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Portfolio Validity Test in the Chinese Market

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Abstract: Modern portfolio theory is one of the most classic theories in financial investment theory. It was first released by a famous economist, Markowitz. As the most important critical model in investment science, it provides investors with scientific investment allocation methods, which are favored by many investors. It has been widely used and researched in the world. Modern portfolio theory analyses the historical returns of investment objects and guides future investment behavior. However, it is still controversial whether this theory is reasonable and adequate in China's stock market. China's stock market is more susceptible to fluctuations than those in Europe and the US, and many of these factors stem from China's strategic policies in various areas. Since the end of the epidemic, China's economic development has also slowed down. In this context, this paper will construct the maximum Sharpe ratio strategy, market capitalization strategy, and average weight strategy. Through the performance evaluation indexes of these three strategies' performance comparison, this paper will verify whether the portfolio strategy is real and effective in China's stock market and can bring more than significant market returns to investors.

Keywords: Portfolio theory, Sharpe ratio, Mean Value Portfolio

1. Introduction

With the continuous improvement of China's financial system, people's investment methods have become more and more diversified. People are increasingly inclined to buy the existing diversified investment portfolio to better allocate their funds and reduce the risks. For this reason, there is an increasing focus on how to master better and better portfolio strategies. In 1952, the American economist Harry Markowitz first used mathematics to build the relationship between risk and return. He established the mean-variance model, which tells people how to better configure a better investment portfolio, and balance the relationship between risk and return.[1] The proposed model also makes it the best asset portfolio of the basic model. Since then, based on the theory of this model, many economists have continued to deepen the research and derived from many theories, which are one of the core research directions in modern finance. William Sharpe put forward the Sharpe ratio and Stefan Ross put forward the arbitrage pricing theory (APT). Tobin and Sharpe suggest that investors should diversify their portfolios based on the cost-return characteristics of their assets and their risk-bearing ability. Sharpe suggested that investors should formulate diversified portfolios based on the cost and benefit characteristics of assets and their risk-bearing ability. They can "put eggs in multiple baskets" to reduce non-systemic financial risk.[2][3]

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Modern investment theory continues to develop and grow. Their theories provide a theoretical basis for people to better configure their investment portfolios, and also promote the investment portfolio to be combination and scientific. The start of the modern portfolio theory has become a hot research topic. Many economists devote themselves to building a better investment portfolio.

However, there are still some controversies about whether the portfolio model is applicable in China. China's stock market has developed rapidly after more than 20 years, however, there is still a gap in the system compared to the European and American securities markets. The disclosure of information and other systems is still not complete, and the T+1 system of the domestic securities market also makes the short-term investors cannot cope with the risk in a short period. These institutional barriers are all factors that affect portfolio modeling in the Chinese securities market. Based on the existing research, this paper randomly selects six stocks in China's A-share market to construct three strategic portfolios, that is maximum Sharpe ratio weighting, market capitalization weighting, and average weighting according to the theory. This paper will analyze the performance of several strategy combinations through performance evaluation indexes and verify the validity of the portfolio model in China's securities market.

2. Review

Since the difficulty of this thesis lies in the construction of the Sharpe Ratio Maximizing Portfolio Strategy model, this paper will talk in detail about the basics of asset portfolio theory as well as the Sharpe Ratio and the related literature in this overview section, and the research will provide a brief overview of the Equal Weighted Portfolio and the Market Capitalization Weighted Portfolio.

Markowitz applies the principle of marginal analysis to the analysis of asset portfolios, using the concepts of mean and variance of portfolio returns as unbiased estimates of portfolio returns and risk-free estimates, respectively, and mathematically defining investor preferences.

Because of its theoretical model, the Markowitz model makes the following four assumptions:

Firstly, the investor considers each investment choice based on a probability distribution of security returns for the position.

Secondly, the investor estimates the risk of a portfolio based on the expected return of the stock.

Thirdly, the investor's decision is based solely on the risk and return of the stock.

Fourthly, at a given level of risk, the investor expects to maximize return. Correspondingly, the investor expects to minimize risk at a given level of return.

Markowitz established the expected return on portfolios, the calculation of risk, and the theory of efficient boundaries, which led to the mean-variance model for optimal asset allocation:

$$min\sigma^2(r_p) = \Sigma\Sigma x_i x_j cov(r_i, r_j) r_p = \Sigma x_i r_i \quad (1)$$

$$\Sigma x_i = 1(Short\ selling\ permitted)\ or\ \Sigma x_i = 1, x_i \geq 0(No\ short\ selling\ permitted)$$

where:

r_p is the portfolio return,

r_i and r_j is the return of the stocks i and j,

x_i and x_j are the investment ratios of stocks i and j,

$\sigma^2(r_p)$ is the portfolio investment variance,

$cov(r_i, r_j)$ is the covariance between the two stocks.

The above equation shows that subject to the constraints and a certain expected return on the portfolio, the Lagrangian objective function can be solved for the proportion of stock i invested in such a way as to minimize the risk $\sigma^2(r_p)$ of the portfolio. Markowitz's portfolio theory reveals not only the minimal risk of a portfolio but also the important conclusion that "the expected return of an

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asset is determined by the magnitude of its own risk". Assets are priced by their riskiness. The risk of individual assets is determined by their variance or standard deviation, and the price of risk for a portfolio of assets is determined by their covariance. Using the standard deviation of the portfolio returns and the expected value as the horizontal and vertical axes, the set of feasible solutions to the model is a boundary curve concave to the origin, the upper part of which is called the efficient frontier, as shown in Figure 1. In Figure 1, it is known that at the vertex of the parabola, representing the minimum variance portfolio. If the investors choose this portfolio, they can avoid market volatility to the greatest extent possible. This portfolio is suitable for more risk-averse people. However, for those who prefer risk for higher returns, finding a suitable point on the efficient frontier would be more suitable for them. The efficient frontier reveals that the expected rate of return on an individual asset or a portfolio of assets is determined by the standard deviation of the fractional line measure. The higher the risk, the greater the reward. With this model, we get that investors can pre-determine a desired return. Through the calculations, we can determine the proportion of investors investing in each investment project, namely, the allocation of their project capital, so that the risk of the total investment can be minimized.

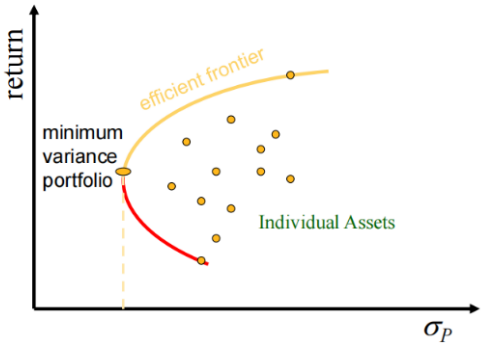

Figure 1: Efficient Frontier

By introducing a risk-free asset, capital can be freely allocated between the risk-free asset and the stock market. The linear relationship between the return and risk of the new portfolio is called the Capital Allocation Line After the introduction of a risk-free asset. Capital can be freely allocated between the risk-free asset and the securities market, and the linear relationship between the return and risk of the new portfolio is called the Capital Allocation Line (CAL). [2]

$$E(r_M) = r_f + \{[E(r_p) - r_f]/\sigma_p\}\sigma_M \quad (2)$$

where:

r_f is the risk-free rate of return,

$E(r_M)$ is the expected return on the capital market portfolio after the introduction of the risk-free asset,

σ_M is the market portfolio risk, and the slope of the CAL,

$[E(r_p) - r_f]/\sigma_p$, is also known as the Sharpe ratio.

The magnitude of the Sharpe ratio indicates how much excess return can be gained by the risky asset for each unit of risk it bears, and the greater the Sharpe ratio, the higher the compensation for risk and the more cost-effective the portfolio. The larger the Sharpe ratio, the higher the compensation for risk and the more cost-effective the portfolio. When the slope of the capital allocation line is tangent to the efficient frontier, the Sharpe ratio of the asset portfolio reaches its maximum, and the tangent point is the optimal capital allocation point on the efficient frontier of the asset portfolio, and the capital allocation market is efficient and in equilibrium, as shown in

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Figure 2, and all the efficient portfolios are the results of the free allocation of risk-free assets and market portfolios by investors with different risk preferences.

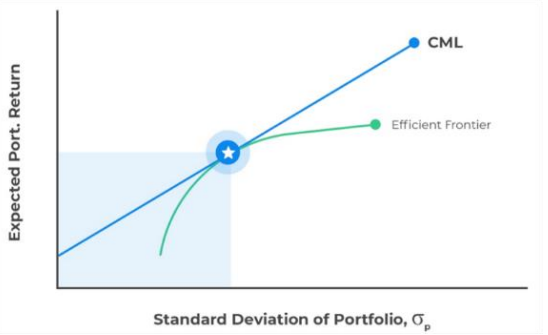

Figure 2: The curve of CML and efficient frontier

Some people believe that the price of a listed company, i.e., its total market capitalization, should fluctuate in a way that reflects the full information of the market. If an index is designed to be weighted by total market capitalization, it should be able to reflect the average value of the market. According to the size of the market capitalization, the larger the market capitalization, the greater the impact of stocks on the index, which tends to favor the "strongest of the strong". Scholars such as Li Jinxin and others believe that the equal-weighted portfolio strategy performs statistically better than the mean-variance strategy in the Chinese securities market.[4] American scholars, such as Frankfurter, believe that market capitalization-weighted strategies are more effective in the US securities market and that different strategies perform differently in markets with different environments. [5]

Roy proposed the "Safety First Portfolio Theory", choosing the mean and variance of the portfolio as a whole to make a choice. In particular, he proposed to maximize the portfolio (E-d)/z to select the portfolio (where d is a fixed return). However, Roy's portfolio differs from Markowitz's in the following ways. Firstly, Markowitz requires non-negative investments; whereas Roy applies to any security. Secondly, Markowitz allows the investor to select an appropriate portfolio from the efficient frontier; whereas Roy recommends a particular portfolio.[6]

Hicks proposed the pure theory of portfolio investment, which states that there is a linear relationship between portfolio expectation and standard deviation in a portfolio containing cash and that the proportion of risky assets remains along this part of the effective boundary of the line.[7]

For the classical Markowitz portfolio theory, Peiro used a large number of other empirical studies to demonstrate that portfolio returns do not follow a normal distribution. Various recent studies have then suggested using skewness or higher-order moments to optimize the mean-variance model in portfolio theory. One of the optimization methods is to add skewness to the model, i.e. to optimize it as a mean-variance-skewness model.[8] Konno and others have developed an original model that maximizes skewness as an objective function subject to fixed constraints on the mean and variance of portfolio returns.[9]

The application of portfolios has been a hot issue in academia. In recent years optimized portfolio theory has been newly researched and validated in foreign markets. Ünlü proposed a method for combining weights by considering internal algorithmic variability, i.e., algorithms that provide solutions with different performances at multiple runtime.[10] Mittal compared the Behavioral Portfolio Theory to asset allocations generated by mean-variance theory. Their results show that a significant number of portfolios satisfy the constrained model of behavioral portfolio theory.[11] Cui helps investors make investment decisions by minimizing investment risk and maximizing return at the same time.[12]

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As for the CAPM model, Merton argued that it is unreasonable for the CAPM model to consider only single-period investments because security returns are highly cyclical and the investment environment varies wildly at different stages of the cycle, so they introduced the cyclicality factor into the traditional CAPM model and established an inter-period CAPM model.[13] Kraus improved the CAPM model by increasing the value of skewness to improve the CAPM model and believed that skewness affects investors' assessment of the value of a stock. [14]Fama conducted an empirical study using data from the U.S. stock market, and they used the addition of factors to directly correct the CAPM model. For the CAPM model under increasing skewness constraints, many scholars conducted many studies.[15] Fonseca used the CAPM model and the estimates given by three lower-bias moment models (LPM) to select the portfolios.[16]

In this essay, I will use the maximum Sharpe ratio portfolios, which are weighted portfolios as well as equal-weighted portfolios, and randomly select six stocks to verify their validity in the Chinese stock market and to verify whether they can outperform the volatility of the broader market.

3. Methodology

To study whether the asset portfolio theory is true and can be used in the Chinese securities market, this paper will select six stocks from different industries to construct asset portfolios using different strategies, and the selected stocks are not highly correlated with each other, and the performance of the industries in the three years is not consistent, to try to make the selected stocks more general. Individual stock market capitalization weighting and average weighting are commonly used asset allocation strategies, given that different scholars in China hold different views on the effectiveness of different strategies, this paper will use the maximum Sharpe ratio weighting, market weighting, and average weighting strategies to construct the asset portfolio at the same time, and finally, through the rate of return and the evaluation of the performance of the way as the judgment criteria and comment. Monthly returns from 2020 to 2022 will be used as historical data to estimate the expected return and standard deviation of the stock and the monthly returns of the three portfolios for the first half of 2023 will be used to test the effectiveness of the different strategy combinations. The data monthly returns for six randomly selected stocks are shown in the following table. The data of the six stocks comes from the Choice database.

Table 1: Monthly returns for each stock from 2020 to 2022

Time	002705.SZ	002559.SZ	000932.SZ	688123.SH	600052.SH	600195.SH
2020.01	27.59%	8.08%	-7.32%	11.61%	12.22%	1.90%
2020.02	-12.12%	0.81%	-10.38%	-1.84%	-9.51%	6.20%
2020.03	0.49%	-6.77%	-1.01%	-29.21%	-9.19%	4.56%
2020.04	43.60%	-4.33%	1.53%	14.43%	-6.27%	10.64%
2020.05	31.11%	1.28%	1.47%	8.25%	-16.71%	-0.90%
2020.06	5.54%	7.03%	-0.79%	12.24%	4.63%	13.26%
2020.07	36.40%	13.30%	18.83%	-1.36%	9.42%	26.30%
2020.08	-11.48%	6.39%	8.71%	-11.30%	-2.76%	16.24%
2020.09	-6.02%	-24.58%	3.49%	-8.77%	-13.07%	-26.82%
2020.1	6.91%	3.89%	0.79%	-0.94%	0.33%	-1.24%
2020.11	-4.77%	7.49%	5.32%	6.46%	6.84%	-4.41%
2020.12	0.24%	-11.77%	-10.65%	-7.19%	-9.76%	-6.15%
2021.01	16.92%	-4.89%	5.44%	-17.86%	-9.46%	8.43%
2021.02	-10.04%	6.52%	15.87%	-6.38%	4.48%	-1.51%

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Table 1: (continued).

2021.03	-21.24%	6.12%	19.86%	-10.70%	-3.21%	-11.55%
2021.04	6.97%	5.94%	12.29%	-6.56%	30.63%	-2.40%
2021.05	-14.80%	8.42%	-11.27%	8.29%	-7.63%	-1.95%
2021.06	-15.93%	3.94%	-2.94%	18.24%	5.20%	3.28%
2021.07	-20.42%	44.83%	16.52%	19.04%	1.74%	-16.39%
2021.08	-1.01%	-3.52%	1.43%	-23.11%	3.71%	-3.54%
2021.09	-11.17%	-15.13%	-15.00%	-6.87%	21.76%	17.49%
2021.10	22.10%	-8.60%	-19.46%	-4.74%	-9.50%	-5.97%
2021.11	6.38%	25.45%	-5.81%	54.79%	4.25%	4.93%
2021.12	3.52%	-5.29%	1.59%	10.18%	24.70%	18.07%
2022.01	-16.80%	-14.67%	7.63%	-5.54%	-12.88%	-7.50%
2022.02	-7.54%	7.91%	6.00%	32.45%	6.84%	8.93%
2022.03	-12.21%	-14.92%	-5.66%	-3.51%	-12.81%	-1.67%
2022.04	-1.14%	-13.08%	6.18%	-13.89%	-19.67%	-14.44%
2022.05	8.00%	10.19%	-8.22%	38.93%	23.89%	12.55%
2022.06	24.76%	16.85%	0.43%	8.97%	4.05%	-1.68%
2022.07	3.46%	18.10%	-10.81%	-12.75%	17.85%	-6.54%
2022.08	-15.78%	-19.12%	-1.76%	-4.30%	6.21%	16.17%
2022.09	-7.52%	-8.83%	-8.52%	-14.23%	-15.54%	0.08%
2022.10	-9.76%	27.34%	-1.96%	28.58%	9.52%	0.68%
2022.11	6.00%	-3.68%	20.00%	16.23%	2.96%	-0.53%
2022.12	-1.77%	-7.90%	-2.08%	-11.23%	4.80%	-11.84%

4. Data processing and portfolio construction

4.1. Calculating the mean and standard deviation of the monthly returns of the above six stocks

The mean value and the standard deviation of the six stocks are presented in the following table.

Table 2: Mean and standard deviation of 6 stocks

	002705.SZ	002559.SZ	000932.SZ	688123.SH	600052.SH	600195.SH
Mean Value	1.35%	1.74%	0.83%	2.40%	1.34%	1.19%
Standard Deviation	16.36%	14.13%	9.91%	17.71%	12.46%	10.94%

4.2. Calculating the covariance matrix of the monthly returns of the above six stocks

Table 3 shows the covariance matrix calculated for the monthly returns of the six stocks

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Table 3: Covariance matrix for 6 stocks

	002705.SZ	002559.SZ	000932.SZ	688123.SH	600052.SH	600195.SH
002705.SZ	0.0260244	0.0010766	-0.0007173	0.0033079	0.0011026	0.0048070
002559.SZ	0.0010766	0.0193991	0.0029704	0.0134410	0.0062480	0.0006759
000932.SZ	-0.0007173	0.0029704	0.0095506	-0.0007297	0.0004373	-0.0008581
688123.SH	0.0033079	0.0134410	-0.0007297	0.0304880	0.0070329	0.0040507
600052.SH	0.0011026	0.0062480	0.0004373	0.0070329	0.0150929	0.0053244
600195.SH	0.0048070	0.0006759	-0.0008581	0.0040507	0.0053244	0.0116341

4.3. Use of the risk-free rate

This paper will introduce the one-year time deposit rate of 2.20 percent as the risk-free rate of return, which translates into a monthly risk-free return of 0.18 percent. According to Markowitz Asset Portfolio Theory, the Sharpe Ratio of a portfolio = (Mean Portfolio Return - Risk-Free Rate of Return) / Standard Deviation of the portfolio. China has a "T + 1" stock market trading system. Also, the cost of shorting securities in the market is high, so the research on short-selling restrictions on the portfolio model is more in line with the actual situation of China's stock market. In the Chinese stock market, the weight of individual stocks in the short-selling restricted portfolio model is non-negative, namely, $\sum x_i=1$ and $x_i \geq 0$ (short selling is not allowed). Using the planning and solving function of the data processing software, the weights of individual stocks can be obtained when the Sharpe ratio of the portfolio is maximum, as shown in Table 4. According to Markowitz's portfolio theory, the portfolio constructed according to the weights when the Sharpe ratio is maximum will be the asset portfolio represented by the optimal capital allocation point on the efficient frontier of the asset portfolio.

Table 4: The weights of individual stocks when the Sharpe ratio of the portfolio is maximum

002705.SZ	002559.SZ	000932.SZ	688123.SH	600052.SH	600195.SH
11.88%	10.99%	28.01%	19.54%	8.48%	21.09%

4.4. Constructing portfolios based on market capitalization weighting strategies and average weighting strategies

Since we need to test the data in 2023, the market capitalization of each company in Table 5 is chosen from the last trading day of December 2022.

Table 5: Market capitalization weights and average weights

Market capitalisation weights and average weights						
	002705.SZ	002559.SZ	000932.SZ	688123.SH	600052.SH	600195.SH
market value(million)	13.765%	4.014%	32.471%	12.236%	4.609%	11.866%
market capitalisation weighting	17.43%	5.08%	41.12%	15.50%	5.84%	15.03%
equal weighting	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%

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4.5. Performance evaluation of the portfolio

Based on the monthly returns of each stock from January to September 2023 in Table 6, we can obtain the monthly returns of the three asset portfolios mentioned above, and introduce the monthly returns of CSI 300, SSE 50, and SZSE 100 for the same period as the market references, of which CSI 300 represents the performance of China's securities market, and SSE 50 and SZSE 100 represent the performance of the Shanghai securities market and the Shenzhen securities market, respectively, as shown in Table 7.

Table 6: The monthly returns of each stock

Time	002705.SZ	002559.SZ	000932.SZ	688123.SH	600052.SH	600195.SH
2023.1	9.19%	7.33%	5.53%	-6.85%	-8.42%	10.59%
2023.2	5.12%	-2.32%	13.31%	-9.89%	-3.80%	23.89%
2023.3	-10.83%	6.46%	-0.89%	16.30%	0.83%	-6.28%
2023.4	-4.17%	-0.99%	-5.21%	-18.25%	1.65%	-12.87%
2023.5	0.67%	9.14%	-7.95%	-1.99%	-3.85%	-5.00%
2023.6	12.27%	3.65%	3.18%	-10.77%	-9.49%	-3.95%
2023.7	1.94%	-4.96%	25.79%	8.82%	16.78%	5.65%
2023.8	-4.08%	-7.46%	-1.33%	-4.04%	-4.59%	-6.16%
2023.9	0.00%	18.44%	1.01%	-1.69%	-2.09%	-2.50%

Table 7: The monthly returns of each portfolio and ETF

Time	Maximum Sharpe Ratio Portfolio	Market Capitalisation Portfolio	Equivalence Portfolio	CSI 300	SSE100	SZSE100
2023.1	3.63%	4.29%	2.89%	6.88%	6.42%	9.53%
2023.2	6.86%	8.08%	4.38%	-1.92%	-2.59%	-3.50%
2023.3	1.11%	-0.29%	0.93%	-0.63%	-2.80%	-0.94%
2023.4	-8.20%	-7.58%	-6.64%	-0.61%	0.41%	-3.99%
2023.5	-2.91%	-3.97%	-1.50%	-5.50%	-6.72%	-6.03%
2023.6	-0.99%	0.82%	-0.85%	2.07%	1.68%	3.92%
2023.7	11.25%	13.89%	9.00%	5.29%	7.44%	3.35%
2023.8	-4.16%	-3.46%	-4.61%	-6.01%	-5.16%	-6.82%
2023.9	1.27%	0.59%	2.19%	-2.05%	-0.27%	-4.35%

Based on the above data we tested each portfolio and their tests are shown in Table 9.

Table 8: The test of each portfolio

	Maximum Sharpe Ratio Portfolio	Market Capitalisation Portfolio	Equivalence Portfolio	CSI 300	SSE100	SZSE100
Average Monthly Rate of Returns	0.87%	1.37%	0.65%	-0.27%	-0.18%	-0.98%
Standard Deviation of Monthly Returns	5.88%	6.58%	4.73%	4.39%	4.82%	5.47%
Aggregate Rate of Return	7.86%	12.36%	5.81%	-2.47%	-1.60%	-8.85%
Sharpe Ratio	11.44%	17.84%	9.42%	-10.81%	-7.84%	-21.62%

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Based on the metrics of the monthly returns of the three portfolios for the nine months of 2023, the test of each portfolio can be obtained. From the generated returns, it can be obtained that the three portfolios in January-September 2023, the overall rate of return and the average of the monthly rate of return of all the mean all beat the same period of the CSI 300, the SSE 50 and the SZSE 100, however, the maximum Sharpe ratio portfolio and the market capitalization portfolio in the standard deviation of the monthly rate of return are greater than the three market evaluation criteria, the mean portfolio of the standard deviation of the monthly rate of return is less than the SSE 50 and the SSE 100 This shows that under the general market downturn, the portfolio investment can gain a short period in a large market. 100, which indicates that in a general market downturn, the portfolios can achieve better returns than the market in a short period, even though they may need to withstand greater volatility and risk compared to the market. From a yield perspective, the Market Capitalization Weight portfolio outperformed the Maximum Sharpe Ratio portfolio, while the Mean portfolio had a slightly lower yield than the two portfolios mentioned above. From a risk-taking perspective, the market capitalization-weighted strategy is the riskiest, while the mean strategy is the least risky, and the mean portfolio strategy is less risky than the individual markets in both the Shanghai and Shenzhen stock markets. Although the market capitalization-weighted portfolio outperforms the other portfolios in the market, it also needs to bear more risk. According to the data processing, we can get that the market capitalization-weighted portfolio has a higher return in the market compared to the other portfolios for every unit of risk it bears in the market. Its risk-return is the highest, and its risk-return efficiency is the greatest, while the maximum Sharpe ratio portfolio is the second highest. The mean portfolio has the lowest risk-return efficiency. Efficiency is the smallest.

Markowitz's portfolio theory suggests that the return on a portfolio of several risky assets is the weighted average of the returns on those risky assets. Still, the risk of the portfolio is not the weighted average risk of those risky assets, a portfolio reduces unsystematic risk, and the standard deviation of the risk measure determines the expected rate of return on the portfolio assets. The higher the risk the higher the rate of return, the lower the risk the lower the rate of return. The mean and variance of historical returns can be used as an unbiased estimate of the return and variance of the portfolio.

5. Conclusion

This paper collects the historical data of six random stocks with good profitability in the Chinese stock market and constructs a maximum Sharpe ratio portfolio, a market capitalization-weighted portfolio, and an average weighted portfolio based on the theory and analyses and evaluates the performance of the three portfolios in a certain period. The three portfolio strategies outperformed the CSI 300, SSE 50, and SZSE 100 benchmark indices in terms of returns over the period, and the return per unit of risk assumed was much higher than the three benchmark indices, which demonstrates that the use of appropriate portfolio investment strategies can avoid losses in the Chinese stock market, and can also be profitable in a depressed market environment. Among the three investment strategies, the Maximum Market Capitalization Portfolio has the best profitability among the three portfolios and strategies and delivers the largest return per unit of risk taken. The maximum Sharpe ratio portfolio strategy is also able to generate profits, which also shows that the maximum Sharpe ratio portfolio strategy is an effective investment strategy and that Markowitz's portfolio model has a high significance in guiding our Chinese securities market. However, in terms of profitability and risk-return ratio, the maximum Sharpe ratio group is much lower than the maximum market capitalization group, which shows that in the more depressed market environment, the larger market capitalization companies in the portfolio tend to be able to create more profit opportunities and create more investment returns, which also shows that investors need to focus

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their attention on the larger market capitalization companies in the depressed market conditions. In Markowitz's theoretical model of investment, asset allocation based solely on the mean-variance calculated from the historical returns of the assets has certain limitations. Due to errors in the estimation process of mean and variance and changes in the macro situation, the mean and variance of the actual portfolio's returns do not necessarily match the historical data, which makes it challenging to achieve the desired results in the final investment.

In this paper, there are also many shortcomings. Firstly the number of underlying of the portfolio is small, the testing results are contingent, and the contingency in the selection of stocks will also lead to the portfolio's return is not satisfactory. Secondly, the analysis of the test results is also relatively simple, and the more the advantage of the maximum Sharpe ratio portfolio constructed with Markowitz's portfolio theory is also not evident in this test Markowitz's portfolio is not better than the market value portfolio. Thirdly, macro-level effects can also bias the returns.

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