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Portfolio Designed Based on Markowitz Model in Terms of Wine Industry of China

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Abstract: Contemporarily, China's Wine industry has a special social status because of the prevalence of the culture of drinking. Since the 21st century, the Wine industry has flourished, and the stock price has risen sharply, which makes it become the favorite object of plenty of investors. Facing the unexpected COVID-19, the Wine industry recovered and maintained a rising trend immediately after a short blow, showing its strong risk resistance. In order to find the best investment strategy for Wine industry, this paper applies the financial analysis method to screen out stocks worth investing and the Markowitz modelto determine the optimal portfolio as a reference for investors with quantitative analysis. To be specific, several typical stocks in the industry are chosen and the effective frontier is obtained. According to the models, the performances of the optimal case are illustrated and demonstrated. These results shed light on guiding further exploration of Wine industry and other similar industries.

Keywords: Wine Industry, Markowitz Portfolio Theory, Portfolio Optimization.

1. Introduction

Wine is a unique liquor in China with a long history, which occupies an important position in China's liquor industry. It is the crystallization of Chinese traditional culture. It has high economic value in China and has become a significant part of the national economy [1]. With the outbreak of COVID-19 from the beginning of 2020, all walks of life have been affected to varying degrees, including the food and beverage industry. However, after a short impact, Wine industry recovered and maintained a steady development trend again. This phenomenon indicates that Wine industry is highly resistant to COVID-19 [2]. Therefore, stocks of Wine enterprises have high investment value.

According to the modern portfolio theory [3], the risk of investing in a single stock is relatively high. Selecting multiple stocks can effectively disperse the risk. Therefore, after comprehensively considering the development potential of the Wine industry, it is sensible to select the appropriate Wine stock portfolio as an investment strategy at this stage.

The rest part of the paper will be separated as follows. In the second part of this article, the author will give an overview of Wine industry and the development of modern portfolio theory; In the third part of this article, the author will conduct a comprehensive financial analysis of all listed Wine enterprises in China and select Wine enterprises with good development potential based on the results, eventually constructing a portfolio of selected stocks; In the fourth part of this paper, the author will determine the final proportion of stocks based on Markowitz portfolio theory, and then

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apply Sharpe, Jenson and Treynor indexes to evaluate the merits of the portfolio; In the fifth part of this paper, the author will explain the limitations and defects of the research and propose the possible optimization direction of the model in the future.

2. Overview of Wine Industry & Modern Portfolio Theory

Before the outbreak of the COVID-19, there were many studies on the development of China's Wine industry. However, With the spread of the epidemic, there were fewer researchers focusing on this area. The latest research before the epidemic shows that China's Wine industry is in a state of monopolistic competition, with no industry oligarchs and low market concentration [1]. After the outbreak of the epidemic, schoalrs applied the residual income model to conduct financial analysis on three representative Wine enterprises with large market shares and approved the investment value of Wine enterprises under the epidemic [2]. One year later, other study used the Markowitz model to analyse Wuliangye and Luzhou Laojiao stocks and determine the optimal investment ratio [4]. Although he made an excellent analysis of the situation of the two companies, he failed to make a strong argument for the reasons why choosing the two companies as representatives. Based on the context, to better evaluate the comprehensive development potential of the entire Wine industry, this article will conduct a more comprehensive and in-depth study on the basis of previous studies.

The author will use the Modern portfolio theory to make the research. Markowitz's paper "Portfolio Selection" published in 1952 laid the foundation and marked the beginning of modern portfolio theory [5]. Although Markowitz systematically and scientifically clarified the important mechanism of portfolio investment to disperse risks in his theory, in practical application, the determination of portfolio parameters meets a lot of heavy and complex calculations, which will make investor confused. In 1964, Sharpe has studied the famous capital asset pricing model [6], which perfectly solves this problem. After that, Samuelson and Fama made a study on the behavior of securities prices in the capital market from theoretical and empirical perspectives and put forward the Efficient Market Hypothesis (EMH) [7]. The efficient market theory believes that in a capital market that can function normally, the movement process of its capital price can now be described by a process, and it provides a strictly theoretical framework for the dynamics of asset price movement, and provides a mechanism for financial markets to adjust according to external information. Another important contribution is Stephen Ross [8]. He proposed the Arbitrage Pricing Theory (APT) which believes that arbitrage behavior is a determinant in the formation of modern efficient markets. If the market can not reach equilibrium, risk-free arbitrage opportunities will occur in the market. Since then, many other scholars have done a lot of meaningful work, making the modern portfolio theory more and more complete.

3. Data & Methodology

Rational stock investors are concerned about returns and risks. The operating condition of a joint-stock company is a significant factor in determining the stock price. Therefore, when evaluating Wine enterprises, the profitability and security of enterprises are the two major aspects that investors first consider. Profitability refers to the ability of an enterprise to earn profits. A high level of profitability means a high return that can be obtained by the enterprise, thus increasing the probability of the stock price rising. The security of an enterprise is to ensure the ability to recover the principal and fixed income. The security of an enterprise is reflected in its capital liquidity and the rationality of its capital structure. The higher the security of an enterprise, the stronger its ability to cope with risks and the less likely the stock price will have a violent wave. Based on the theory above, the author will select profit margin as an indicator to reflect the profitability of the enterprise and select asset-liability ratio and cash flow as indicators to evaluate the security of the enterprise.

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Finally using these two indicators to select Wine stocks with high investment value. At present, there are 18 listed Wine enterprises in China. Table 1 shows parts of the operating performances. The data were obtained by consulting the balance sheet.

According to the research conducted by Holz [9] and analyses of Wine securities by many securities companies in China, it is generally believed when the profit margin is 25% or more, it reflected that the profitability of the Wine enterprise is good. When the asset-liability ratio is below 50% and cash flow is above 0, it indicates that the Wine enterprise has strong security. Based on these standards, 8 stocks that meet the requirements are selected out of all 18 Wine stocks. Next, this article will combine these eight stocks as a portfolio and determine the optimal one.

Table 1: Operating performances of Wine enterprises.

Symbol	Profit Margin	Total Debt/Equity	Operating Cash Flow
600199.SS	-12.94%	N/A	-593.72M
200596.SZ	18.53%	0.95	6.36B
603589.SS	34.46%	0.02	566.06M
603198.SS	30.82%	<0.01	1.68B
000860.SZ	-1.96%	91.9	168.36M
000995.SZ	4.18%	40.66	16.34M
600559.SZ	14.28%	0.48	767.92M
603369.SS	31.78%	3.77	3.35B
002304.SZ	31.34%	0.03	8.89B
603919.SS	14.71%	2.89	391.99M
000799.SZ	26.88%	0.05	1.36B
600519.SS	50.20%	0.2	36.68B
000568.SZ	41.14%	12.75	10.05B
600809.SS	30.34%	0.12	9.66B
600702.SS	24.69%	0.58	1.67B
600779.SS	25.18%	0.42	1.29B
000858.SZ	36.03%	0.45	22.16B
600197.SS	10.45%	5.07	24.47M

4. Portfolio Construction

4.1. Markowitz Model Introduction

Markowitz model is a portfolio optimization model proposed by Harry Markowitz. In 1955, he explained the model in detail in his dissertation submitted to the University of Chicago. This model consists of four essential factors: expected returns of portfolios, the standard deviation of portfolios, efficient frontier, and optimal asset allocation. The model is based on several assumptions: An investor is rational in nature and risk averse. Portfolio risk is dependent on the variability of returns. The model can be described as below:

$$\sigma^2(R_p) = \sum\sum w_i w_j cov(R_i, R_j) \quad (1)$$

$$R_p = \sum w_i R_i \quad (2)$$

$$\sum w_i = 1 (w_i \geq 0) \quad (3)$$

where R_p is expected return of the portfolio, R_i, R_j are expected return of the stock, $w_i w_j$ are weight of stock in portfolio, σ^2 is variance $cov(R_i R_j)$ is covariance of the portfolio

Eq. (1) calculates the variance of two stock prices in the portfolio. Eq. (2) calculates the expected return of a portfolio by summing the returns of included stocks with their weights. Eq. (3) is the restraint conditions showing that the sum of the weights should be equal to 100% and each weight must be greater than zero. The economic significance of these formulas is: A portfolio is

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constructed by several stocks. The stocks must be bought and held instead of sold because the weight of each stock is greater than zero. The total return of this stock portfolio is R_p and the risk size of this portfolio can be represented by the size of σ^2.

4.2. Wine Portfolio Construction

According to the assessment above, this article selects 8 out of 18 stocks of Wine Companies with good operating conditions and development potential as a portfolio to carry out research. To evaluate the performance of stocks during COVID-19, daily closing prices from January 2020 to September 2022 are selected to be analyzed. The daily return of a stock can be represented by its daily percentage change in closing price. It can be calculated by formula 4:

$$Daily\ return = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{4}$$

Here P_t is the stock price of a certain day, while P_{t-1} is the price of the day before that day. In Markowitz Model, the return and risk of a single stock are represented by the daily return and variance(or standard deviation) of its return respectively, while the return and risk of a portfolio are represented by the weighted average sum of stock returns and the covariation between these stocks. Moreover, the strength of the relationship between stocks can be measured by the correlation coefficient. The formulas are shown as below:

$$Var(X) = E[(X - E[X])^2] = \sigma_X^2 \tag{5}$$

$$Cov(X, Y) = E\big[\big(X - E(X)\big)\big(Y - E(Y)\big)\big] \tag{6}$$

$$Corr(X, Y) = \frac{COV(X,Y)}{\sigma_x \sigma_y} \tag{7}$$

Table 2 Shows the annual return and daily variance of these eight stocks which can be calculated through Python based on the daily closing price crawled from yahoo finance. It can be seen from the table that all selected stocks kept upward trend during COVID-19. Two of stocks even rose more than 70%. It indicates Wine shares have high investment value. The majority of the correlation coefficient between any two stocks is between 0.5 and 0.7, which means the rise and fall of Wine shares have a high positive correlation.

Table 2: Return and Risk of stocks.

Ticker Symbol	Annual Return	Daily Variance
603589.SS	7.86%	0.000853
603198.SS	52.37%	0.001229
002304.SZ	23.85%	0.000761
000799.SZ	70.82%	0.001310
600519.SS	24.98%	0.000408
600809.SS	71.98%	0.000982
600779.SS	27.60%	0.001123
000858.SZ	16.79%	0.000670

A portfolio with certain stocks varies with the change of weights of stocks. When a specific weight combination is determined, the return and risk of this portfolio can be predicted by previous data. With the help of python, the author can create $k(k \in \mathbb{N}^+)$ random weights combinations. For a specific weight combination:

$$W_k = \{w_{k1}, w_{k2}, \ldots, w_{kn}\}, (n\ is\ the\ number\ of\ stocks) \tag{8}$$

Based on Markowitz model, the variance of this portfolio can be calculated:

$$\sigma_k^2(R_P) = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ki} w_{kj} cov\big(R_i, R_j\big), (k, n \in \mathbb{N}^+) \tag{9}$$

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The expected return of this portfolio is:

$$R_P = \sum_{i=1}^{n} w_{ki} R_i \quad (10)$$

$$\sum_{i=1}^{n} w_{ki} = 1, (w_{ki} \geq 0) \quad (11)$$

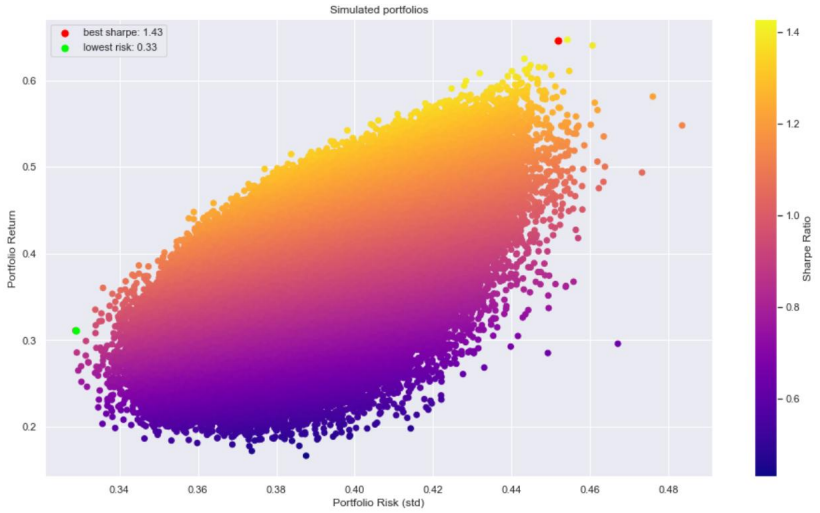

Figure 1: Simulated Portfolios.

Then, according to the result in chapter 3, n=8. The author chooses $k = 1{,}000{,}000$. Fig. 1 shows the result of all outcomes, where each spot represents a certain weight combination. When an investor set an expected return for a portfolio, they can get a series of spots that lies in the same Y-axis, which represents all the portfolio have the same expected return. Therefore, the spot of the lowest risk, which is on the far left of this Y-axis, is the optimal choice for the investor. Similarly, if an investor set an expected risk, the spot on the top of determined X-axis is the optimal choice. In this case, the top left edge of all possible spots constitutes an optimal portfolio set that offer the portfolio with the largest return under the same risk or the lowest risk under the same return. These spots form a curve called the "efficient frontier". The leftmost spot of the efficient frontier represents the portfolio who has the lowest risk regardless of the return. The green point in Fig. 1 represents the lowest risk portfolio with the annual return 31.1% and the risk 0.33. Table 3 shows the weight of each stock.

Table 3: Weight of Stocks with lowest risk.

Ticker Symbol	weight
603589.SS	3.2682%
603198.SS	3.3425%
002304.SZ	7.7256%
000799.SZ	1.1715%
600519.SS	60.0640%
600809.SS	11.9583%
600779.SS	4.8271%
000858.SZ	7.2429%

When people make investments, they often need to consider risks and benefits together. Sharpe ratio is an indicator for evaluating portfolios taking both return and risk into consideration. This

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concept was proposed by economist Sharpe in 1966 and its simplest formula form is shown in formula 12:

$$Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_p} \tag{12}$$

Here, $R_p$is the return of investment, R_f is risk-free rate, σ_p is standard deviation of the portfolio's return. At this stage, Simplified Sharpe ratio is applied to obtain the portfolio with the highest Sharpe index, as the risk-free rate is the same and can be omitted without no impact on the final outcome. The simplified Sharpe formula is shown as below:

$$Simplified\ Sharpe\ Ratio = \frac{R_p}{\sigma_p} \tag{13}$$

According to outcomes created by Python, the highest sharp of the portfolio with these 8 stocks is 1.43 ($k = 773826$) with the annual return 64.54%% and the risk 0.45. The corresponding W_k is shown in Table. 4.

To summarize, investors can choose their favorite point from the efficient frontier whatever based on risks or returns. These all chosen portfolios are the optimal stock combinations. If investors do not have clear requirements for neither risk nor returns and they want to consider these two factors comprehensively, Sharpe ratio can help them to get the relatively optimal portfolio. In author's trail, the weight of stocks in portfolio with the highest sharp ratio (1.43) are shown in figure 1.

Table 4: Weight of Stocks with best Sharpe.

Ticker Symbol	weight
603589.SS	1.2180%
603198.SS	13.8935%
002304.SZ	0.8532%
000799.SZ	33.6140%
600519.SS	3.5424%
600809.SS	44.0417%
600779.SS	1.0392%
000858.SZ	1.7980%

5. Portfolio Evaluation

Portfolio performance can be measured through three tools [10]. They are Treynor, Jensen, and Sharpe ratios. They all combine returns and risks into a single value, but each is slightly different. Although investors can choose any spot from the effective frontier to invest according to their needs, for those investors who do not have clear investment requirements, they still want to find a relatively better investment plan. Therefore, Regarding the portfolio with the best simplified Sharpe ratio as the final optimal investment strategy has rationality and universality. Based on this, this article will analyse the performance of this portfolio by three tools mentioned above.

5.1. Sharpe Ratio

To obtain the relatively optimal portfolio and the corresponding weight of stocks, the author uses a simplified Sharpe Ratio as an indicator for convenience. However, when a portfolio is measured for investment advice, market information (risk-free rate) cannot be omitted. Risk-free rate refers to the interest rate that can be obtained from an investment object without any risk. In this article, the author chooses the rate of US three-year treasury bonds as the risk-free rate. According to US department of the treasury R_f=4.1783%. According to formular, the real Sharpe ratio is calculated to be 1.34. When the Sharpe ratio is above 1, the portfolio is considered good [10].

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5.2. Jensen Ratio

Jensen ratio, also called Jenson's alpha, is proposed by Michael C. Jensen. It calculates the excess return that a portfolio generates over its expected return. The formula is:

$$Jensen\ ratio = R_p - CAPM \tag{14}$$

CAPM refers to the capital asset pricing model proposed by Sharpe [6]. The formula is as follows:

$$\overline{r_i} - r_f = \beta_i(\overline{r_m} - r_f) \tag{15}$$

Here, $\overline{r_i}$ is expected return of investment, r_f is risk-free interest rate, β_i is beta of the investment, $\overline{r_m}$ is expected return of the market. Beta is a measure of a stock's volatility in relation to the overall market. The calculation formula of β is:

$$\beta = \frac{Cov(r_i, r_m)}{Var(r_m)} \tag{16}$$

To estimate the β of optimal portfolio, this article will take the average yield of the Shanghai Composite Index from January 2020 to September 2022 as the market return, and use the optimal portfolio selected above as the expected return of this investment. Through Python, the result is calculated to be $\beta = 1.32 > 1$. If β is greater than 1, it means that this portfolio tends to be more volatile than the market. In the context of economic recovery, the portfolio will achieve higher returns than the market. Then, Stock Market Line can be used to calculate the expected return of the portfolio. The formula is:

$$CAPM = r_f + \beta(r_m - r_f) \tag{17}$$

When applying all data to this article, CAPM is 3.036%. Finally, Jensen's alpha is calculated to be 0.6151. When Jenson's alpha is greater than 0, it means the realized return of selected portfolio is more than the market expectation, which indicates that the portfolio performs excellent.

5.3. Treynor Ratio

Treynor ratio is defined as:

$$Treynor\ Ratio = \frac{R_p - R_f}{\beta} \tag{18}$$

It measures the risk-adjusted performance of an investment portfolio by analysing a portfolio's excess return per unit of risk. According to Formula 16 and 18, the Treynor ratio of the market is calculated to be -0.0087, while the Treynor ratio of the selected portfolio is 0.4572, greater than that of the market. When this happens, it means the portfolio performed better than the aggregate market.

6. Limitations & Prospects

This article only considers profit margin, asset-liability ratio, and cash flow as the criteria to evaluate the profitability and security of Wine enterprises and uses them as stock selection strategies. Although with representativeness to some extent, they are not completely reasonable. To simplify the selection process of model data, the author only selects factors that have significant impacts on stock prices, ignoring many other factors, so there may be some deviation between the results of the model and the actual situation. In the future, the author will try to use the multi-factor quantitative stock selection strategy for this research to improve the reliability and accuracy of stock selection. Second, the Markowitz model does not take transaction costs into account and forecasts the future market based on historical stock data. The market is subject to uncertainty due to factors such as transaction technology and macro policies. Therefore, only when it truly occurred can the effectiveness of this portfolio be proved. There still exist some risks in the real market. Third, this article selects the Shanghai Composite Index as the standard to evaluate the overall market returns

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and risks, which means that only the performance of enterprises in the Chinese market is considered. In fact, Wine has a certain sales volume in other countries, which also has a certain impact on the stock price. Moreover, Markowitz model is not completely applicable to China's stock market, because Chinese investors tend to evaluate a single stock and ignore the relevance of multiple stocks. Thus, there may be some systematic bias in this conclusion. Further study will try to adjust Markowitz's model to obtain better performance and consider more practical factors in the optimization process to make it more consistent with the Chinese market, so as to improve the accuracy of prediction.

7. Conclusion

In summary, the purpose of this paper is to conduct a comprehensive evaluation of Wine enterprises with strong resistance to the epidemic and select stocks of enterprises with good development potential as the overall investment strategy of the Wine market. According to the analysis, there are eight Wine stocks with good comprehensive operation during the epidemic period. Based on the Markowitz's portfolio theory, the optimal portfolio is determined with the largest return-risk ratio 1.43. Finally, through the comprehensive evaluation of the three evaluation criteria, it is found that this portfolio is more sensitive to economic fluctuations than the market, and its profitability is far higher than the market average. Under the general environment that the epidemic situation is slowly improving, and the stock market is recovering, it can be concluded that this portfolio has excellent investment value. Overall, these results offer a guideline for portfolio construction for a certain industry.

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