the future could use this data to link market caution with changed consumer perception of good and services.

Low betas could indicate industry initially moving with/against the market, then as observation of how different industries adapt to market events, the correlation to the market changes. More research needs to be done.

What goes against the market?

Food Retail is the only stock that has gone against the market. The initial surge in market price during the 'panic buying' happened at the same time the market was crashing; however further research would need to be done to determine why this is the case. Although the correlation is negative it is not strong (-0.056)

Gold has gone against it's reputation.

The Gold Industry has been recognised as a safe haven in extreme stock market conditions in the past (Baur & Lucey, 2010), however, has seen an increased risk having 43% of the market's volatility, with a positive correlation. More research would need to be done to try and determine why Gold industries have begun to move with the market during COVID-19.

How could this study be extended or improved?

Using the above method to compare industries during different time periods of the pandemic, comparing volatility for specific events rather than from the 19th of March to the 26th of May could give insight to how industries react to particular major events. For the scope of this study, however, the 9 week period gave enough data to compare the majority of the global event against the previous year. Comparing the data against past years and determining if the change in volatility for each industry is significant, or if it possibly part of some kind of pattern. The same method above could be used for many stocks across many markets. For further insight, every stock on the NASDAQ could be added by using every ticker symbol in the NASDAQ and subsequently categorising them, providing a larger dataset overall whilst including industries that are not in the S&P500 which may provide important information.

Conclusion.

Every day COVID-19 creates new speculation on how the market will perform. The change in stock volatility for unique sub-categories within the S&P500 indicates that the pandemic has a larger effect on some industries than others. Food Retail was the only industry with a negative relationship with the market.

Almost one-third of the industries gained or lost .5 off of their beta coefficient from the same trading period last year. This disproves the null hypothesis, but only for a portion of industries. Some industries maintained similar volatility to

the year prior. These findings offer an insight that could be significant in deciding economic policy and could also help future researchers to evaluate the effects that COVID-19 has had on specific industries.

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