Portfolio Optimization for Six Companies in Different Industries

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Abstract. Portfolio optimization is an essential step in the process of asset management. Studying portfolio can help people gain greater benefits after investing their assets. This paper makes a subjective analysis of the stocks in the American stock market, and finally selects six stocks from different fields, including health care, finance, public utilities, Internet software and services, non-energy minerals, and industry for portfolio analysis. This paper uses mean-variance analysis, CAPM model and Fama-French model to get the best portfolios, and analyses portfolio performance under different methods. The results show that, in the CAPM model, "GS" gets the largest weight in the maximum Sharpe ratio portfolio and "AWK" gains the largest weights in the minimum variance portfolio. At the same time, in the Fama-French model, "GS" and "AWK" still get the largest weight in the maximum Sharpe ratio portfolio and minimum variance portfolio, respectively. This paper will be helpful to investors who pay attention to the six areas involved in this paper.

Keywords: Portfolio; Company; Fama-French; CAPM.

1. Introduction

Markowitz was the first to propose the idea of using mathematic models like the mean-variance models, to analyse the quality of investment portfolios. With the profits from investments soar, having a good investment portfolio that maximize profit and minimize risk became the focal point for most investors. Thus, ways to maximize profit and minimize risk became an important topic for investors, and there is where the mathematic models were used for predictions and analysis tools for an investment portfolio.

With significant growth on the research of portfolio optimization in recent years. Many researchers in a variety of fields have studied to analyse the market trend in their fields. For examples, Bekiros, Hernandez, Hammoudeh, and Nguyen studied portfolio optimization about gold and iron ore-nickel stocks [1]. Andriosopoulos, Doumpos, Papapostolou, and Pouliasis studied portfolio optimization about the shipping stocks and the freight markets [2]. Gatfaou studied portfolio optimization by trying to diversify the portfolio with crude oil and natural gas [3]. Wood also studied portfolio optimization about trying to predict the value and risk of oil and gas stocks [4]. Faia, Pinto, Vale, and Corchado studied portfolio optimization for the electricity markets [5]. Chen, Liu, Xian, Pan, Wang, Yang, and Quan studied portfolio optimization for energy stocks [6].

However, from the example above it may be noticed that portfolio optimization can sometimes be too broad or narrow, making their portfolio optimization to be quite limited. Thus, raising the interests to make in-depth investigations on this issue. This paper selects stocks from different fields to ensure a diverse portfolio, stocks can range from entertainments to infrastructure, they are: ACHC Express, GS, AWK, NFLX, NEM, and MYRG. The process of researching is by choosing several companies and consider them using different analysis methods to ensure accuracy. First, this paper chooses these six companies from different fields for the closing prices during the period between August 2017 and August 2022 to ensure diversity in the portfolio. The data of the companies are to be sorted out in the specified period of time. This paper first considered using the Mean-variance analysis to find the optimal portfolio, but this method has a relatively high bias by using expected return to calculate. As a result, this paper considers and compares the methods between CAPM and the CAPM-based Fama-French Three Factors Model (FF3F) in order to get more accurate information. Second, this paper

used the CAPM to find the optimal portfolios which are the maximum sharp ratio portfolio and minimum variance portfolio. But this model might be too limited as it just has one factor needed to be considered, so a multifactor model is tried to use in this paper. Last, the Fama-French Three Factors Model is used through the same steps as CAPM's to find both the maximum sharp ratio portfolio and minimum variance portfolio and but with the two risk factors in addition to the CAPM this paper believe that this is a more accurate and realistic method than CAPM.

The following is a summary of the remaining parts. Part 2 shows the data, Part 3 depicts the methods, Parts 4 and 5 show the results and conclusion, respectively.

2. Data

All the data from the paper came from Choice financial terminal software. Six companies are selected for their closing prices in five years from August 2017 to August 2022. The six companies are ACHC Express, GS, AWK, NFLX, NEM and MYRG. These data are chosen because of their relatively high beta and overall performance. In order to avoid high correlation in assets, these companies are also chosen from different fields, ranging from entertainment company to industrial corporations. Table 1 shows the mean return, variance and standard deviation of these stocks.

Table 1. Descriptive statistics

	ACHC	GS	AWK	NFLX	NEM	MYRG
MEAN RETURN	0.017	0.012	0.014	0.012	0.009	0.024
VARIANCE	0.017	0.008	0.003	0.016	0.008	0.011
STANDARD DEVIATION	0.131	0.09	0.058	0.127	0.091	0.105

From the table above, all the companies have a decent average return of around ten to thirty percent annually, the returns also reflect their risk, for example, NEM, which has the lowest average return of around 0.0094, also has one the lower standard deviations which means that the return is more consistent, while MYRG has the highest average returns and also has one of the higher standard deviations.

3. Methods

3.1 Mean-Variance Analysis

The theory of Mean-Variance portfolio optimization was developed by Markowitz and has become an important topic which was deserved to discuss in finance [7]. It is used by investors to weigh the risk of investments, expressed a variance against return. This method allows the investors to weigh their investment decisions and how much risk they are willing take for what kind of return, this allows them to find the biggest return at a given level of risk and vice versa. The following are the relevant formula:

$$\sum_i Weight_i = 1 \tag{1}$$

The $\mathrm{Weight_i}$ means the weight of different assets in the portfolio.

$$E(R_P) = \sum_{i=1}^{n} w_i r_i \tag{2}$$

The Rp means the Portfolio return, so the E(RP) stands for the expected income of the portfolio. The proportion of total capital invested in asset i is denoted by $\mathrm{w_i}$, while the expected return for asset i is expressed by $\mathrm{r_i}$.

$$Variance\ of\ Portfolio = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j Cov(r_i, r_j) \tag{3}$$

$Cov(r_i, r_j)$ shows the variance-covariance between expected return for asset i and expected return for asset j.

$$\text{Sharpe ratio} = \frac{\mathrm{E}(R_P) - R_f}{\sigma_P} \tag{4}$$

The Sharpe ratio is created to help investors find the comparison between return and risk. The portfolio's expected return is E(RP), the risk-free rate of this asset is represented by R_f and the standard deviation is σ_P.

3.2 Capital Asset Pricing Model

Although the CAPM had been criticized by many scholars, practitioners and academics still trust this model [8]. The CAMP describes the systematic risk and the expected return of certain stocks, since investors needs to be compensated when taking the risk and the time value of money when investing, one of the CAMP components called the risk-free rate which considers the money's time value. Besides, the CAPM still has components take into account additional risks that the investors are taking. Thus, the goal of the CAPM is to consider whether the current price of a stock is consistent with its likely return by taking the time value of money and risk to compare with its expected return. In other words, the CAPM evaluate whether a stock is fairly valued or not. The related equation is showing below:

$$\mathrm{E}(\mathrm{R_i}) = \mathrm{R_f} + \beta_\mathrm{i}(\mathrm{E}(\mathrm{R_m}) - \mathrm{R_f}) \tag{5}$$

$\mathrm{E}(\mathrm{R_i})$ means the anticipated reward, β_i means the beta value of investment, the market portfolio's return is represented by $\mathrm{R_m}$, the expected reward of the market is $\mathrm{E}(\mathrm{R_m})$. And $\mathrm{R_f}$ stands for risk-free interest rate. β_i is positive in almost all situations, and it can be thought of as the sensitivity of an asset to market fluctuations. It means that the asset has higher risky when the beta is greater than one. And the beta of less than one stands for that the investment has lower risky relative to the whole market.

3.3 Fama-French Three-factor Model

The FF3F model is based on the CAPM, it expands the CAPM model by evaluating another two risk factors the size and the value risk factors, which makes the model a better estimator than the other models when estimating the portfolio's performance relative to the market performance thus analysing the manager's performance [9,10]. The model is shown as:

$$\mathrm{E}(\mathrm{R_i} - \mathrm{R_f}) = \beta_\mathrm{i}(\mathrm{E}(\mathrm{R_m}) - \mathrm{R_f}) + \mathrm{s_i}\big(\mathrm{E}(\mathrm{SMB})\big) + h_\mathrm{i}(\mathrm{E}(\mathrm{HML})) \tag{6}$$

The equations stands for anticipated excess return($\mathrm{E}(\mathrm{R_i} - \mathrm{R_f})$) equal to the product of the factor coefficient β_i and the abnormal reward of the market portfolio($\mathrm{E}(\mathrm{R_m}) - \mathrm{R_f}$) plus the product of the factor coefficient $\mathrm{s_i}$ and firm condition SMB---more small cap firms in portfolio to outperform market, and plus the product of the factor coefficient $\mathrm{h_i}$ and firm condition HML---value stocks outperform growth stocks in the long run.

4. Results

Using the covariance function, this paper finds that the covariance between any two stocks is all less than 0.02, which means that there is less correlation between the different stocks. Furthermore, the covariance are non-zero and have both positive and negative numbers. This illustrates that all assets are inter-correalted and the relationship between them have positive or negative situations. So this paper finds an appropriate model.

Table 2. The covariance between the stocks

	ACHC	GS	AWK	NFLX	NEM	MYRG
ACHC	0.0169	0.0065	0.0007	0.0028	0.0009	0.0057
GS	0.0065	0.0075	0.0007	0.0042	-0.0002	0.0043
AWK	0.0007	0.0007	0.0033	0.0009	0.0013	0.0010
NFLX	0.0028	0.0042	0.0009	0.0158	-0.0003	0.0043
NEM	0.0009	-0.0002	0.0013	-0.0003	0.0081	0.0009
MYRG	0.0057	0.0043	0.0010	0.0043	0.0009	0.0109

This paper can find the maximum Sharpe ratio portfolio by using the CAPM model. The results is below.

Table 3. Results for maximum Sharpe ratio portfolio under CAPM model

	ACHC	GS	AWK	NFLX	NEM	MYRG
weight	0.0131	0.4879	0.2163	0.1122	0.0927	0.0778
Expected return				0.0078		
variance				0.0035		
Standard deviation				0.0592		
Sharpe Ratio				0.1171		

The ‘GS’ gets the largest weight which is 0.4879. Probably because the ‘GS’ is a international investment bank which focuses on finance which is not real economy. So it won’t be affected a lot by unknown negative situation, such as epidemic situation. The smallest weight which is 0.0131 appears in ‘ACHC’. The ‘ACHC’ gets this weight may because it focuses on medical care which is affected by COVID-19 in recent years. Besides, this paper finds the results of minimum variance portfolio.

Table 4. Results for minimum variance portfolio under CAPM model

	ACHC	GS	AWK	NFLX	NEM	MYRG
weight	0.0000	0.1945	0.5261	0.0502	0.1886	0.0405
Expected return				0.0078		
variance				0.0035		
Standard deviation				0.0592		
Sharpe Ratio				0.1171		

The largest weight 0.5261 appears in ‘AWK’. Among the water work companies in the Unites States, AWK can be regarded as leader. According to operating income and service population, AWK is the largest and most geographically distributed water company in the United States. So it has stable development in the future. The ‘ACHC’ gets the smallest weight 0.0000 which can infers that it has high uncertainty and may has big risk in the future. The reason for its smallest weight maybe is the occurrence of medical risks is uncertain and inevitable. The estimations of FF3F parameters are shown below:

Table 5. The estimations of FF3F parameters

	ACHC	GS	AWK	NFLX	NEM	MYRG
FF3F MKT beta	1.2886	1.3735	0.4084	1.2151	0.2883	1.0887
FF3F SMB beta	0.7258	0.4941	-0.0726	0.2838	-0.0846	0.4040
FF3F HML beta	0.1978	0.1094	0.2234	-0.7990	-0.0339	-0.2976

Then this paper can find the muximum Sharpe ratio portfolio and the results are showing below.

Table 6. Results for maximum Sharpe ratio portfolio under FF3F model

	ACHC	GS	AWK	NFLX	NEM	MYRG
weight	0.0566	0.5608	0.3231	0	0.0464	0.0131
Expected return			0.0087			
variance			0.0036			
Standard deviation			0.0598			
Sharpe Ratio			0.1312			

From the table, the 'GS' gets the largest weight 0.5608. Because the future of finance is an indispensable part for the development of a country. So finace is valued in every era. The smallest weight appears in the 'NFLX' which concentrates on streaming entertainment service. This industry is very competitive in the information age. So it gets weight zero.

Moreover, this paper finds the minimum variance portfolio and the results are showing below.

Table 7. Results for minimum variance portfolio under FF3F model

	ACHC	GS	AWK	NFLX	NEM	MYRG
weight	0.0000	0.1930	0.5270	0.0497	0.1867	0.0436
Expected return			0.0056			
variance			0.0022			
Standard deviation			0.0467			
Sharpe Ratio			0.1021			

As the table above, the 'AWK' gets the largest weight 0.5270. In this minimum portfolio, the 'AWK' has this weight may beacuse it engages in the provision of complementary water and wastewater services which is necessary in our daily life. The smallest weight 0.0000 appears in the 'ACHC' which concentrates on health care. There are too many uncertain things in medical industry. So the 'ACHC' has a high volatility and gets the smallest weight in this portfolio.

5. Conclusion

Up to now, most of research focuses on investing in a specific field and studies the stocks in this field. This paper concentrates on stocks from different field in the American stock market and aims to help people optimize portfolio management in different field. In this paper, mean-variance analysis, CAPM model and Fama-French model are used to optimize the investment portfolio. The results show that no matter which model is used, the field related to financial industry accounted for a large proportion in the maximum Sharpe ratio portfolio. At the same time, if you look for a minimum variance portfolio, the water utilities are worth investing. Inevitably, this paper still has some defects, such as not considering the suitability of the model used with the current market, as well as other influencing factors in the market.

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