# Portfolio Optimization Based on 9 Chinese Stocks

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**Abstract.** Geopolitical conflicts and the impact of the pandemic have triggered volatility and downward trends in the Chinese stock market, prompting investors to pay more attention to stabilizing returns and controlling risks through optimizing portfolios. This study selected nine stocks listed on the Shenzhen and Shanghai Stock Exchanges in China and first identified the efficient frontier composed of these nine stocks, then constructed portfolios with maximum Sharpe ratio and minimum volatility. The results indicate that China Yangtze Power Co., Ltd. holds the highest investment weight in all portfolios, followed by Kweichow Moutai Co., Ltd. which also holds significant weights in both portfolio types. By comparing the cumulative returns of the two portfolios with the HS300 index, it was found that the performance of all portfolios outperformed the benchmark index. This result can provide guidance for some investors in managing investments during this particular period of market downturn.

**Keywords:** China, China Yangtze Power, Kweichow Moutai, HS300 index.

## 1. Introduction

Since the beginning of 2021, the general trend of Chinese stock market has turned to a downward trend, and reached a bottom at the end of 2022, many funds' sentiment and confidence has declined, and most of them hold a bearish and wait-and-see attitude, which makes the supply of the seller's market increase, while the demand decreases, which lead to the index continues to fall. Therefore, under the background of many assets individually underperform and are volatile, how to reduce the risk while improving the return, and maintain the gain through a recession period, optimize the portfolio investment has become a more concerned issue for investors.

Portfolio management is a key component of asset management, pioneered and developed by Harry Markowitz [1]. It includes a range of strategies designed to optimize returns while minimizing risk and has attracted much research, for example, Jeffery and Leliveld emphasize the importance of aligning IT investments with overarching business objectives, advocating for a strategic approach to portfolio management [2]. Building on this, Širůček and Křen apply the renowned Markowitz Portfolio Theory to construct optimal portfolios within the US stock market context, underscoring the significance of diversification in mitigating portfolio risk [3]. Complementing these insights, Clarke, de Silva, and Thorley delve into the concept of minimum-variance portfolios, demonstrating their efficacy in reducing volatility without sacrificing returns in the US equity market [4]. Furthermore, Coelho, Hutzler, Repetowicz, and Richmond explore the intricacies of sector analysis for a FTSE portfolio of stocks, shedding light on the role of sector-specific dynamics in portfolio diversification strategies [5]. Collectively, these studies highlight the multifaceted nature of portfolio management and underscore the importance of evidence-based practices for achieving optimal investment outcomes.

Compared with the research in the Chinese market, and the underperformance of the Chinese market today, there is a lack of research on how to hold a well performance portfolio in a down-market. This paper aims to provide an idea for controlling risks and stabilizing returns through portfolio investment in the recession period and provide reference for individual investors' asset allocation and portfolio construction in this special period. In this paper, a portfolio consisting of nine stocks is constructed and the asset weights under the minimum volatility allocation and the maximum Sharpe ratio allocation are derived [6]. The cumulative portfolio return is then compared with the cumulative index return of the same period to reach a conclusion of weather the portfolios is efficient or not. The results show that the returns of both target portfolios outperform the index returns over

the validation period. Finally, to ensure the reliability and rationality of the research methods and results, a robustness test was conducted in this study.

This paper is structured as follows, Section two is mainly about the stocks chose and data used in the study. Section 3 introduce the method of construct the model and built the optimal portfolios. Results and the robustness test are presented in Section 4 and Section 5 reaches to the conclusion and discussion.

## 2. Data

The data of this paper consists of nine companies listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange in mainland China, so the CSI 300 Index used to be their background market data. The stock ticker of the 9 stocks is: 600519.SS, 300042.SZ, 600011.SS, 601225.SS, 601601.SS, 600900.SS, 601088.SS, 600566.SS, 000568.SZ. The collected data is divided into two sets: data from January 1, 2018, to December 31, 2022, which is used for computing the efficient frontier and constructing the weights for the optimal portfolio, while the testing data, covering the period from January 1, 2023, to December 31, 2023, is used to verify the performance of the portfolio formed by the weight calculated in first Part. The companies selected for this study are primarily leading firms in four sectors: liquor brewing, energy, pharmaceuticals, and insurance. Due to their business operations and the cultural context in China (supported by the liquor consumption culture), these companies are expected to have relatively stable demand for their products and lower systematic risks. The basic information of the nine chosen stocks is presented in Table 1, Table 2, Fig. 1. It is worth noting that stock 300042.SZ has the largest volatility of all stocks, stock 000568.SZ has the highest cumulative return of all stocks, and 601601.SS is the only stock with negative cumulative return in the selected range.

**Table 1.** Selected stocks

| | Company |
|---|---|
| 600519.SS | Kweichow Moutai Co., Ltd. |
| 300042.SZ | Netac Technology Co., Ltd. |
| 600011.SS | Huaneng Power International, Inc. |
| 601225.SS | Shaanxi Coal Industry Company Limited |
| 601601.SS | China Pacific Insurance (Group) Co., Ltd. |
| 600900.SS | China Yangtze Power Co., Ltd. |
| 601088.SS | China Shenhua Energy Company Limited |
| 600566.SS | Hubei Jumpcan Pharmaceutical Co., Ltd. |
| 000568.SZ | Luzhou Laojiao Co., Ltd |

**Table 1.** Descriptive statistics of the daily return of the 9 stocks

| | Max | Min | Mean | StedDev. | Cumulative Return |
|---|---|---|---|---|---|
| 600519.SS | 0.0950 | -0.1411 | 0.001 | 0.0207 | 123.24% |
| 300042.SZ | 0.1687 | -0.1167 | 0.0000 | 0.0330 | 12.06% |
| 600011.SS | 0.1011 | -0.1004 | 0.0005 | 0.0263 | 71.34% |
| 601225.SS | 0.1003 | -0.0991 | 0.0011 | 0.0238 | 138.52% |
| 601601.SS | 0.1001 | -0.0876 | 0.000 | 0.0218 | -10.81% |
| 600900.SS | 0.0681 | -0.0600 | 0.0005 | 0.0122 | 56.67% |
| 601088.SS | 0.1000 | -0.0790 | 0.0006 | 0.0205 | 74.96% |
| 600566.SS | 0.1003 | -0.0999 | 0.0001 | 0.0255 | 21.57% |
| 000568.SZ | 0.1001 | -0.1035 | 0.0015 | 0.0286 | 179.92% |

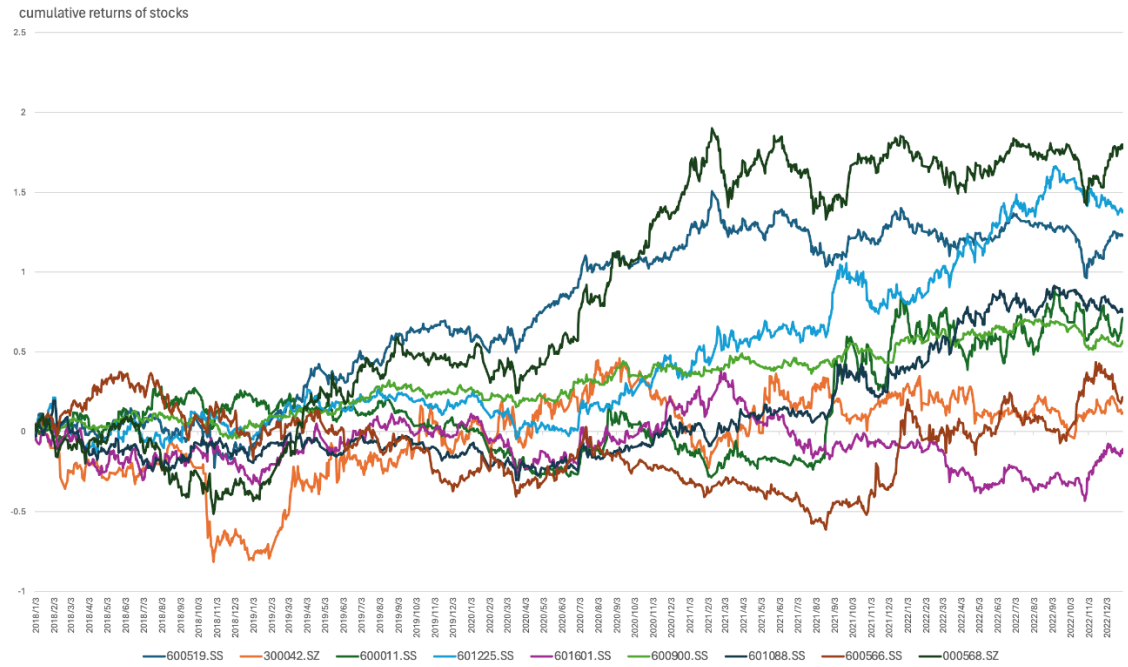


**Fig. 2** Cumulative returns of selected stocks

## 3. Methods

The core idea of Mean-Variance Model is to select the optimal portfolio by weighing risk and return. This study will use the following formula to calculate the return of the portfolio as well as the risk [7].

$$R_p = \sum_i w_i \mathrm{R}_i \tag{1}$$

$w_i$ is the $i^{th}$component stock's weight of the portfolio, $\mathrm{R}_i$ is the expected return of the $i^{th}$ stocks.

$$\sigma_p^2 = \sum_{\mathrm{i}=1}^{\mathrm{n}} \sum_{\mathrm{j}=1}^{\mathrm{n}} w_i w_j cov(r_i, r_j) \tag{2}$$

$w_i$ is still the $i^{th}$component stock's weight of the portfolio as well as $w_{\mathrm{j}}$, and of particular importance is the covariance matrix of the different assets. Monte Carlo simulation methods are utilized to construct diverse portfolios by simulating stochastic processes under defined conditions. Within this framework, weights are randomly generated for each asset in the portfolio, leveraging the average return and covariance matrix of the provided stocks as parameters. Through this process, one can ascertain the expected return and portfolio variance associated with these weights. By iteratively repeating simulations in a similar manner, the resulting dataset represents the most probable asset allocations, facilitating the delineation of the efficient frontier.

In this paper, two specific efficient portfolios are considered and can be pointed out from the efficient frontier namely the maximum Sharpe ratio portfolio and the minimum volatility portfolio. The Sharpe ratio is a measure used to assess the risk-adjusted return on a portfolio, which measures the additional return earned per unit of risk. The calculation method is as follows:

$$SR = \frac{R_p - R_f}{\sigma_p} \tag{3}$$

Where $R_p$ is the expected return of the portfolio. $R_f$ is the risk-free rate (usually chosen as the Treasury yield). $\sigma_p$ is the standard deviation (risk) of the portfolio. A higher Sharpe ratio indicates that the portfolio achieves a higher excess return while taking the same risk. Therefore, the Sharpe

ratio can be used to compare the relative performance of different portfolios, as well as to assess whether the portfolio is able to provide sufficient return to the investor to justify the risk.

The portfolio with the highest Sharpe ratio outperforms other portfolios in terms of risk-adjusted returns. The minimum variance strategy can assist risk-averse investors in selecting portfolios that minimize risk while maintaining stable performance. Therefore, these two distinct investment portfolio strategies are commonly employed by investors with different preferences and hold research value.

## 4. Result

After obtaining all the necessary data, the portfolio efficient frontier and weights was constrained and optimized [8]. Firstly, under the conditions of full investment and long position only, the sum of weights was ensured to be 1 and no negative weights were allowed, thereby maintaining the legality and feasibility of the portfolio. Subsequently, optimization objectives were added: minimizing risk and maximizing return, aiming to find the optimal asset allocation that achieves the highest return at a given level of risk. Finally, the ROI optimization method was employed to maximize the Sharpe ratio. The Fig. 2 illustrates the efficient frontier of the investment portfolio composed of nine chosen assets.

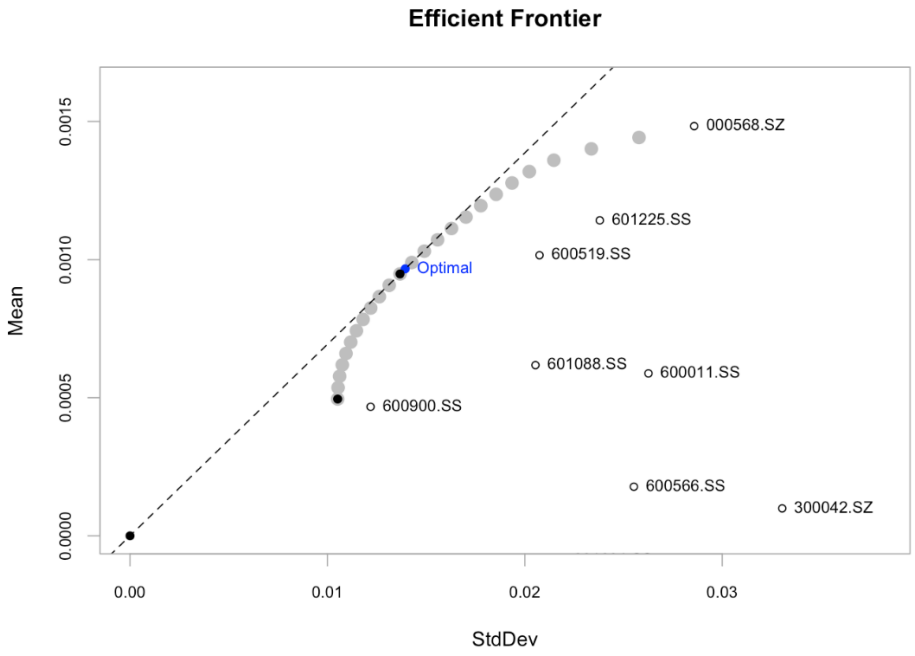


**Fig. 2** Efficient Frontier

Through the visualization of the efficient frontier, it can identify two optimal portfolios, the min-volatility portfolio (located at the leftmost of the efficient frontier) and the maximum Sharpe ratio portfolio (the tangency portfolio). The stocks weight in the min-volatility portfolio are: 600519: 11.12%, 300042: 4.95%, 600011: 3.09%, 601225: 0.09%, 601601: 1.18%, 600900: 59.31%, 601088: 10.50%, 600566: 9.76%, 000568: 0.00%. The stocks weight in the max Sharpe Ratio portfolio are: 600519: 16.43%, 300042: 8,11%, 600011: 3.79%, 601225: 21.23%, 601601: 0.00%, 600900: 30.14%, 601088: 0.00%, 600566: 0.00%, 000568: 20.40%. It is worth noting that the assets with code 600900 have a large weight in the both optimal portfolio investments, 601225 and 000568 have a large weight of 21.23 and 20.40 in the maximum Sharpe Ratio portfolio, while only 601225 accounts for 0.09 in the min-volatility portfolio and 000568 does not participate in the asset allocation for the min-volatility portfolio (See Table 3). The following Table 4 gives the annualized return and annualized standard deviation of the two portfolios with the Sharpe Ratio under the assumption of 0 risk-free rate. The standard deviation of the min-volatility portfolio is 16.30% and the Sharpe Ratio of the maximum Sharpe Ratio portfolio is 121.41%.

**Table 3.** Weight of each stock in the two optimal portfolios (%)

| | Max Sharpe Ratio | Min Volatility |
|---|---|---|
| 600519 | 16.43 | 11.12 |
| 300042 | 8.11 | 4.95 |
| 600011 | 3.79 | 3.09 |
| 601225 | 21.23 | 0.09 |
| 601601 | 0.00 | 1.18 |
| 600900 | 30.14 | 59.31 |
| 601088 | 0.00 | 10.50 |
| 600566 | 0.00 | 9.76 |
| 000568 | 20.40 | 0.00 |

**Table 4.** Return and volatility of the two portfolios

| | Return | Volatility | Sharpe Ratio |
|---|---|---|---|
| Max Sharpe Ratio | 26.20% | 21.58% | 121.41% |
| Min Volatility | 2.67% | 16.30% | 77.73% |

After obtaining the asset allocation weights for the two portfolio investments, the next step is to calculate the cumulative returns of the two portfolios. By matching the daily stock return data for all trading date of entire year of 2023 with each stock's weights, daily portfolio returns can be obtained and then derive the cumulative portfolio return. The stocks selected for this essay are all listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange in mainland China, hence the HS300 Index is chosen as the benchmark market portfolio investment. It is clear evidence that both optimal portfolios are outperformed the benchmark market through the graph. The cumulative return of the maximum Sharpe Ratio portfolio was 18.51%, the min-volatility portfolio was 20.47%, while the market cumulative return at the end of the period was -11.63% (See Table 5). Additionally, it can be observed that at the beginning of the period, the market portfolio is outperformed than the others, but was later surpassed by both optimal portfolios in March. Subsequently, in the case of market downturn, both portfolio investments showed an upward trend. Compared to the min-volatility portfolio, the maximum Sharpe Ratio portfolio has a longer yield lead but exhibits higher volatility. By the end of the year, the min-volatility portfolio investment exhibits more stable performance and closes with higher cumulative returns than the maximum Sharpe Ratio portfolio and the market (See Fig. 3).

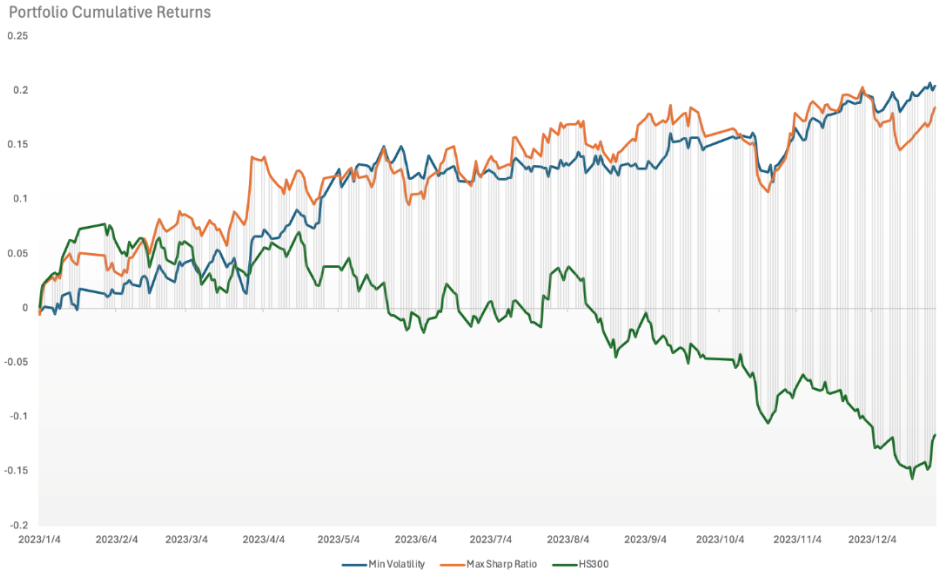


**Fig. 3** Comparison between HS300 index return and the portfolio returns

**Table 5.** Cumulative return comparison

| | Cumulative Return |
|---|---|
| Max Sharpe Ratio | 18.51% |
| Min Volatility | 20.47% |
| HS300 | -11.63% |

To ensure the reliability of the study, a robustness test is also required. It is noted that some assets have a weight of 0 in the optimal portfolios results. All assets with a weight of 0 are removed from the domains of the two optimal asset allocations. Additionally, asset "600900" is removed from both portfolio investments because it shows a significant weight in both portfolios. After removing these assets, the weights of the remaining assets for construct the min-volatility and maximum Sharpe Ratio portfolios and the cumulative returns for these two portfolios are recalculated (See Table 6 and Table 7).

**Table 6.** Weight of the remaining stocks in the two optimal portfolios (%)

| | Max Sharpe Ratio | Min Volatility |
|---|---|---|
| 600519 | 24.89 | 25.81 |
| 300042 | 2.58 | 8.17 |
| 600011 | 9.08 | 14.93 |
| 601225 | 37.91 | 0.92 |
| 601601 | No weight | 8.54 |
| 601088 | No weight | 27.13 |
| 600566 | No weight | 14.50 |
| 000568 | 25.55 | No weight |

The Fig. 4 presents a comparison of the cumulative returns of the two portfolios from the robustness test with the HS300 index. At the end of the period, the min-volatility portfolio still has the highest cumulative return along the maximum Sharpe Ratio portfolio and the market portfolio, like the conclusion of the main results. Thus, it can be concluded that the inference method and the results obtained in the main results are valid and reliable.


**Fig. 4** Comparison between HS300 index return and the test portfolio returns

**Table 7.** Comparison between HS300 index

| | Cumulative Return |
|---|---|
| Max Sharpe Ratio | 8.28% |
| Min Volatility | 21.45% |
| HS300 | -11.63% |

## 5. Conclusion

In summary, this article examines the minimum volatility and maximum Sharpe ratio portfolios composed of 9 Chinese stocks. By obtaining stock price data from Yahoo Finance, the returns and cumulative returns of stocks can be calculated. Then, by computing the portfolio's returns and volatility, the relationship between the returns and volatility of the portfolio under different weightings of the nine assets is depicted, visualizing the data of all observation groups and forming an efficient frontier. The two optimal investment portfolios are those tangents to the efficient frontier and at the minimum portfolio variance (leftmost of the efficient frontier). After obtaining the weights of the two optimal portfolios, they are applied to observe the cumulative returns and standard deviation of the portfolio during the testing period. Comparing them with the HS300 index, both cumulative returns outperform the index, with the minimum volatility investment portfolio achieving the highest returns. From the results, it is observed that, apart from China Yangtze Power Co., Ltd., which dominates the minimum volatility investment portfolio, Kweichow Moutai Co., Ltd., and China Shenhua Energy Company Limited also hold significant proportions in the primary results and robustness tests. It can be concluded that these three companies are good investment options in the Chinese market when volatility is high.

From a theoretical standpoint, the portfolio with the maximum Sharpe ratio will provide the highest return but also carry higher risk. However, from a broader practical perspective, it can be noted that during periods of overall market volatility or recession, the minimum variance investment portfolio strategy effectively hedges risk by reducing the portfolio's volatility, thereby stabilizing investors' returns in an unstable market. Both investment portfolios studied in this article maintain positive returns in unfavorable investment environments (when the index's cumulative return is negative), and the minimum variance investment portfolio achieves the goal of minimizing risk during special periods. Therefore, when overall market sentiment tends toward pessimism, this may be a more suitable and robust asset allocation strategy.

Of course, there are also shortcomings of this study. The assets selected in this paper are mostly enterprises with stable demand and low systemic risk, such as energy, electricity and liquor. They can usually maintain good performance in the market downturn, which is a special way to deal with the market instability. However, this strategy has limitations and difficulties in asset selection, and the selection of the number of companies does not fully display the ability of diversification and risk control. In short, choosing a portfolio that minimizes risk in a bad market can make investment effective and safe.

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