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Further Research in the Chinese Mid-cap Stock Market by Using the Markowitz Model, Capital Asset Pricing Model, and Fama-French Model

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Abstract:

This article aims to identify the optimal portfolio of 10 mid-cap stocks in the Chinese stock market. Markowitz model is used to analyze the data from January 1, 2024, to July 1, 2024, including 117 trading days in total, and give some advice on portfolio selection. Markowitz's model uses "Solver" in Excel to generate different portfolios and gets the optimal portfolio when the Sharpe ratio becomes the largest. In the Capital Asset Pricing Model (CAPM) and the Fama-French model, they can judge whether the stock is worth investing by the result given by linear regression in Excel. It turns out that the optimal portfolio of Markowitz has a Sharpe ratio of 2.14. Although the CAPM and Fama-French Model don't give an exact percentage of each stock, they can take more conditions and factors into consideration to give a better judgment of the amount of the profit of each certain stock. The research fulfills the blank of using these models in the Chinese mid-cap stock market finding some supporting ideas from CAPM and Fama-French Model.

Keywords: Markowitz Model; Capital Asset Pricing Model; Fama-French model; Chinese Mid-cap Stock.

1. Introduction

The Chinese stock market has become more and more complicated in recent years. It is reported that in the past year, the monthly growth of stock investors has been approximately 1 million [1]. Chinese investors become more enthusiastic but according to the Shanghai and Shenzhen Stock Exchange (SHSE and SCSE), the trading volume and transaction amount of the Stock Main Board are consistently decreasing. From June 2023 to June 2024, the trading volume of stocks decreased by 282.2 billion (yuan) and the transaction amount decreased by 2710 billion at SHSE while the trading volume of stocks decreased by 53 billion and the transaction amount decreased by 1957 billion at SCSE [2,3]. The contradiction between the increasing number of investors and the flat stock market indicates that the majority of investors suffer low returns. Because of the huge risk in the stock market, how to maximize the returns of stock investment become a momentous topic for investors. Therefore, this paper aims to help people find the optimal portfolio of 10 stocks in the Chinese stock market.

Guerand, et al. reviewed and compared the past stock selection models, and they found that stock selection models are usually based on momentum, analysts' expectations, and fundamental data [4]. Situmorang, et al. discussed the optimal portfolio among the IDX Top Ten Blue 2017 stocks with the Markowitz method. Besides, they estimated the parameter of Generalized Extreme Value (GEV) and calculated Value at Risk (VaR) values using GEV [5]. Mallieswari, et al. employed Monte Carlo and Markowitz model for the efficient portfolio optimization of 8 pharma companies' stocks. They calculated the expected return and volatility using standard deviation in Python [6]. For the Chinese renewable energy stock market, Lan et al. applied the robust portfolio method and traditional Markowitz approach to optimize the investment portfolio [7]. Their analysis shows that in various market statuses, the robust portfolio method has better performance and more flexibility with the problem of uncertain parameters.

Liu illustrated the factors, unsystematic volatility (management problems, liabilities) within enterprises themselves play a vital role in their stock price [8]. All these factors related to the enterprises can be transformed into some parameters used later. It's of great significance to consider various factors. For this reason, using CAPM (Capital Asset Pricing Model) can calculate the risk and return of a certain enterprise better than some other models, especially using it in the stock price or portfolio selection [9]. It can not only calculate the investing weights

but also judge whether the stock is worth investing. The volatility, beta and some other parameters about the stock can be required items to be used in the CAPM, which can calculate the best portfolio selection with the highest Sharp ratio [10]. What's more, the Fama-French model is another tool taking three coefficients to make the prediction more accurate as there are more corporations' related parameters taken into consideration [11].

In summary, the article aims to analyze 10 stocks in the Chinese stock market to compare the performance of the original Markowitz model, CAPM, and Fama-French model in the Chinese stock market. Besides, probable reasons for the result and advice on these stocks are given.

2. Methods

2.1 Data

10 Stocks in the Chinese market are imported from Yahoo Finance and the data that the paper uses is from January 1, 2024, to July 1, 2024, including 117 trading days. For Markowitz, CAPM, and Fama-French Model, the adjusted closed price and systematic risk (beta) are used for modeling. 10 stocks are in Table 1.

Table 1. Stock List

Stock name (Full)	Stock code	Short
Shanghai Cambrian Biotechnology Co Ltd	688256.SS	HWJ
Glodon	002410.SZ	GLD
TCL Technology Group Corp	000100.SZ	TCL
Advanced Micro-Fabrication Equipment Inc. China	688012.SS	ZW
Hangzhou First Applied Material Co Ltd	603806.SS	FST
Air China Ltd	601111.SS	ZGGH
Gd Power Development Co Ltd	600795.SS	GDDL
Power Construction Corporation of China Ltd	601669.SS	ZGDJ
XCMG Construction Machinery Co Ltd	000425.SZ	XGJX
Bank of Beijing Co Ltd	601169.SS	BJYH

Simultaneously, some related parameters like risk-free return, β_{SMB} (The coefficient in front of SMB, Small Minus Big), β_{HML} (The coefficient in front of HML, High Minus Low) in the Asia Pacific market are downloaded in Data Library (a website specializing in offering the two models' parameters in different areas all over the world).[12]

2.2 Methods

2.2.1 Markowitz Model

The Markowitz model's monthly return of each stock can be calculated by the equation (1). P_T represents the T month closed price and R_i is monthly returns. Then it is easy to calculate the covariance matrix related to the 10 stocks by "Covariance" in Excel with the monthly returns calculated in Eq. (1).

Next, it's time to multiply the weight of each stock with the average monthly return of certain stocks according to equation (2). The original weight can be set as the same value(for convenience, set them as 0.1 for each stock). In the following steps, the weights will be changed to fit in different combinations of constraints.

After that, the principle of matrix multiplication is used to calculate the σ_P in Eq (3) by using the function, "MMULT" in Excel with the weights in Eq (2).

To select the optimal portfolio, the Sharpe ratio is introduced to compare the returns and risks of the investment. Rational investors usually fix the risks and seek the maximum return, or fix the expected returns and pursue the minimum risk. Portfolios with a high Sharpe ratio can have better performance. The Sharpe ratio can be calculated through the equation (4). In this equation, $E(r_p)$ is the expected return rate, R_f is the risk-free rate and in this situation, σ_p is the standard deviation of excess returns. By multiplying the square root of the total trading days, it outputs the annualized Sharpe ratio. Then it can change the weight ($1 \geqslant Eachweight \geqslant 0, \sum_{i=1}^{10} \omega_i = 1$) of each stock to fit the following constraints by utilizing the "Solver Parameters" to make the Sharp Ratio largest.

Ultimately, with some random values of the portfolio, it can calculate the corresponding Sharp ratio. If there

are many random values, it will draw the plot with these points to illustrate the efficient frontier and CML of the model

$$R_i = \frac{P_T - P_{T-1}}{P_{T-1}} \quad (1)$$

$$E(r_p) = \sum_{i=1}^{10} \omega_i * E(r_i) \quad (2)$$

$$\sigma_P = \sqrt{\sum_{i=1,j=1}^{10} \omega_j \omega_i Cov(r_j, r_i)} \quad (3)$$

$$TheSharpeRatio = \frac{E(r_p) - R_f}{\sigma_p} \quad (4)$$

2.2.2 CAPM

The Eq(5)~(6) is another linear regression to calculate the expected return and volatility factor. The only main difference from the CAPM is that CAPM uses linear regression like:

$$\alpha = R_p - R_f - \beta(R_m - R_f) \quad (5)$$

α represents the expected return, β is the volatility factor to judge the systematic risk and R_m is a factor related to the market itself.

2.2.3 Fama-French Model

Fama-French model can include 3,5 or 8 factors instead of only one factor in CAPM(Market Factor).In the Fama-French model the linear regression uses the equation below:

$$\alpha = R_p - R_f - \left[\beta(R_m - R_f) + \beta_{p,SMB}(SMB) + \beta_{p,HML}(HML)\right] \quad (6)$$

$\alpha and \beta$ have the same meaning as CAPM. $\beta_{p,SMB}$ means SMB factor related to the scale and market value of the enterprise and $\beta_{p,HML}$ can be another basic factor to judge the stock is “value stock” or “growth stock”. The two factors’ value will indicate the market prefers which kind of stock.

3. Results and Discussion

3.1 Result of the Markowitz Model

Fig. 1 is an efficient frontier and CML is given by the Markowitz model, it’s worth noting that the point of tangency (0.017536558,0.059566677), which is a point with the largest Sharp Ratio, Optimal Selection of high profit and low risk.

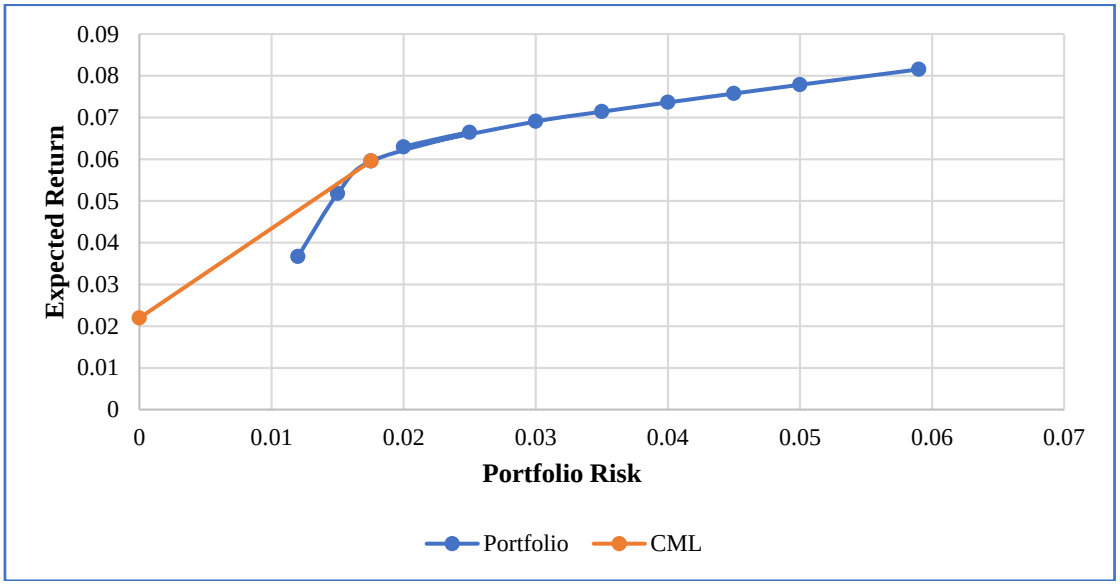

Fig. 1 Efficient Frontier and CML

3.2 Result of Markowitz Model and CAPM

Table 2 indicates some key figures used in the equation (1) ~ (5) during the process of the calculation (R_f=2.193%). From Table 2, it can be out that the annualized volatility and the Sharp ratio of this portfolio selection are 0.018 and 2.146 respectively. Some stocks do not choose (Air China, Glondon, Firstpvm AMEC, etc.).

From this table, it’s obvious that there are lots of similarities between the $\alpha, and \beta$ given by CAPM and X weights given by Markowitz Model. There are some stocks with 0 weight in the Markowitz Model. It can easily find its reason from CAPM: there are two situations of these stocks. First, their expected return, $\alpha < 0$ so they can’t make profits. Secondly, their volatility factor, $\beta > 1$, which means

the stock fluctuates more heavily than the market. According to these two situations, it can exclude the stocks in the two situations. However, there is an exception, Cambricon Technologies Corporation Limited. It's easy to see that its volatility factor > 1, it fits the second situation, but we still put it into our portfolio selection because of its exceptional expected return which is much higher than other stocks. Although there is a higher risk, it's also equipped with amazing profits.

Table 2. Key figures of CAPM and Markowitz model

Stock	α	β	X weights
688256.SS	0.09206376	4.31940999	0.131994319
002410.SZ	-0.069768925	3.533935657	0
000100.SZ	0.004480785	0.029077872	0
688012.SS	0.010895309	3.280456922	0
603806.SS	-0.012910869	1.054647243	0
601111.SS	-0.001064447	0.81547281	0
600795.SS	0.053908602	0.131480995	0.768557124
601669.SS	0.019396791	0.118615543	0
000425.SZ	0.039374365	0.166395987	0.01287594
601169.SS	0.037209932	-0.559726993	0.086572795

3.3 Result of the Fama-French Model

In Table 3, there are some key values of the factors and coefficients in the Fama-French Model, which are calculated by the linear regression in Eq. (6). The α, β have the same meaning as CAPM. Although the value is not the same as the CAPM, the size relationship among these stocks is similar to what is shown in CAPM.

Table 3. Values of the factors in Fama-French model

Stock	α	β	SMB	HML
688256.SS	0.214136672	3.318844602	7.265567011	-9.425295336
002410.SZ	-0.021966623	3.103353407	6.715008279	-1.562831245
000100.SZ	0.079316434	-0.649320712	10.94286188	-2.210003323
688012.SS	0.105181503	2.451762849	11.18925414	-4.212881824
603806.SS	0.060068487	0.388236739	11.15445883	-1.889570942
601111.SS	0.010128483	0.712095682	1.827446477	-0.225648363
600795.SS	0.058845053	0.08043613	1.350141602	0.199717126
601669.SS	0.024785656	0.083261541	-0.559147642	-0.899911804
000425.SZ	0.061021312	-0.096171658	9.786132157	3.001419984
601169.SS	0.041207643	-0.584306442	-0.579267834	-0.758034037

It's worth noting that there are some new things, SMB and HML. It can be found that GD Power Development Co., Ltd. and BOB (Bank of Beijing) portfolio selection have chosen to have a lower β_{SMB} because it indicates that these stocks fluctuate more slightly than other stocks related to the change in the scale of the market. According to the market value, this paper finds the two enterprises have a larger market value than other corporations. So, some enterprises with higher can be influenced less than some small value companies. When it comes to β_{HML}, XCMG, GD Power Development Co., Ltd., and BOB (Bank of Beijing) have a much higher value factor which means they can increase more dramatically when the market trend is increasing. However, there is always a special

exception, Cambricon Technologies Corporation Limited, whose factors do not fit the principle this paper has concluded before. So one can just guess the reason for choosing it for the portfolio selection is because of its exceptional expected return.

3.4 Limitations

There are some limitations in the investigations in the paper. The investigation includes 10 stocks so there are many sectors involved that are not included in one market index. The time range of the investigation only covers half a year so the time is too short which may lower the accuracy of the models. As some related data about China can't be found on the Internet, the investigation just used the market data in the whole of Asia which may also lower the accuracy. Furthermore, the article just mentions the 3 factors situation. More factors can influence the selection of the stocks. Although it's hard to say how many factors can lead to the best result, it can be more objective to take more conditions or constraints into consideration, like Return on Equality (ROE, which describes the level of the enterprise to make profits), Conservative Minus Aggressive (CMA, which describes the level of the risk of investment) and so on.

In addition, some personal factors such as the investors' preferences and thinking are hard to take into consideration but this can influence their portfolios to an unpredictable degree. Nowadays, some new optimal portfolio selections can combine the real price of a certain stock and some psychological knowledge to advise on investing when the investors want to make rational decisions or irrational decisions, which is called Behavioral Theory. For the result of the calculation, the final Sharp ratio of the Markowitz model is too high, so further evaluation is needed to verify the results.

4. Conclusion

This paper selects 10 stocks in Chinese stocks from January 1, 2024 to July 1, 2024 and aims to find the optimal portfolio. During the analysis, the paper uses the Markowitz model to find the optimal portfolio. The models are performed based on the Sharpe ratio and portfolio risk. This paper fulfills the blank of research on the combination of the Markowitz model, CAPM, and Fama-French model in the Chinese stock market and investors can make more rational investments with the Markowitz portfolio for high returns and low risk.

Simultaneously, it's obvious that the selection of stocks in the Markowitz model also can be supported and verified by CAPM and the Fama-French model's result because they give some figures to support why a certain stock can be put into the final selection. Although their function is extremely different, they have some similarities in some fields. From the results, it can be found that the Markowitz model pays more attention to the expected return and slightly ignores other possible factors like market value, scale of the company, etc when the stock processes an exceptional return. From the other two models, it's easy to find that more factors added can give the investors more proper advice. Besides, investors can combine the results of these models to identify which stock deserves investment. However, this paper has some limitations. As the paper chooses 10 stocks and evaluates the adjusted close price in 117 trading days, it may not be suitable for other stocks. The Sharpe ratios of both portfolios are larger than 2 which is unusual for the stock market. To improve this, more stocks and larger date ranges can be considered to improve the accuracy.

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