

Stock performance during Covid-19 pandemic by sector: Conditional value at risk approach

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Abstract. The Covid-19 pandemic affects many areas of our lives, with financial markets being no exception. Comparison of the risk-return patterns of the sector stock indices allows us to draw conclusions on the relative vulnerability of the economic sectors to the underlying pandemic. Previous research suggests that although market was negatively hit in general, it is possible to find small portion of the winners. We used daily prices from the 1.8.2018 to 31.7.2021 on the sector stock indices to assess its risk-return patterns before and during the pandemic. Special emphasis was set on the calculation of the Conditional value at risk. Our results suggest that, although all the sectors reported increased CVaR measures, in terms of the Sharpe ratio most sectors reported higher values in Covid-19 period. IT, Consumer Discretionary and Health care sector showed the lowest relative increase in the riskiness while Real Estate, Utilities, Energy and Materials were hit the most. With regards to the Healthcare sector, the improved performance seems to be driven by the industries of Biotechnology and HC equipment rather than Pharmaceuticals.

Keywords: Conditional value at risk, sector stock indices, financial markets.

JEL classification: *G 10, G 11*

1 Introduction

Covid-19 pandemic represents unprecedented global event, affecting all aspects of our lives, stock market being no exception. The fall of the financial markets provided us with the unique opportunity to assess the performance of the stocks on the sector-to-sector basis, and thus draw conclusions on the relative vulnerability of the sectors for the future.

To this end we have decided to use less common Conditional value at risk methodology to assess the increased risk within the stock market. We have compared the performance of the 11 S&P sector stock indices before and during Covid-19

pandemic based on Sharpe ratio and CVaR 95%. We used the data on the historical prices of the indices ranging from 1.8.2018 to 31.7.2021.

Our results suggest that although all the sectors reported significantly higher CVaR 95 values during the Covid-19 pandemic, pointing to the higher riskiness, the Sharpe ratios showed that it is offset by higher expected returns. In line with previous research the IT, Consumer Discretionary and Healthcare sector showed the lowest relative increase in the riskiness while Real Estate, Utilities, Energy and Materials were hit the most. The performance of the Healthcare sector was driven not by the Pharmaceuticals, but rather by the Healthcare equipment and Biotechnology industries.

2 Review of the literature

Stock prices are said to be equal to the sum of discounted values of expected future cash flows at different investment horizons. Thus, they are vulnerable to the several underlying factors, which might be affecting the expected future returns of the all the sectors within the economy or just some of them. A typical example of such a discriminating factor, studied commonly in the literature, might be the oil price change, that leads to the volatility of the transport sector returns (Arouri and Nguyen, 2010) and other gas related sectors.

On the other side of the scale are factors affecting economy, and thus spilling the increasing the risk measures of the stocks within sectors either by decreasing expected returns or increasing the volatility of the returns. Covid-19 might be considered one such factor. There is a vast body of literature analyzing the linkage of the Covid-19 pandemic and the financial markets. In general, studies conducted during the first year of the pandemic showed, that there were negative volatility shocks in the stock markets. These were reported for example by Baker et al. (2020) or Hassan and Gavilanes (2021) reporting the drop rates of the same scale as during the global financial crisis of 2008. Similarly, Baek et al. (2020), analyzing the US stock market volatility, concluded that total and idiosyncratic risk is significantly increased by Covid-19 pandemic across all industries.

Other stream of literature analyzed the impact of Covid-19 on the stock market on the sector-by-sector basis. Özkan (2021) studied 23 sector indices from the Istanbul stock market between June 2019 and July 2020 and found that volatility jumps had occurred in all sector indices analyzed. He also states that the volatility shocks were asymmetric, with the sports companies being the most hit, while the stocks of the insurance related sector were the least affected. Interestingly, author concluded that the volatility shock disappeared in the march 2020. In contrast, studies from US reported market crash in March 2020 triggered by Covid-19. One such study, conducted by Mazur, Dang and Vega (2021) reported, that despite of the market crash negatively affecting the returns of 90% of the S&P1500 stocks, some sectors, such as healthcare or software stocks earned high positive returns. Similar results are reported by Smales (2021) who analyzed the impact of Covid-19 on the 11 S&P sector indices, used also in our publication, and concluded that the investor attention, measured by the Google search volume might explain, why some sectors were hit stronger than others. Increased

attention helped to realize gains in sectors of Consumer Staples, Healthcare and IT. Study conducted by He et al. (2020) with the use of the data on the Chinese stock market and abnormal average return rate methodology, reports findings supporting the previous studies. However, besides of IT and Healthcare, also education and manufacturing are found to be resilient to the pandemic.

We extend the existing literature by assessing the longer time-period, as we believe, that although the main disturbance in the returns might have been at the beginning of the pandemic, in the long run investors might have used to the new conditions on the market to a certain degree. The pandemic is not over yet, and although we have a relieve in the form of the vaccines, new mutations and governmental restrictions are likely to be still negatively influencing the expectations of the investors. We expect the long run risk measures to be still considerable higher when compared to its pre-Covid counterparts. Secondly, instead of the analysis of the most common volatility measures we aim to compare the 95% Conditional value at risk for the sectors during the 1.5 year before and after the Covid-19 pandemic. This method allows to assess the risk of the indices more conservatively, as it weights the extreme losses more heavily. Special emphasis will be set on the industries within the healthcare sector, where higher volatility is expected, caused by the increased public scrutiny set on the pharmaceutical companies during the quest for the most effective vaccine.

3 Data and methodology

The aim of this paper was to assess the performance of the individual S&P sector indices during the pandemic and their potential role in the portfolio diversification. Additionally, we intended to put special emphasis on the performance of the healthcare related industries during Covid-19 pandemic, as it was reasonable to expect higher attention of the investors towards pharmaceutical companies. To this end we have analyzed 3 years of daily returns of the S&P indices, beginning from August 2018 till the end of the July 2021. To compare the indices performance before and during Covid-19 pandemic we divided this period into two sub-periods of approximately equal length. As a beginning of the pandemic, and thus the breakpoint between two sub-periods, we chose 1.1.2020. We did so because the outbreak of Covid-19 was firstly reported on 31. December 2019 in Wuhan, China and first case of Covid-19 in the US followed on January 21. As the final day of our sample, we used 31.7.2021, which represents the day of the data collection.

We picked sector indices based on the S&P website (2021) and its breakdown of the companies into 11 sectors – Communication services, Consumer Staples, Consumer Discretionary, Energy, Financials, Healthcare, Industrials, Information technology, Materials, Real Estate and Utilities. To follow our interest in healthcare sector we separately also assessed S&P Pharmaceuticals Industry, S&P Biotechnology Industry and S&P Healthcare Equipment Industry, all incorporated in broader Healthcare sector index. The first two are picked due to their importance in the Covid-19 struggle and the last for its increasing importance on the market. Table 1 provides the information on

the top 10 constituents within each Industry. As one can see, both Pharmaceuticals and Biotechnology industries incorporate companies linked to the Covid-19 vaccines.

Table 1. Top ten constituents of chosen healthcare industries, based on S&P website

Industry	Top 10 companies
Pharmaceuticals	Zoetis Inc, Catalent Inc, Eli Lilly & Co, Elanco Animal Health Inc., Pfizer Inc, Johnson & Johnson, Bristol-Myers Squibb, Perrigo Company pls, Jazz Pharmaceuticals plc, Merck & Co Inc
HC equipment	DexCom Inc, ResMed Inc, Inogen Inc, Biolife Solutions Inc, Qidel Corp, Masimo Corp, OraSure Technologies Inc, Hill-Rom Holdings Inc, Danaher Corp. West Pharmaceutical Services Inc
Biotechnology	Intellia Therapeutics Inc., Moderna Inc., Cytokinetics Inc., Celldex Therapeutics Inc, Translate Bio Inc, Arcus Biosciences Inc, Veracyte Inc, ChemoCentryx Inc, Biohaven Pharmaceutical Holding Company Ltd, Kymera Therapeutics Inc

Source: Based on the information from the S&P website.

The data on daily prices were downloaded from the website of spglobal.com for the period from 1.8.2018 to 31.7.2021. All the prices were in USD.

To get preliminary notion on the market development we calculated expected returns and standard deviations of the chosen indices. This was done separately for the pre-Covid-19 and Covid-19 period. Calculated parameters can be seen in Table 2. As the market recovered from the initial Covid-19 hit, one might see that the returns in Covid-19 era are higher for most the stock sector indices. Only exceptions are sectors of Consumer Staples and Utilities. Similarly, in line with the abovementioned studies, standard deviations were alleviated in the Covid-19 era. Interestingly, when the two main industries within HC sector, Pharmaceuticals, Biotechnology and HC equipment are compared, the lastly mentioned is the obvious winner. This is a surprise, considering the hopes related with the vaccinations and the Covid-19 drugs we would expect that higher attention and investments would be put into the Industry of Pharmaceuticals.

Table 2. Expected daily returns and standard deviations of the S&P stock indices by sectors and selected industries.

S&P Index	Pre-Covid19 (8.2018 – 12.2019)		Covid-19 (1.2020 –7.2021)	
	E(r)%	St.dev	E(r)%	St.dev
Com. Services	0.06	0.011	0.12	0.018
Cons. Staples	0.05	0.010	0.05	0.015
Cons. Discre.	0.03	0.011	0.11	0.018
Energy	-0.05	0.013	0.00	0.033
Financials	0.03	0.011	0.07	0.024
Healthcare	0.04	0.010	0.08	0.016

Industrials	0.03	0.011	0.08	0.021
IT	0.07	0.013	0.15	0.022
Materials	0.02	0.011	0.10	0.021
Real Estate	0.05	0.009	0.07	0.021
Utilities	0.06	0.008	0.03	0.021
Pharmaceuticals	0.00	0.013	0.04	0.019
HC equipment	0.02	0.013	0.12	0.019
Biotechnology	0.02	0.019	0.10	0.025

Source: Own calculations, based on the data from the S&P website.

In the practical part of the paper, we will calculate the Sharpe ratios based on the formula: Sharpe ratios for the 13 selected indices.

$$\text{Sharpe ratio} = \frac{E(r) - r_f}{\sigma} \quad (1)$$

where $E(r)$ stands for the average daily return of the index, r_f represents risk free rate of return and σ stands for the standard deviation of daily returns. As risk-free rate we used the return on the one-year US treasury bill of 1.56% published on 1.1.2020 (U. S. Department of the Treasury), which after accounting for 250 trading days, gave us daily risk-free return of 0.00006%.

Once the descriptive statistics were analyzed, we proceeded to the calculation of the Conditional Value at risk and the construction of the efficient frontier for the portfolio consisting of selected indices. As we want to test the performance of the separate S&P sector indices in the investment portfolio and short positions are closer to the speculation than investing, we disregarded them. The efficient frontier is constructed by using Solver function to minimize Conditional Value at Risk - CVaR 95 for the given rate of return. The maximization formula might be specified as follows:

$$\text{Min } CVaR_\alpha(w) \text{ subject to } \mu_p(w) = r_T, \sum_i w_i = 1, w_i \geq 0, \quad (2)$$

where $\mu_p(w)$ is the portfolio mean and r_T is a target return. Weights of the individual constituents are w_i .

Conditional value at risk, is a measure of the expected loss in the left tail given a particular threshold on the percentile of the distribution of outcomes and was introduced by Rockafellar and Uryasev (2000). It addresses several shortcomings of the Value at risk (VaR) method. Firstly, CVaR fulfils the subadditivity condition, not allowing the portfolio to have higher risk than the sum of constituents itself. This is not accounted for by VaR calculation. CVaR exceeds VaR measure and thus leads to the more conservative portfolios (Hafsa, 2015). Generally, in times of the market stability, VaR and CVaR give very similar results, however under conditions of higher volatility, such as Covid-19 pandemic, VaR might not give the full picture of the risks, as it does not take into account the distribution of the losses beyond its threshold.

Consequently, we proceeded to the construction of the efficient frontier based on the weights provided by the Solver function and compared it to the risk-return pattern of individual sector indices.

4 Results and discussion

To assess the risk-profile of the sector indices before and during the Covid-19 we will focus on the Conditional Value at Risk (also known as Expected shortfall). Before doing so, we shortly assess the Sharpe ratio, the parameter which is more suitable for the less risk-averse investors, as it gives the information on the ratio between excess returns and standard deviation for the given period, regardless the distribution of the losses. This will provide us with the hindsight on the development of the sector stock indices. Results are reported in Table 3.

Regarding Sharpe ratios, one might see that, besides Consumer staples, Utilities and Real Estate the parameter improved for all the other sectors. Obvious winner is the sector index of Materials, which reported the five-fold higher value of the Sharpe ratio in the Covid-19 era. However, the caution while interpreting the results is needed is needed, as it is questionable what value of risk-free rate to use for the calculation of the excess returns. The results could vary greatly depending on choice.

Table 3. Sharpe ratios and CVaR 95% of the S&P stock indices by sectors and selected industries. Risk free rate based on the 1Y Treasury bond from 1.1.2020 equal to 1.56%.

S&P Index	Pre-Covid19 (8.2018 – 12.2019)		Covid-19 (1.2020 –7.2021)	
	Sharpe	CVaR	Sharpe	CVaR
Com. Services	0.047	0.027	0.062	0.044
Cons. Staples	0.040	0.019	0.027	0.036
Cons. Discre.	0.024	0.028	0.056	0.046
Energy	-0.041	0.032	-0.002	0.075
Financials	0.023	0.026	0.026	0.058
Healthcare	0.038	0.024	0.044	0.040
Industrials	0.019	0.027	0.034	0.052
IT	0.050	0.034	0.066	0.053
Materials	0.009	0.025	0.047	0.050
Real Estate	0.045	0.022	0.032	0.055
Utilities	0.064	0.019	0.011	0.051
Pharmaceuticals	-0.005	0.032	0.019	0.044
HC equipment	0.011	0.031	0.063	0.045
Biotechnology	0.008	0.041	0.039	0.055

Source: Own calculations, based on the data from the S&P website.

As for the focus of the research, we assess the values of CVaR for chosen stock indices. Values are reported in the Table 3. The graphical demonstration of the relation between Expected returns and CVaR 95% in Covid-19 period is provided in the Figure 1, together with the efficient frontier build from the indices. CVaR can be interpreted as a weighted average of the 5% of the losses. The results show, in line with the expectations, that all the CVaR parameters increased by 1.4 to 2.7 times when compared to the pre-Covid period. The highest relative rise is reported in the sectors of Utilities, Real Estate, Energy and Materials. While an investor in Utilities lost on

average 1.8% on the worst 5 out of 100 trading days before the Covid-19 pandemic, the value lost during the pandemic would be 5.1%. Similarly, instead of losing on average 2.1% in the 5 worst days out of 100 days, investor in Real Estate loses 5.5% in pandemic. The riskiest sector based on the expected shortfall is Energy sector, in which the 95% CVaR equals to 7.5%.

On the other hand, the least impacted sectors based on this measure were IT, Consumer Discretionary and Healthcare. While CVaR in IT before the pandemic was 3.4%, being the highest from all the sectors, it raised only 1.57 times to the value of 5.3% during the pandemic. Although still rather high, it lost the position of the riskiest sector based on CVaR to the Energy and is also surpassed by Financials and Real Estate.

As for the Healthcare sector, the value of CVaR 95 increased from 2.4% to 4%. When focused on the two main industries within the sector, Pharmaceuticals and Healthcare equipment, we can see comparable development within both indices. However, the indifference disappears once the values are mapped to the expected returns. Surprisingly, Healthcare equipment outperforms Pharmaceuticals greatly, offering 3 times higher returns for the same value of CVaR. Even the Biotechnology offers better Sharpe ratio than the Pharmaceuticals, however, its CVaR is 1 percentage point higher. Thus, in conclusion, the positive performance of the HC sector relative to the other sectors is driven not by the industry of Pharmaceuticals but rather the performance of the Healthcare equipment and Biotechnology industries.

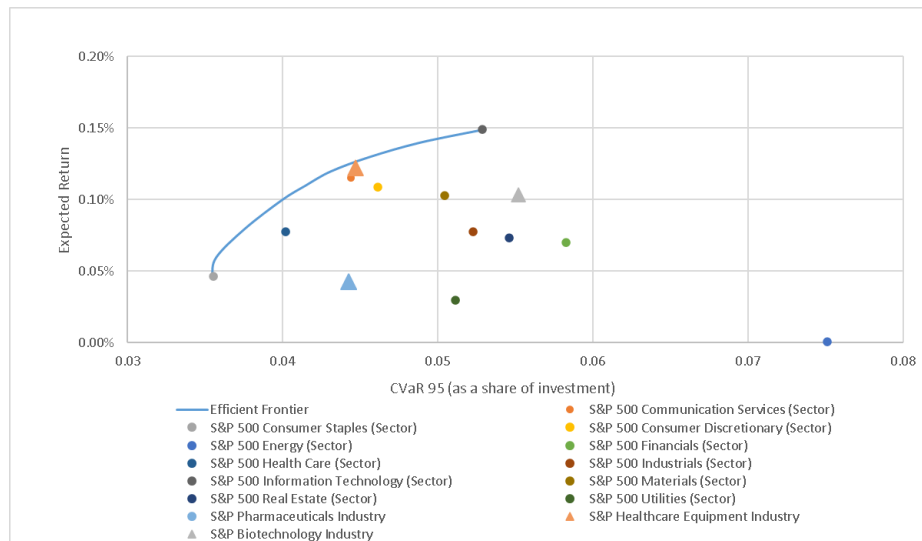


Fig. 2. Efficient frontier and individual S&P indices. Based on the data from the S&P website.

Regarding the relation between CVaR 95 as a risk measure and the expected return, shown in Figure 1, the efficient frontier runs through Consumer staples and IT sector indices. Other indices in its close neighborhood are Communication services, Healthcare and Consumer Discretionary.

Our results are in line with Smales (2021) and He et al (2020), supporting the notion that IT and Healthcare did the best during pandemic. Even in the prolonged period of analysis these two sectors showed the lowest relative increase in the risk-measures. Surprisingly, our results showed that within the HC sector the performance of the Healthcare equipment industry outperforms the industry of Pharmaceuticals.

Results also showed the increased volatility of the sectors related to physical goods. Significant increase in the riskiness of Energy and Materials stock index, might be attributed to lockdowns and restrictions in transportation and manufacturing due to the pandemic. Increased riskiness of the Real Estates is also likely to be attributed to the restrictions when less people had to change the residence as the work was conducted often from house. The most surprising comes the underperformance of the Utilities in comparison to the period before the Covid-19 outbreak. Although one would have expected that because of the home office the usage of the electricity would go up thus creating demand and attracting investor attention, the same goes for water. However, the Sharpe ratio declined 6 folds. The possible reason is the lower demand by the companies which had outpaced the home usage.

5 Conclusions

Although Covid-19 pandemic has increased the volatility of the whole market, regardless the sector, there are still sectors that were hit less than the others. Comparing the CVaR 95% we conclude that the CVaR of the sector indices is higher from 1.4 to 2.7 times in comparison to the pre-Covid period. The highest rise of the CVaR is reported in the sectors of Utilities, Real Estate, Energy and Materials. The Sharpe ratios also showed that Utilities had the highest drop in performance sector. Except for the Consumption Staples and Utilities, other sectors actually reported increased Sharpe ratio for the Covid-19 period, suggesting that the market has recovered.

In line with previous research the least impacted sectors based on the chosen measures are IT, Consumer Discretionary and Healthcare. Interestingly, the performance of the Healthcare sector was driven more by the industries of Healthcare equipment and Biotechnology than the classical Pharmaceuticals, although there are several companies producing Covid-19 vaccines within this industry.

The biggest drawback of our paper is how to define the period of the Covid-19 pandemics. As the restrictions are still set in many countries, we have decided to analyze the data up to July 2021, however we are aware that the main rise in the volatility was present in the first half of 2020. Increased volatility is likely to disappear in the future research as the longer and longer period will be analyzed. As the CVaR cares about the distribution of the worst losses, it will remain affected longer than traditional measures such as VaR. It would be viable to try to analyze CVaR on the month-by-month bases and see how the volatility settled or increased over time.

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