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The Research of Optimal Portfolio in Technology Industry Based on Arithmetic Average Return, CAPM, and Fama-French Three-factor Model

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Abstract: As hotspots of the stock market, technical companies are always popular to invest. In this background, this paper uses three common models in asset pricing to help the investors to make proper decisions. This paper comes to a conclusion that CAPM forecasts the ideal portfolio expected return with more accuracy than other techniques when the contrast group's time period is shorter than the experimental group's time period. Because Fama-French the three-factor model's factors don't operate over short time periods and arithmetic average return doesn't take enough market factors into account, it might not be more accurate. The conclusion in this paper takes an instruction of investment strategy to technical companies' investors. Furthermore, it also helps the investors to allocate a proper portfolio.

Keywords: optimal portfolio, CAPM, Fama-French Three-factor model

1. Introduction

After a huge fluctuation of Tesla stock, people had concentrated on stock market, especially on technology industry. More and more countries have complex and developed stock markets, which made the lots of people in this world has invested money into stock markets. In the modern world, technology has become into an essential and crucial industry for all the countries to develop, which made technology industry stocks becoming popular. Under this situation, models that can predict future stocks expected returns have become important and popular in finance. In this article, the research focuses on which model can predict optimal portfolio expected return the most precise. The research uses arithmetic average return, CAPM, and FF3F to predict expected return when the model choosing the optimal portfolio to invest. After the calculation of these three models, the research compared three results with a month expected returns under the same conditions.

The research of composing portfolio has always been focused by the academic world. Rutkowska et al. made efforts on accounting factor of CAPM testing by using the conventional approach of symmetric variance and a modified approach. The result indicated accounting factor is important in unconventional CAPM [1]. Zhang used GPT models and BERT to find extra factors in the CAPM. The result showed that the additional factor is sentiment, which can be the power of CAPM [2]. Hens and Trutwin used a parsimonious CAPM modeled various aspects of sustainable investing for modelling sustainable investing in the CAPM, finding that returns are increased by ESG grading

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heterogeneity [3]. Gleißner et al. state a DCF analysis based on CAPM lead to a strong distorted company's value. The result is that the mistakes may be avoided by explicitly considering the risks of a company [4]. Zhou, et al. demonstrated that, when all other factors are equal, funds with more CAPM investors outperform those with fewer, as determined by investors' revealed use of various asset pricing models [5]. Ko et al. made a new model by using FF3F and Black Litterman Portfolio Models [6]. Schmidt et al. used regression etc. demonstrates that the industrial beta that FF5MI 'borrowed' from NBSPM greatly improves the precision of the Fama-French framework in-sample [7]. Urbano et al. suggested calculating the weights for the Efficient Frontier's point of minimal variance by calculating the var-cov matrix only from the returns that can be accounted for by the FF5F [8]. Li et al. discovered that regularization techniques like lasso and ridge work less well than OLS. The fitting power of support vector machines and random forests has improved a lot, however the neural network is inferior to OLS due to the tiny monthly data sets by using a new-built seven factors model [9]. Allen et al. found SMB and HML usually lack independence, making them susceptible to endogeneity by using rolling OLS regressions [10].

Thus, this paper will undertake a comparison analysis of the arithmetic average return, CAPM, and FF3F based on the existing research. Theoretically, this study develops and enhances the existing research. Practically, it gives investors a method for reference.

2. Data and Method

2.1. Data Collection

The research used the expected returns of Tesla, Google, Amazon, and Netflix as the research data, which are from Yahoo finance. The research used four companies' data from 2018-9-1 to 2023-7-1 into three different methods (arithmetic average return, CAPM, and FF3F) as the experimental group to calculate the expected returns, and used four companies (Tesla, Google, Amazon, and Netflix) data from 2023-7-3 to 2023-7-31 into three different methods as the contrast group to calculate the expected returns with the purpose of comparing with the experimental group expected returns. Meanwhile, the research used data from Kenneth R. French website to calculate parameters in Fama-French Three-factors model.

2.2. Method

2.2.1. CAPM

According to [11], the CAPM is an improvement of mean variance analysis. It describes the situation after everyone behaves as the analysis result. It states assets prices are valued by the contribution to the risk on the tangency portfolio. Furthermore, it will be the market portfolio. Then the author shows the CAPM equation:

$$E(r_i) = r_f + \beta_i E\left(r_m - r_f\right) \tag{1}$$

where $E(r_i)$ is the expected return of asset i, r_f is the risk-free rate, $E(r_m - r_f)$ is the equity risk premium, which is also the excess expected return.

2.2.2. FF3F

According to [12], The FF3F is a more precise, more complex model than CAPM. It advocates multiple factor models to capture the expected return. The equation of this model is:

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$$r_i - r_f = a + b(r_m - r_f) + s(SMB) + h(HML) + e_i \quad (2)$$

Where, b, s, and h are coefficients of three factors. SMB is small stocks portfolio expected return minus large stocks portfolio expected return, HML is the difference between the returns on portfolios of high B/M and low B/M, and e_i is a zero-mean residual.

3. Result

3.1. Arithmetic Average Return

The research used arithmetic average return to calculate the expected returns of TSLA, GOOG, AMZN, and NFLX. The research used the MMULT function to multiply weights with expected returns of each company in excel as the portfolio expected return. Lastly, the research used solver to find the optimal portfolio, and used the weights from the optimal portfolio to calculate the optimal portfolio expected return.

3.2. CAPM

The research used CAPM to calculate the expected returns: Step 1, the research used the data from Yahoo finance to calculate SPY return, then the research used 0.001 as risk-free return to figure out TSLA, GOOG, AMZN, and NFLX excess returns, and SPY excess return. Step 2, the research used SPY return into average function to calculate the market return. Meanwhile, the research used regression from data analysis to calculate the betas of four stocks (TSLA, GOOG, AMZN, and NFLX). Step 3, the research used CAPM formula to calculate the expected returns. Lastly, the research used solver to calculate the optimal portfolio, and its expected return.

3.3. FF3F

The research used FF3F to calculate the expected return—firstly, the research used data from Kenneth R. French website to calculate the parameters, then the research used data analysis to calculate coefficients of these parameters. Secondly, the research used SUMPRODUCT function in excel to calculate the expected returns. Lastly, the research used solver from data analysis in excel to find the optimal portfolio, and the its expected return.

Table 1: Calculation result of 3 methods.

	Arithmetic average optimal portfolio	CAPM optimal portfolio	Fama-french 3 factors model
TSLA	0.7789	0.0663	0.0709
GOOG	0.2211	0.6783	0.9112
AMZN	0.0000	0.2553	0.0178
NFLX	0.0000	0.0001	0.0001
Optimal portfolio expected return (2023/7/3~2023/7/31)	-0.0115	0.0745	0.0922
Optimal portfolio expected return (2018/9/1~2023/7/1)	0.0564	0.0490	0.0088
Difference (The absolute value)	0.0679	0.0254	0.0834

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3.4. Comparison

The CAPM optimal portfolio expected return has the lowest absolute value, which shows the CAPM is the best method to predict optimal portfolio expected return in the optimal portfolios. As the table 1 shows the differences between optimal portfolio expected returns in three methods, it worth noting that FF3F is not the best method when the research aiming to predict the optimal portfolio expected return, though it has three factors, which has more factors than CAPM. On the one hand, the arithmetic average optimal portfolio expected return has the biggest difference with the other methods when the research using the contrast group data (2023-7-3 to 2023-7-31). On the other hand, the arithmetic average optimal portfolio expected return is close to the CAPM optimal portfolio expected return when the research using the experimental group data (2018-9-1 to 2023-7-1). Lastly, the CAPM and the FF3F shows two similar optimal portfolios (put most of weights into GOOG) that quite different from the arithmetic average optimal portfolio, which probably because CAPM and FF3F consider more factors that play significant roles in the stock market.

4. Discussion

After observing the data and the chart again, the research took note of the contrast group data's time period is shorter than the experimental group data's time period, which leads the contrast group data more fluctuant than the experimental group data. The research believes that the reason why the hypothesis is invalid is the experimental group's result is not same with the result when the author using the contrast group data in calculation.

Under the background that CAPM optimal portfolio expected return has a lower difference (the absolute value) than the other optimal portfolio expected returns, the author makes a conjecture that CAPM predicts more precise optimal portfolio expected return than other methods when the contrast group's time period is shorter than the experimental group's time period.

As the experimental group data has a longer time period, it might make the result inoperative when the author predicting the optimal portfolio expected return in a shorter time period. For improvement, the research can make the experimental group data has the same time period with the contrast group data, which can make the result more precise.

5. Conclusion

This paper used arithmetic average return, CAPM, and FF3F to analyze two groups of technology industry companies' data, and made a comparison of them. The conclusion is when the contrast group's time period is shorter than the experimental group's, the CAPM forecasts the optimal portfolio expected return with greater accuracy than other methods. Fama-French Three-factor model may not be more precise because of its factors don't work in a short time period, and arithmetic average return doesn't consider enough factors in the market.

This paper takes an instruction for the people who are eager to invest technology industry stocks. Moreover, as the paper has made a comparison of three common models of portfolio management, it provides many pieces of information to those investors. Also, it provides a reference of the stocks in technology industry.

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