

Analysis of Investment Portfolios Formed with Stocks from Sectors Largely Impacted by COVID-19

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Abstract. COVID-19 has led the market into a highly volatile period. Risks in investment have increased significantly during this time. Although risk-prone investors are able to withstand the high risk in investment and continue to invest, risk-averse and risk-neutral investors do not have that level of risk tolerance. This study focuses on the stocks from sectors that are highly affected by the pandemic, and it aims to analyze the best sector for investment and construct an optimal portfolio that is able to minimize the risk while keeping a reasonable rate of return for the investors. This study uses the daily adjusted closing price for stocks from January 31st, 2019, to May 12th, 2021 for calculation. The study makes use of Sharpe's single-index model to perform portfolio optimization. As a result, the study has found that the healthcare sector is indeed the best sector to invest in during the pandemic, as all of the low-risk portfolios have set weight heavily in the healthcare stocks. The portfolio formed by healthcare stocks and technology stocks is able to obtain a low-risk level while returning at a high rate.

Keywords: Portfolio optimization; Single-index model; Sharpe ratio; Systematic risk; Risk-averse.

1. Introduction

1.1 Background

The current macroeconomic situation globally is at a low. Since the first quarter of 2020, the inflation rate in the United States continues to show a growing trend. The real GDP of the United States is also ongoing a continue decrease in 2022, which reflects a global slowdown in economic growth. As the world is still recovering from the pandemic, the market will take longer to reflect the recovery. Large market like the United States still has an increasing trend in the unemployment rate. Another aspect that reflects the economic situation is the import and export rate. Although the United States has demonstrated growth in import and export rates, the growth is relative to a major decrease that took place in 2021. The United States continues to suffer from the negative impact of the pandemic with difficulty in imports and exports. The global situation is also under tension with the war between Russia and Ukraine and the energy crisis that recently happened in Europe. Various conflicts have happened between nations which caused instability in the market as well. Consumers endure greater risk when they invest during the pandemic. Without the proper methods and knowledge, consumers can experience significant downturns in their investments. Therefore, a well-constructed portfolio plays an important role in a consumer's investment strategy. Through analyzing historical trends, consumers will be able to gain a deeper understanding of the current market. At the same time, a reasonable prediction could be made for future investments that can minimize the volatility within the market. Especially for risk-averse investors, investment decisions could be difficult to make as the market is highly volatile.

During this period of unstable market performance, some of the sectors have been largely affected. The paper will focus on three sectors: consumer defense, healthcare, and technology.

The consumer defense sector is non-cyclical, so it can serve as a defensive sector for investment. The demand is inelastic. As it is non-cyclical, it has resistance to inflation with predictable growth. This sector serves as a critical part of a well-rounded portfolio. The healthcare sector is also a defensive sector for investment, as the demand is inelastic. Due to the pandemic, the healthcare sector's margins have overall decreased because of the stay-at-home order. Furthermore, innovations continue to be developed in the healthcare sector, as seen in the COVID-19 vaccine and the rapid

shift to virtual healthcare in response to the pandemic. The risk that come along with politics and principal-agent problems differ the healthcare sector from the other sectors. The technology sector is an ongoing trend for the past decade, but it is a sector with high elasticity and rapid changes. Therefore, the technology sector has a relatively high risk, but it also results in greater returns. Due to rapid changes and continuous innovations in the technology sector, governments have to post regulations and support simultaneously in this sector. This sector can therefore serve as a backup investment, as the current rising interest rate has a significant negative impact on the sector. However, this sector expects to go through a significant increase in the long term.

1.2 Related Research

Faisal and Aboud conducted portfolio optimization through Sharpe's Index Model in the modern scenario. They provided an in-depth analysis and explanation of the logistic behind the model. Through a complete run-through of the optimization process with ten stocks, they presented how the model selects the 5 optimal stocks to be included in the portfolio [1]. Mandal conducted an in-depth analysis of the idea behind the single-index model through a complete run-through of the optimization process empirically with BSE SENSEX as the market index. The single-index model requires calculating a cut-off rate to select the securities to be included in the portfolio. Then the weight of asset allocation for each security is calculated [2]. Mahmud conducted portfolio optimization on Dhaka Stock Exchange to experiment with the effectiveness of the single-index model. The scrips chosen were from 16 industrial sectors. With month-end prices used from 2013 to 2018, Mahmud found out that the model provides a decent return with diversified risk on the scrips in Dhaka Stock Exchange [3]. Krishnamoorthy and Basha constructed an optimal portfolio with the single-index model using the BSE SENSEX as the market index. With 30 stocks evaluated, the authors went through the optimization process and selected the stocks that are over the cut-off rate. The data they used was from 2016 to 2021, and they found out that during the pre and post Covid-19 period, Pharmaceutical and Financial services companies had the highest risk and return in the period of study [4].

Senthilkumar et al. analyzed the performance of the Markowitz model and the index model in the context of Indian companies with intra-sector and inter-sector portfolios. Through experiments on 191 scrips from 2013 to 2019, the authors found that inter-sector portfolios have a better performance in general, and Sharpe's index model has a better performance than Markowitz's model [5]. Ali et al. examined the return on Malaysian stock from 2000 to 2010. They found out that in the short term, strong intra-sector return reversal exists in all sectors. The intra-sector contrarian strategy outperforms the other strategy in the short term. However, when a holding period of 52 weeks has been reached, the returns are no longer as high [6]. Varadharajan and Ganesh analyzed the portfolio optimization of companies from large-cap sectors in India through the application of the single-index model. 18 stocks were chosen from three different sectors. Risk and return for each stock were calculated individually during the process. The authors then ranked and selected the top five to form the optimal portfolio [7]. Subashree conducted a study using the single-index model to construct an optimal portfolio from 10 scrips chosen from the banking sector and automobile sector. These scrips are listed on the Bombay stock exchange. The prices used to construct the portfolio are from October 2016 to September 2017. The "cut-off" line is calculated by the prices to form a threshold for the optimal portfolio [8].

Sankaran and Patil used Elton, Gruber, and Padberg's ranking procedure to select at most k securities that form the portfolios which maximize the excess return. The authors claimed that the ranking procedure is able to solve for any value of k . They also claimed that the optimal ratio will experience a gradual decrease in its increasing rate [9]. Behr et al. conducted an analysis on whether naively diversified portfolios outperform the established portfolio strategy. The authors calibrated the Ledoit and Wolf strategy and 1-norm constrained minimum-variance portfolio, and they successfully minimize the out-of-sample variance. They also achieved higher Sharpe ratios than $1/N$ [10].

1.3 Objective

This study aims to analyze the sectors that are heavily impacted by COVID-19 and construct the optimal portfolio to minimize the risk for investment during this volatile period.

2. Methodology

Portfolio optimization aims to select the best stocks and allocate the asset accordingly to formulate the maximum excess return and simultaneously minimize the financial risk that comes along. Investors tend to have different levels of risk tolerance which is directly correlated with the rate of return. This study uses Sharpe's single-index model as the tool to construct an optimal portfolio for risk-averse investors. Risk-averse investors are individuals who do not like risks. Sharpe's single-index model was first developed by William Sharpe in 1963 which performs a simplified analysis process compared to the traditional Markowitz model. The single-index model makes the assumption that only 1 macroeconomic factor is usually represented by the market index's rate of return. The model assumes that the macroeconomic factor will affect the returns of all stocks by causing systematic risk, which is the uncertainty faced by all individuals in the market [11]. Unlike the Markowitz model which uses the correlation matrix, the single-index model takes into account the alpha and beta when optimizing the portfolio. Alpha is the measurement of the return in comparison to the macroeconomic factor, and beta is the measurement of the volatility of the investment in comparison to the whole market [11]. Alpha can be found by finding the y-intercept of the line formed by the market index return (x-axis) and the stock's return (y-axis), and beta can be calculated by finding the slope of the line formed by the market index return (x-axis) and the stock's return (y-axis). For risk-averse investors, a low beta is preferred. To further explain the embedding theory inside the single-index model, below is the mathematical form [11]:

$$r_j = \alpha_j + \beta_j r_1 + e_j$$

Where: r_j is the excess return, the return greater than the projected market return, for stock j during the period. This is calculated by the return of stock j minus the risk-free rate; α_j is the alpha for stock j ; β_j is the beta for stock j ; r_1 is the excess return for the market; e_j is the residual or random return for stock j which is independent of the market index's return.

Going into stock sectors, the sectors can be generally divided into two categories, the growth sector, and the defensive sector. Some of the defensive sectors include consumer defense, health care, and utilities. The defensive sectors typically provide a relatively high dividend payout ratio and stable earnings that are subtly impacted by the overall market [11]. On the other hand, growth stocks normally consist of stocks in the technology sector. These stocks usually have a large market cap and have the potential to outperform the whole market in case of a return. The growth stocks typically do not pay a dividend, as the majority of the equity is being used for rapid growth. Growth stocks usually are more volatile, as they are highly responsive to market change [11].

Sharpe ratio is calculated by return divided by the variance. It represents the degree of historical excess returns that were accompanied by excess variance (volatility). It can also be used as an evaluation of a portfolio's performance after risk adjustments. In general, a higher Sharpe ratio represents better portfolio performance. On the opposite hand, a negative Sharpe ratio could be a sign of a historical return lower than the risk-free rate or even a negative expected return.

The main purposes of Sharpe's single-index model are to either maximize the return of the portfolio, minimize the variance(risk), or maximize the Sharpe ratio. This study is focusing on minimizing the risk, and four stocks with the lowest risk from each of the three sectors are selected. After performing the pre-requisite parameters calculations mentioned above, the remaining is just running all possible combinations of weights for the stocks in the portfolio that satisfy the intended purpose.

No constraint has been set during this analysis, as the purpose of this paper is to examine the sector's performance for risk-averse investors and not for individual investment strategies.

3. Results

The values below the stocks are the corresponding weight allocated to the corresponding stock in the given portfolio.

Table 1. Technology Sector Portfolio

Technology	ADBE	AKAM	ORCL	MSFT	Sum
	0.036	0.252	0.317	0.395	1.000
Return	28.904%	StDev	15.366%	Sharpe	1.881

Table 2. Consumer Defense Sector Portfolio

Consumer Defense	KO	PEP	PG	CL	Sum
	0.063	0.234	0.328	0.375	1.000
Return	14.258%	StDev	12.347%	Sharpe	1.155

Table 3. Health Care Sector Portfolio

Health Care	UNH	JNJ	PFE	LLY	Sum
	0.255	0.385	0.186	0.174	1.000
Return	16.959%	StDev	12.097%	Sharpe	1.402

Table 4. Bi-sector Portfolio (Consumer Defense and Health Care)

Consumer Defense	KO	PEP	PG	CL	Sum
	0.058	0.127	0.149	0.169	0.503
Health Care	UNH	JNJ	PFE	LLY	Sum
	0.111	0.189	0.139	0.057	0.496
Return	14.538%	StDev	7.451%	Sharpe	1.951

Table 5. Bi-sector Portfolio (Technology and Health Care)

Technology	ADBE	AKAM	ORCL	MSFT	Sum
	0.050	0.083	0.120	0.162	0.415
Health Care	UNH	JNJ	PFE	LLY	Sum
	0.133	0.223	0.158	0.071	0.585
Return	21.153%	StDev	8.226%	Sharpe	2.571

Table 6. Bi-sector Portfolio (Technology and Consumer Defense)

Technology	ADBE	AKAM	ORCL	MSFT	Sum
	0	0.103	0.067	0.028	0.198
Consumer Defense	KO	PEP	PG	CL	Sum
	0.023	0.179	0.280	0.321	0.802
Return	16.610%	StDev	12.028%	Sharpe	1.381

Table 7. Tri-sector Portfolio

Consumer Defense	KO	PEP	PG	CL	Sum
	0.031	0.092	0.122	0.139	0.384
Health Care	UNH	JNJ	PFE	LLY	Sum
	0.108	0.184	0.140	0.054	0.486
Technology	ADBE	AKAM	ORCL	MSFT	Sum
	0.000	0.045	0.043	0.042	0.130
Return	16.329%	StDev	7.288%	Sharpe	2.241

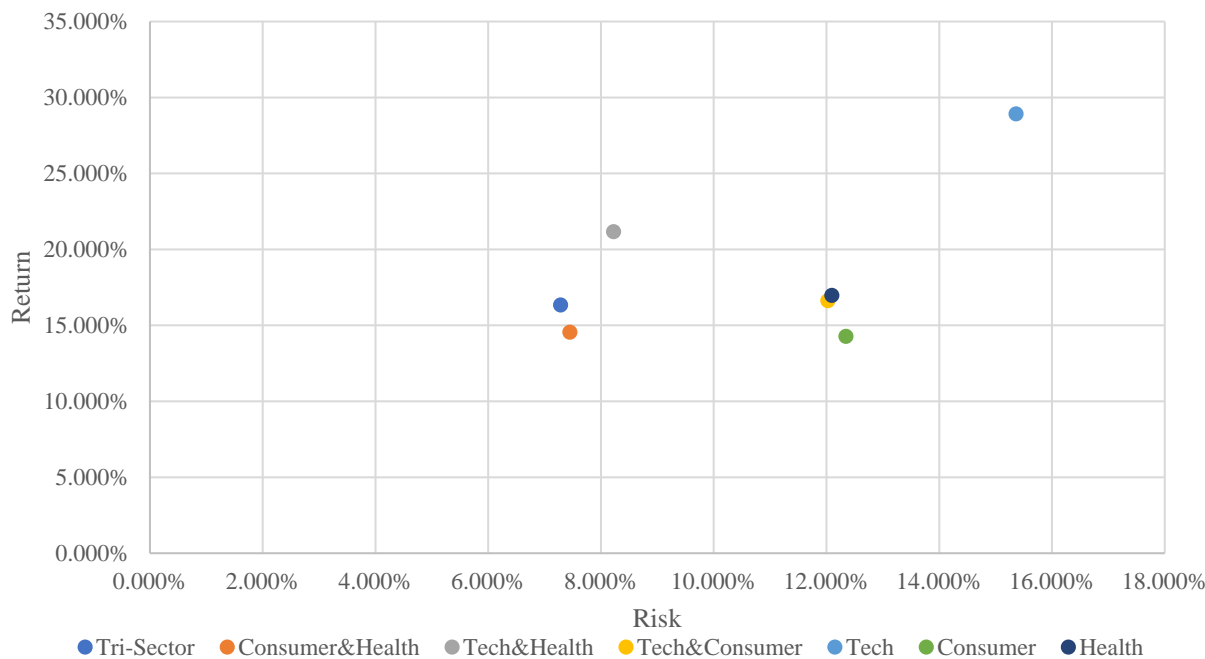


Fig. 1 Portfolios Return vs. Risk

4. Analysis

As shown in the results section, portfolios have been constructed with various combinations between the three sectors.

Examining the returns of the three portfolios constructed with each of the sectors independently (Tables 1, 2, 3), it is clear that the technology sector portfolio (Table 1) has the highest return among the three. In fact, it is nearly double the return of the other two portfolios. This result does match the expectation of the technology sector is a growth sector that yields high returns. On the other hand, the risk for the technology sector is also the highest. Risk-averse investors are more motivated to allocate their funds to a lower-risk portfolio rather than a higher return. The healthcare sector has a return placing between the other two sectors, but it has the lowest risk. This follows the current trend of macroeconomics. With the COVID-19 pandemic dominating the market, the healthcare sector plays an important role in the current time. Therefore, although it is traditionally considered a defensive investment sector, it now yields a higher return than the consumer defense sector and with a lower risk. The consumer defense sector has the lowest return among all three sectors. Meanwhile, it does not have the lowest risk and thus results in the lowest Sharpe ratio. Among all three sectors, if a risk-averse investor wants to select a single sector to allocate the money, it appears that the healthcare sector is the best investment choice. On the opposite, a risk-prone investor will choose to invest in the technology sector which yields higher returns along with higher risks. During the pandemic, the consumer defense sector does not appear to be a good sector choice to be invested in independently as it has the lowest return and not the lowest risk.

Looking at the investment in pairs of sectors (Tables 4, 5, 6), the risks for these portfolios decrease significantly from individual sector investment portfolios. The returns also demonstrate a slight increase as a whole. The pair between the healthcare sector and the technology sector yields the highest return rate of 21.153%, and it has a low risk as well. It is indeed the best portfolio to choose for all investors among all three pairs. With a majority of the weight on the healthcare sector stocks, this portfolio ensures low risk while maintaining an acceptable level of return. Furthermore, the technology stocks in this portfolio enhance the return rate. The portfolio formed between the healthcare sector and the technology sector has 4.543% more return and nearly 4% less risk than the portfolio formed between the consumer defense sector and the technology sector. Furthermore, the portfolio formed between the healthcare sector and the technology sector has significantly more return

than the portfolio formed between the healthcare sector and the consumer defense sector. Therefore, the lower risk in the portfolio formed between the healthcare sector and the consumer defense sector is negligible.

Lastly, the portfolio built with all the stocks yields the lowest risk among all combinations. The majority of the weights are being set on the healthcare sector as well. While some weights are being allocated to selected consumer defense stocks, only minor weights are being set on the technology sector. With the lowest risk, this does not yield the highest return among all the combinations.

From all the portfolios, they have all demonstrated a trend of investing in the healthcare sector will result in a lower risk while maintaining a relatively reasonable rate of return. Considering all the portfolios with risk lower than 10%, all of these portfolios have set weights heavily on healthcare sectors. Among them, the combination of the healthcare sector and the technology sector is indeed the best investment portfolio for risk-averse and risk-neutral investors.

5. Conclusion

Through portfolio optimizations, the study has demonstrated that the healthcare sector in the short term is the best investment option among all three sectors. Combining the healthcare sector stocks with high-return stocks like the ones from the technology sector can not only hedge the volatility caused by the pandemic in the short term, but the healthcare sector stocks can also maintain a relatively high rate of return to pursue continual growth in the investors' funds.

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