The asset allocation analysis for industries

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Abstract: Portfolio optimization currently plays a key role in financial area. This paper aims to do the asset allocation analysis for several industries, i.e., retail industry, aerospace industry, new energy vehicle industry, managed healthcare industry and technology industry, etc. We choose five representative assets from these five industries and then adopt ARIMA model to forecast their compound return. These predicted data are utilized for portfolio optimization in the framework of mean-variance analysis to get the performance of the portfolio. At last, the portfolios' performances were explained by the Fama-French three-factor model. Finally, the performance of the portfolios is accessed, including return volatility and the weight of these assets. The results show that, first, ARIMA model can be well applied to forecast the future return for financial asset; second, TSLA accounts for the largest proportions both in the minimum variance portfolio and the maximum Sharpe ration portfolio. The findings may be useful to related investors interested in the retail, aerospace, new energy vehicle, managed healthcare, and technology industries.

1. Introduction

Since Markowitz originally proposed the mean-variance (MV) model, the optimization of the investment portfolio has been a hotspot of financial research. Due to the limited amount of capital held by natural investors, investors have weak risk tolerance and high loss aversion. Thus, how to obtain higher returns under the lowest possible risk conditions is undoubtedly their most important concern (Wang, Wu, & Xie, 2021). Therefore, during investing, how to balance between return and risk is definitely an attractive direction of financial research. In other words, making portfolio decisions are of interests (He & Yang, 2020). Furthermore, for the investors in the organization, they are supposed to invest in a portfolio instead of a single asset. Because this diversification will help to minimize the risk (Hosseini & Hamidi, 2016).

We find that currently, there are numerous studies regarding portfolio optimization. However, few studies aim to focus on the industries of on retail, aerospace, new energy vehicle, managed healthcare, and technology. Most of the current portfolio analysis is based on the analysis of the overall market environment. For instance, Li Bo and Teo Kok Lay (2021) researched portfolio optimization under the entire uncertain real financial market and Kenig Eyal (2021) analyzed portfolio selection in non-stationary markets. Meanwhile, some researchers studied for certain industries, such as Girardi Giulio (2021). Some scholars studied in different areas where the current market trend is relatively good or relatively poor. For example, Wenjiao Chen (2012) researched the current investment portfolio of new energy companies; Qixiu xin (2009) studied the portfolio analysis in new energy industry and precious metals industry. Our intention is to focus on the asset allocation of five representative companies from five different industries i.e., retail industry, aerospace industry, new energy vehicle industry, managed healthcare industry and technology industry. The empirical process in this paper can be summarized

as follow. First, we choose five typical companies from retail industry, aerospace industry, new energy vehicle industry, managed healthcare industry and technology industry for closing prices from July 10, 2019 to July 10, 2021; Second, we do data cleaning to match the time of the financial time series; Third, we apply to ARIMA to the selected time series and the results show that ARIMA model can be well applied in financial time series forecasting; Fourth, we construct certain portfolios by the selected securities, i.e., the maximum sharpe ratio portfolio and minimum volatility portfolio, and the results show that the new energy vehicle industry occupies the most weight in the portfolios. Fifth, we use factor-model to analyze the performance of these 5 assets and the results show that two illustrations of how the three different elements in the three-factor model effect the returns from the different portfolios. Therefore, we can plainly see the varied effects of market conditions on returns under two different investment portfolios in these two images. The market element has a higher impact on the minimal volatility portfolio than it does on the maximum volatility portfolio.

2. Data

The data in this article is derived from Yahoofinance (https://finance.yahoo.com/). We select the representative companies. i.e., BA, WMT, TSLA, UNH, AAPL for closing prices, from July 10, 2019, to July 10,2021. Then, to implement further investigations, we do data cleaning to match the time. Finally, 506 data are collected. We transfer these closing prices to log-returns and some basic information is shown in Table 1.

Table 1. Descriptive statistics of the selected assets

	'BA'	'WMT'	'TSLA'	'UNH'	'AAPL'
Mean	0.0021	-0.0007	0.0052	0.0010	0.0004
Variance	0.0006	0.0017	0.0021	0.0005	0.0002
Max	0.2177	0.1107	0.1814	0.1204	0.1131
Min	-0.2724	-0.0950	-0.2365	-0.1896	-0.1377

Through visualizing the data, we can discover that the 'TSLA' has the highest average return, while the 'WMT' has the lowest average return. When it comes to variance, 'AAPL' is the lowest, while 'TSLA' is the highest. What's more, the BA has the highest max return and the lowest min return, while the WMT has the lowest max return and the highest min return.

3. Methods

The process of stock price changing is just a time series data which contains both the randomness and some regular pattern. With mature theoretical foundation, ARIMA now is a usual model to deal with time series data for predicting short-time result. (Liu & Zhang, 2021) According to Zhang Qiang (2016), the ARIMA performs well in predicting short-time compound return.

An autoregressive integrated moving average, or ARIMA, is a statistical analysis model that uses time series data to predict future trends in short time. There are three types of ARMA models, the AR (p) model is autoregressive type, where p is the order of autoregression; MA(q) model is moving average model, where q is the moving average order. ARMA (p, q) is autoregressive moving average model. ARMA is a combination of the first two models. The general ARMA (p,q) model form can be expressed as,

$$X_t = \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \cdots + \alpha_p X_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \cdots + \beta_q \varepsilon_{t-q} \quad (1)$$

where $\{\varepsilon_t\}$ are the white noise series.

Mean-Variance Analysis

The mean-variance analysis is a mathematical approach for the asset allocation to achieve some goals for related investors, i.e., maximizing the expected return or minimizing the risk. According to

Rubinstein (2002), the mean-variance analysis has been a common approach for the measurement and construction of the asset portfolio.

$$\sum_i w_i = 1 \tag{2}$$

where w_i is the weight of the Asset $_i$ in the portfolio. The return and variance of one certain portfolio can be calculate as follows.

$$R_p = \sum w_i R_i \tag{3}$$

where R_i is the compound return of Asset$_i$'s time series data.

$$E(R_p) = \sum_i \ w_i E(R_i) \tag{4}$$

where $E(R_i)$is the expected return of Asset $_i$. $E(R_p)$is the expected return of the portfolio.

$$Var(R_p) = \sum_{i,j} w_i w_j \cdot Cov(R_i, R_j) \tag{5}$$

where $R_i \ and \ R_j$ denote Asset Return $_i$ and Asset Return $_j$ .The Cov denotes the variance-covariance between $R_i \ and \ R_j$.Var denotes the variance of portfolio return. The Sharpe ratio of one portfolio can be achieved by the following equation,

$$\text{SharpeRatio} = \frac{E(R_P) - R_f}{\sigma_P} \tag{6}$$

where $E(R_P)$ is the expected return of the portfolio, R_f is the risk-free rate, and σ_P is the standard deviation of the portfolio.

Fama-French three-factor model

The advantage of the Fama-French three-factor model is that the model can match most data in usually research. Compared with the five-factor model, the three-factor model shows several advantages. For instance, Li Shuai and Zhang Qiang (2021) analyzed the impacts of the new crown pneumonia epidemic on the U.S. stock market based on the three-factor model and the five-factor model mentioned and pointed out that the three-factor model is more suitable for analyzing financial data than the five-factor model. And in Li Ziyi and Li Huan's research paper (2020) on the return of Chinese 5G sector companies, the authors adopted three-factor and five-factor models to show that the five-factor model, which is more applicable in developed countries, has worse effect in China's 5G industry stocks. Three-factor model can explain some research results better than CAMP. For example, Yang Qilin, Yang Jing and Lv Longchao (2020) compared CAPM and three-factor model and pointed out three-factor model beats the CAPM regarding explanatory power.

Fama-French three-factor model are generally used to explain stock returns. The model believes that the excess return rate of an investment portfolio which including a single stock can be explained by its exposure to three factors, which are market asset portfolio (Rm−Rf), market value factor (SMB), and book-to-market value ratio factor (HML).This multi-factor equilibrium pricing model can be expressed as,

$$\hat{E(R_{it})} - R_{ft} = \hat{\beta_i}[\hat{E(R_{mt}} - R_{ft})] + \hat{siE(SMB_t)} + hiE(HMI_t) \tag{7}$$

As Fama and French(1993) mentioned in their paper, Rft represents the risk-free rate of return at time t; Rmt represents the market rate of return at time t; Rit represents the rate of return of asset i at time t; E(Rmt) − Rft is the market risk premium;

SMBt is the simulated portfolio return of the market value factor at time t, which is the difference between the return on the portfolio of companies with small market capitalization and the return on the portfolio of companies with large market capitalization. HMIt is the simulated portfolio return of the book-to-market factor at time t, which is the difference between the return of the portfolio of companies with higher book value and the return of the portfolio of companies with lower ratios.

4. Results

Through exhaustive attack method from 1 to 50, we find the most appropriate parameters for ARIMA model and the corresponding AIC value. The results are shown in Table 1 and Figure 1 below.

Table 2. Parameters for ARIMA model and the corresponding AIC value

	'BA'	'WMT'	'TSLA'	'UNH'	'AAPL'
ARIMA	0,0,2	4,0,4	0,0,3	4,0,3	4,0,4
AIC	-1790	-2797	-1651	-2425	-2381

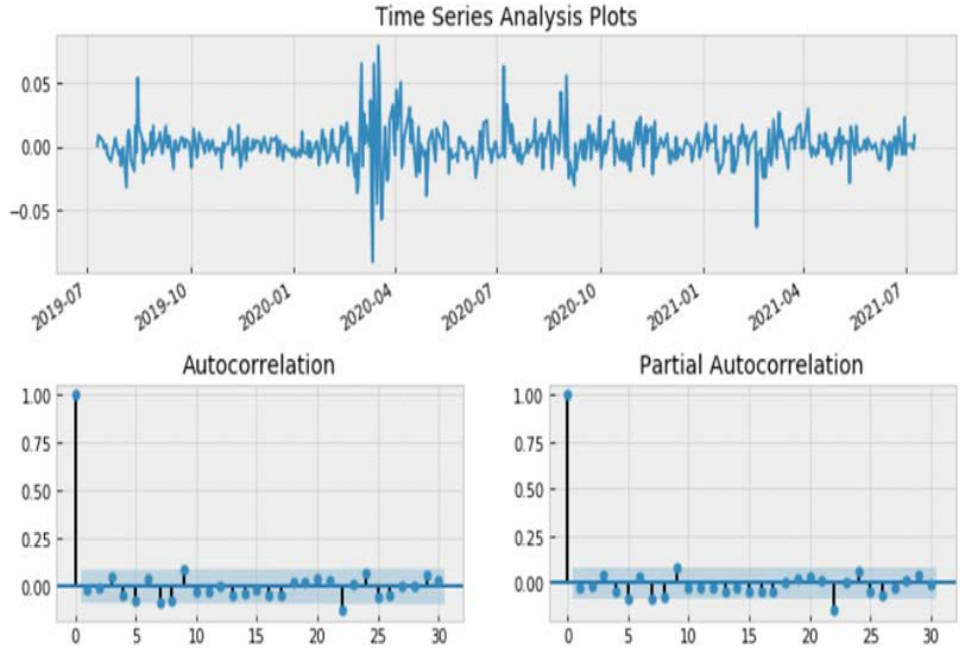

Figure 1. Residual of the ARIMA model for 'WMT'

Notes: We only show 'WMT' as an example to show the fitness of the ARIMA model

Through the Figure 1 above, we can see that there is almost no autocorrelation or partial autocorrelation in the residual of the ARIMA model.

We construct certain portfolios, i.e., maximize sharpe ratio portfolio and the minimum variance portfolio. And the results are shown in the following Table 2.

Table 3. Results for portfolio construction of maximize sharpe ratio portfolio and the minimum variance portfolio

	'BA'	'WMT'	'TSLA'	'UNH'	'AAPL'
Max sharpe ratio	37.79%	1.22%	51.78%	1.71%	7.49%
Mini volatility	22.00%	1.18%	51.29%	21.85%	3.68%

As the table indicates, 'TSLA' has the largest weight in both maximum Sharpe ratio portfolio and minimum volatility portfolio, accounts for 51.78% and 51.29%, respectively. 'UNH' accounts for only 1.71% in maximum Sharpe ratio portfolio, however 21.85% in minimum volatility portfolio. The return of the maximum Sharpe ratio portfolio is 0.40% and that of the mum volatility portfolio is 0.15%. 'TSLA' has such performance is probably because the demand for Tesla cars is really high currently and the sales and profits of 'TSLA' is still increasing.

Performance of the return of our portfolio and the selected asset is shown in the following Figures 2 and 3, respectively.

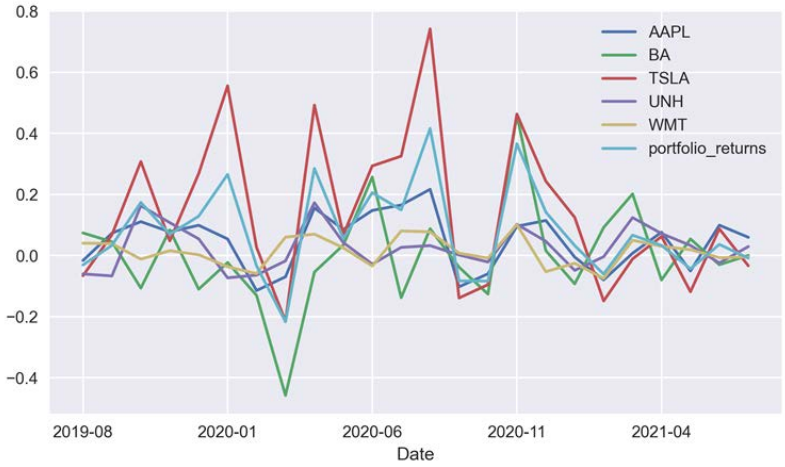

Figure 2. Minimum volatility portfolio and five stocks returns

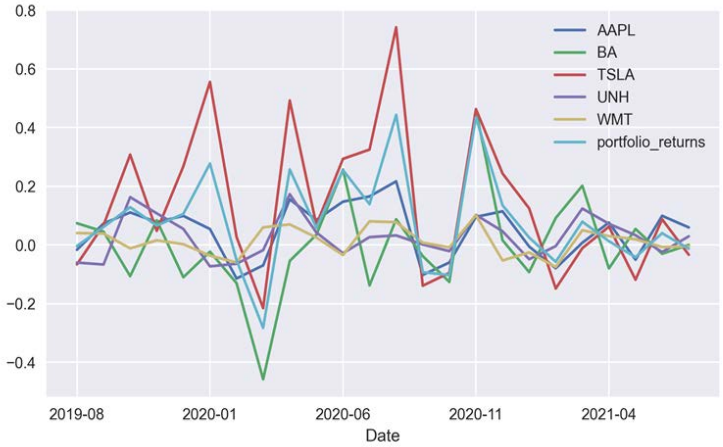

Figure 3. Maximum Sharpe ratio portfolio and five stocks returns

The two figures show the returns of five different stocks and the returns of these two different investment portfolios during the time on the horizontal axis. Although the difference in the proportions of the two sets of investment portfolios is not obvious, it can still be seen that the investment portfolios composed of these five stocks under different proportions have different returns.

In this paper, we use the Fama-French three-factor model to analyze the investment portfolio calculated from the forecast data. We combine the Fama-French three-factor model and the above-mentioned portfolios, i.e., minimum volatility portfolio and the maximum sharpe ratio portfolio, and show the results in the following Figure 4 and 5.

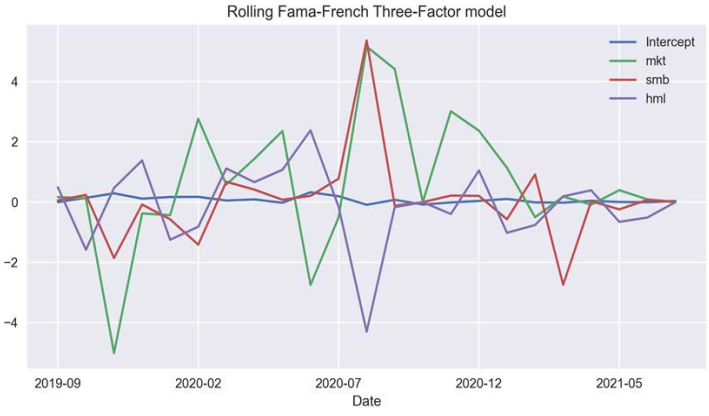

Figure 4. Minimum volatility portfolio

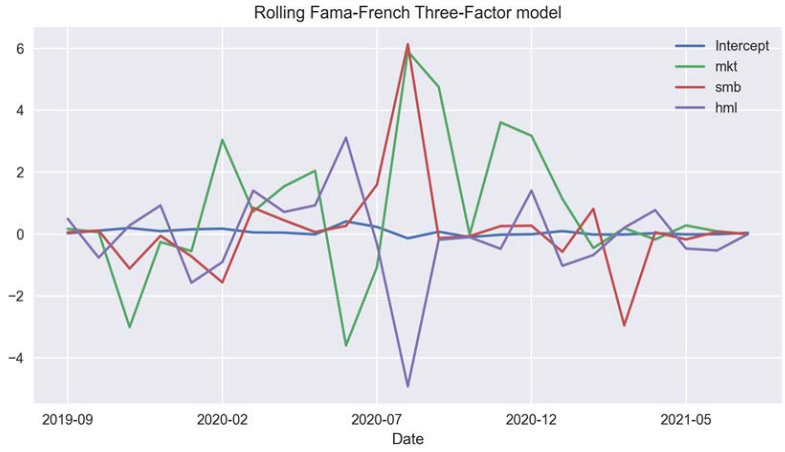

Figure 5. Maximum volatility portfolio

The two figures show the impacts of the three factors on the return of the two types of portfolios, i.e., maximum sharpe ratio portfolio and the minimum volatility portfolio, during this period. Inside the figures, volatilty is calculated by equation (5). In the two figures, we can clearly see the different effects of market factors on returns under two different investment portfolios. The minimum volatility portfolio is greater affected by market factor than maximum volatility portfolio.

5. Conclusion:

Currently, most of the portfolio research is based on the analysis of general market situations or a specific industry. The purpose of our study is to do portfolio analysis on retail industry, aerospace industry, new energy vehicle industry, managed healthcare industry and technology industry to benefit the potential investors when making investment decisions. In the paper, we use time-series analysis to find out the predicted data for the asset allocation. Then, the mean-variance analysis is applied to do portfolio optimization and construct maximum Sharpe ratio portfolio and minimum volatility portfolio. The study has identified the new energy vehicle industry and aerospace industry occupied the most in both two portfolios; We also apply the Fama-French three-factor model to analyze these two portfolios and found out that the minimum volatility portfolio is more sensitive to the market than the maximum Sharpe ratio portfolio. However, deficiencies also exist. For example, the ARIMA model does not solve the problem of heteroscedasticity; Solving heteroscedasticity may deserve further discussions.

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