The Use of Portfolio Theory in Investment

Danni Li

Business School, The University of Melbourne, Victoria, 3010, Australia

danni3@student.unimelb.edu.au

Abstract. This paper focuses on the application of portfolio theory to practical investment. The main research objects of this paper are the Industrial and Commercial Bank of China (601398) and China Yangtze Power Company (600900) and determine this portfolio's feasibility and risk-return characteristics. This research evaluate this portfolio's potential benefits and risks by analysing the historical data of the two companies and the stock market. The research adopts the portfolio theory, through the analysis of historical data, calculates the return rate, standard deviation and Sharpe ratio of ICBC and China Yangtze Power Company stocks to evaluate their performance in the past. The results show that the ICBC and China Yangtze Power Company stock portfolios have shown good returns over the past few years and have relatively low volatility. In general, the stock portfolio of ICBC and China Yangtze Power Company has specific investment potential in the Chinese market. Still, investors should carefully consider their personal risk preferences and investment objectives.

Keywords: Portfolio theory, investment decision-making, risk management.

1 Introduction

Portfolio theory is one of the most influential theories in modern finance, which provides a method to optimise asset allocation to maximise the expected return of investors and minimise risk. This paper discusses the basic principles and fundamental concepts of portfolio theory and its application to practical investment. With the introduction of national policies such as the Federal Reserve's interest rate hike, the investment market has heated up in recent years. There is an increase in investment products, and more and more people use their funds for investment activities. Most investors are risk-averse, meaning they are willing to sacrifice some of their returns for less risk, but a few are eager to pursue higher returns, even if the risk is high [1]. However, most investors do not know how to choose reasonable and correct investment products, and only a few will use portfolio theory to help them make investment decisions. The reason for this may be that most investors do not understand the theory or know little about it and do not know how to apply it. This paper will introduce portfolio theory to investors and provide an example of how it can be used to build a portfolio. For this purpose, this research will use portfolio theory to construct investor portfolios based on invested

B. Siuta-Tokarska et al. (eds.), *Proceedings of the 2024 2nd International Conference on Management Innovation and Economy Development (MIED 2024)*, Advances in Economics, Business and Management Research 300,
https://doi.org/10.2991/978-94-6463-542-3_61

assets. The financial assets selected in this paper are the Industrial and Commercial Bank of China Stock (601398) and China Yangtze Power Company (600900).

The Industrial and Commercial Bank of China (ICBC) is one of the largest commercial banks in China. In recent years, with the steady growth of China's economy and the expansion of its financial business, ICBC's operating income has shown a steady growth trend, and profits have risen accordingly. ICBC has maintained a sound level of capital adequacy in recent years, which provides a solid guarantee for dealing with various risks and responding to regulatory requirements. The global banking industry has experienced digital transformation in recent years. Technological innovation and the application of information technology have improved service efficiency and customer experience while costs have been reduced. Despite the growth in operating income, the bank's profit margin came under some pressure due to the uncertainty and risk in the financial market. Therefore, many banks are seeking new profit growth points, such as increasing the proportion of fee income and developing new financial products and services. Overall, ICBC has maintained solid economic performance in recent years.

China Yangtze Power Company (600900) has maintained a solid financial performance as one of China's largest hydropower power generation enterprises. Its primary revenue comes from hydropower, thermal power, and new energy power generation business. Changes in government energy policies, fluctuations in energy demand, and changes in market competition may all impact its performance. At the same time, China Yangtze Power Company has shown some concern in sustainable development. As a hydropower power generation enterprise, it pays attention to clean energy, environmental protection, and sustainable development. The company may actively promote technological innovation and industrial upgrading to improve power generation efficiency, reduce costs, and cope with market competition and environmental pressure.

The portfolio theory can help investors reduce overall risk and achieve more stable investment returns by collecting different financial assets, securities, or instruments. As in the above example, investors can have both stock and debt to balance stock market fluctuations and seek fixed income. The rest of this paper will introduce the portfolio theory in detail and how to use it to select the optimal solution of investment, introduce the investment characteristics of the selected financial assets, explain the approximate calculation process, and use the theory to find the ratio of the optimal solution of the portfolio, and finally summarise the whole article.

2 Methodology

Portfolio theory considers risk not as the variance of return on individual financial assets but as the interaction of variances between different types of financial assets in the portfolio. It quantifies the trade-off between return and risk and aims to minimise portfolio variation at a given return level. The theory suggests efficient diversification by investing in securities with low return correlation rather than simply holding many different securities. Institutional portfolio managers widely accept it as a portfolio structure and performance measure. It helps market participants to make informed decisions regarding capital allocation, contributing to the efficiency of financial markets [2][3].

The expected return of a portfolio is calculated as a weighted average of the returns of all included assets. In contrast, the standard deviation of the portfolio represents the inherent risk of the portfolio. Portfolio developers rely on past returns and relevant information to form expectations for returns and variability for each asset. The theory involves selecting weight vectors for assets, determining the proportion of each asset to be purchased in the total investment, and ensuring that the sum of the weights is 1. By analysing past returns and covariance matrices of asset returns, portfolio managers can optimise their portfolios to achieve the desired balance between risk and return [3]. Since the stock market has various risks, portfolio investment can also minimise these risks.

Systematic risk and unsystematic risk are two key components that influence the volatility in stock returns in the capital market. Systematic risk, also known as non-diversifiable risk, is associated with market-wide changes and affects the market as a whole. On the other hand, unsystematic risk, also called diversifiable risk, is specific to individual companies and can be mitigated through the diversification of portfolios. By diversifying their investments across multiple stocks to form a portfolio, investors can reduce unsystematic risks, although these risks should still be considered, as shown in Figure 1. The results suggest that both types of risk play a significant role in determining the expected return of portfolios, providing valuable insights for investors in their decision-making processes [4].

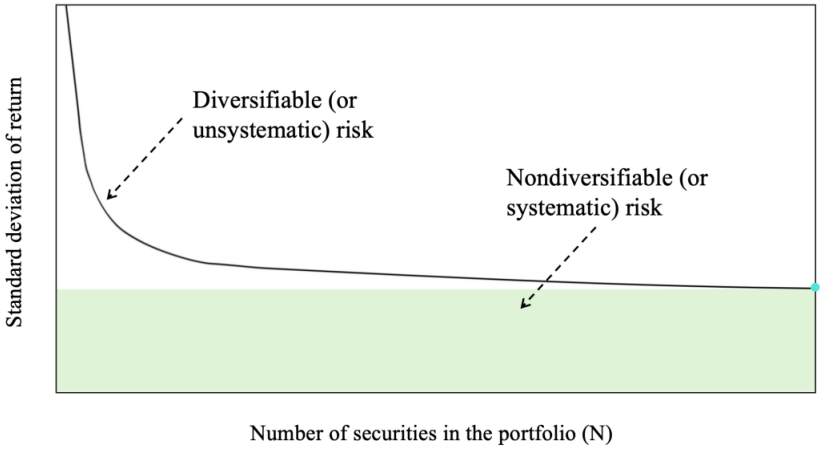

Fig. 1. The number of securities in the portfolio with systematic and unsystematic risk

Most people exhibit risk aversion due to their preference for known chances of outcomes over unknown chances, a phenomenon known as ambiguity aversion. The objective of a risk-averse investor is to minimise the risk of the portfolio, given the expected level of expected return, or to maximise the expected return of the portfolio if the expected level of risk is achieved [5].

The expected return is the outcome measured as the weighted average of the individual outcomes. Equation 1 shows how to calculate the expected return of a portfolio,

$$E(r_p) = \sum_{i=1}^{n} w_i E(R_i) \quad (1)$$

The standard deviation of the portfolio is used to measure the volatility of returns and is calculated as shown in Equation 2,

$$\sigma_p = (\sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i,j=1,i\neq j}^{n} w_i w_j Cov_{i,j})^{0.5} \quad (2)$$

After calculating the expected return and standard deviation, the investors could use these two data and the risk-free rate to find the Sharpe ratio of this portfolio. It is calculated as the return on the portfolio minus the risk-free rate, divided by the portfolio's standard deviation; the detailed calculation formula is shown in Equation 3 below. Generally speaking, a high and positive Sharpe ratio indicates that the portfolio has performed well with the risk taken, while a low or negative ratio suggests underperformance [6].

$$\text{Sharpe ratio} = \frac{E(r_p) - R_f}{\sigma_p} \quad (3)$$

3 Analysis

In this section, the optimal solution of the ratio of two financial assets will be obtained by importing the data found on the official website into Excel and calculating it using the formula contained in it. This paper's main analysis objects are the ICBC and China Yangtze Power Company stocks. To make better portfolio investments for these two financial assets, the stocks' closing prices for each month from February 2023 to February 2024 from Sina Finance, as shown in Table 1 below.

After obtaining these data, the author calculated the monthly investment growth rate with the data between each two months. Since the analysis need to use the annual growth rate for subsequent calculations, the investors can multiply the calculated monthly increasing rate by 12 to get the annual percentage rate (APR). The APR for China Yangtze Power Company is presented in Table 2, while the data for ICBC are presented in Table 3.

Table 1. The data of the stock prices of each month from 2023/02 to 2024/02

	China Yangtze Power Company (600900)	ICBC (601398)
2023/02	21.16	4.03
2023/03	21.25	4.18
2023/04	21.88	4.43
2023/05	22.51	4.53
2023/06	22.06	4.52
2023/07	21.46	4.77
2023/08	22.06	4.62
2023/09	22.24	4.68
2023/10	22.57	4.73
2023/11	22.83	4.81
2023/12	23.34	4.78
2024/01	24.40	5.17
2024/02	25.05	5.33

Table 2. The increasing rate and APR for China Yangtze Power Company (600900)

	China Yangtze Power Company (600900)	Increasing rate	APR
2023/02	21.16		
2023/03	21.25	0.43%	5.10%
2023/04	21.88	2.96%	35.58%
2023/05	22.51	2.88%	34.55%
2023/06	22.06	-2.00%	-23.99%
2023/07	21.46	-2.72%	-32.64%
2023/08	22.06	2.80%	33.55%
2023/09	22.24	0.82%	9.79%
2023/10	22.57	1.48%	17.81%
2023/11	22.83	1.15%	13.82%
2023/12	23.34	2.23%	7.18%
2024/01	24.40	4.54%	7.18%
2024/02	25.05	2.66%	31.97%

Table 3. The increasing rate and APR for ICBC (601398)

	ICBC (601398)	Increasing rate	APR
2023/02	4.03		
2023/03	4.18	3.72%	44.67%
2023/04	4.43	5.98%	71.77%
2023/05	4.53	2.26%	27.09%
2023/06	4.52	-0.22%	-2.65%
2023/07	4.77	5.53%	66.37%
2023/08	4.62	-3.14%	-37.74%
2023/09	4.68	1.30%	15.58%
2023/10	4.73	1.07%	12.82%
2023/11	4.81	1.69%	20.30%
2023/12	4.78	-0.62%	-7.48%
2024/01	5.17	8.16%	97.91%
2024/02	5.33	3.09%	37.14%

To get the average annual return of each asset, investors can use the formula in Excel to calculate the expected return of the two assets, the standard deviation, and their covariance, shown in Table 4.

Table 4. The expected return, standard deviation, and covariance of two assets

	China Yangtze Power Company (600900)	ICBC (601398)
Expected return	11.66%	28.81%
Standard deviation	21.11%	36.05%
Covariance	-0.99%	

Covariance is a statistic that measures the relationship between two variables, and in the case of financial assets, covariance indicates the correlation between them. The above table shows that the covariance of these two financial assets is negative, -0.99%, which shows a negative correlation. Specifically, a covariance of -0.99% indicates that when the yield on one financial asset rises, the yield on another financial asset is likely to fall,

After completing the above calculation, investors can then use 'Solver' in Excel to find out under what proportion the Sharpe ratio of these two financial assets is the largest. The restriction when using 'Solver' is that the sum of the weights of the two assets must equal 1. The final weights are shown in table 5,

Table 5. The weights of the two assets and their Sharpe ratio

	China Yangtze Power Company (600900)	ICBC (601398)	Total
Weight	0.5858	0.4141	1

The above calculation will obtain the optimal solution ratio for the two stocks, China Yangtze Power Company and ICBC, as 0.5858:0.4141. This weight ratio means that when investors invest $10,000, they need to invest $5858 in the stock of China Yangtze Power Company and the remaining $4141 in the stock of ICBC to achieve the optimal solution.

Once the investors have obtained the optimal solution for this portfolio, they can use the weights corresponding to these two assets under this portfolio to calculate the expected return and standard deviation using the formula mentioned in the above section. These data are shown in table 6 below,

Table 6. The expected return and standard deviation of the portfolio

The expected return of the portfolio	18.76%
The standard deviation of the portfolio	18.11%

These data imply a return of $18.76 per $100 for the portfolio, representing a high return. However, the portfolio has an annualised volatility of 18.11%. Shows that its volatility is relatively high. It also means that the portfolio's return may fluctuate significantly, which may bring more significant risk to investors. Considering the expected return and standard deviation, this research will apply the Sharpe ratio to evaluate this portfolio.

A Google search shows that China's risk-free rate is about 2.37% [7]. In this way, analysis can obtain the portfolio's maximum Sharpe ratio by the portfolio's return rate, standard deviation and risk-free interest rate, as shown in table 7 below.

Table 7. Sharpe ratio for the portfolio and the risk-free rate

Risk-free rate	2.37%
The expected return of the portfolio	18.76%
The standard deviation of the portfolio	18.11%
Sharpe ratio	0.91

Sharpe ratio measures the relationship between return and risk of a portfolio or asset. A Sharpe ratio of 0.91 means the average portfolio earns an excess return of 0.91 per unit of risk. This also represents the more favourable relationship between the return and risk of the portfolio. This should be due to the high return of ICBC stock and the low risk of China Yangtze Power Company. At the same time, a high Sharpe ratio indicates that the portfolio can perform well in different market environments, which may attract more investors, especially those who seek high returns and are willing to take some risk.

4 Conclusion

This paper investigates how portfolio theory should be practised in the Chinese market. The researcher used portfolio theory to construct a portfolio for investors about ICBC and China Yangtze Power Company stocks.

First, this analysis provide a comprehensive financial analysis of two companies, ICBC and China Yangtze Power Company, and explain why they were chosen. As one of the largest commercial banks in China, ICBC has maintained solid financial performance over the past few years and has a strong market position in the banking industry. As a leading hydropower power generation enterprise in China, the stable cash flow and sustainable profitability of China Yangtze Power Company provide particular attractiveness for its stock investment.

Second, this research analyse the industry and market environment in which the two firms operate. China's financial and energy industries are experiencing rapid development and change, subject to policy, technology, and market competition. However, ICBC and China Yangtze Power Company have certain competitive advantages and market positions in the industries in which they operate, which provide specific guarantees for their future development.

Next, the author conduct a detailed analysis of the investment performance of the stock portfolios of ICBC and China Yangtze Power Company. By calculating the historical rate of return, standard deviation, and Sharpe ratio, it find that this stock portfolio has shown good returns over the past few years and has relatively low volatility. The shares of ICBC and China Yangtze Power Company have performed steadily in different market environments, delivering considerable returns to investors.

However, despite the excellent performance of the ICBC and China Yangtze Power Company stock portfolios, investors still need to consider with caution. Market uncertainty, macroeconomic factors' impact, and changes in industry competition may all affect investment performance. Therefore, investors should consider their individual risk preferences and investment objectives comprehensively and adopt appropriate risk management strategies.

In conclusion, the stock portfolio of ICBC and China Yangtze Power Company has specific investment potential in the Chinese market. Still, investors should treat it rationally, carefully evaluate the market situation and formulate appropriate investment strategies.

Reference

1. Van den Bergh-Lindeque, A., Ferreira-Schenk, S., Dickason-Koekemoer, Z., & Habanabakize, T. (2022). What makes risk-averse investors tick? A practitioners guide. Cogent Economics and Finance, 10(1).
2. Leković, M. M. (2021). Historical development of portfolio theory. Tehnika, 76(2), 220-227.
3. Zhang, X., Jin, X., Fuller, R. A., Liang, X., Fan, Y., & Zhou, Y. (2023). Using modern portfolio theory to enhance ecosystem service delivery: A case study from China. JOURNAL OF ENVIRONMENTAL MANAGEMENT, 347, 119064. Sukrianingrum, D. R., & Manda, G. S. (2020). The effect of systematic risk and unsystematic risk on expected return of optimal portfolio. SAR (Soedirman Accounting Review): Journal of Accounting and Business, 5(2), 181-195.
4. Sukrianingrum, D. R., & Manda, G. S. (2020). The effect of systematic risk and unsystematic risk on expected return of optimal portfolio. SAR (Soedirman Accounting Review): Journal of Accounting and Business, 5(2), 181-195.
5. Stefánsson, H. O., & Bradley, R. (2019). What is risk aversion?. The British Journal for the Philosophy of Science.
6. Vidal, M., & Vidal-García, J. (2023). Sharpe ratio: International evidence. Available at SSRN 2765647.
7. Trading Economics. (n.d.). China Government Bond Yield.