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China's Low-altitude Economy Sector: Portfolio Strategy Construction and Analysis

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Abstract: Markowitz's efficient frontier and the Capital Allocation Line (CAL) model, as classic paradigms for portfolio optimization, require theoretical and practical innovation in emerging industries, especially in risk-return optimization for innovation-driven sectors. This study, based on modern portfolio theory, constructs and empirically tests a five-asset allocation strategy for China's low-altitude economy. It selects five stocks with positive average returns from December 2021 to December 2024 in relevant fields (like airframe manufacturing, battery technology, and information navigation systems). Using monthly closing prices, it calculates individual stock return characteristics, analyzing their average returns, variance, and standard deviation. A multi-dimensional portfolio is built using a covariance matrix, the efficient frontier is determined through risk-return analysis, and a CAL is constructed with the 3-month Treasury bill risk-free rate to identify the optimal risk portfolio with maximum Sharpe ratio. The results demonstrate that the dynamic strategy's expected return (3.70%) significantly outperforms the CSI 300's average passive return (-0.46%) over three years, with controllable risk.

Keywords: Low-altitude economy, Portfolio analysis, Markowitz, Efficient frontier, Optimal risky portfolio

1. Introduction

The low-altitude economy (LAE) is an emerging vision for integrating unmanned aerial vehicles (UAV) into logistics, mobility, and communication networks [1]. As a strategic emerging industry, the low-altitude economy features an extensive industrial chain and diverse application scenarios, playing a significant role in constructing modern industrial systems and holding immense development potential. Meanwhile, given the high technological requirements of related industries, the rapid development of the low-altitude economy will generate substantial funding gaps and diversified financial demands [2]. This paper explores the low-altitude economy from a financial investment perspective. Focusing on key sectors including complete aircraft manufacturing, battery technology, and information-navigation systems, five representative stocks with positive average returns from December 2021 to December 2024 are selected for empirical analysis. Monthly returns are calculated, and the average returns, variance, and standard deviation of each stock are analyzed. Covariance matrices are then constructed to form various investment portfolios.

This study further identifies the minimum variance portfolio and delineates the efficient frontier (Markowitz curve) based on the principle of maximizing returns at equivalent risk levels. Using 3-month Chinese government bonds as the risk-free rate, the Capital Allocation Line (CAL) is

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plotted, and the CAL with the maximum Sharpe ratio (the tangent point between CAL and the efficient frontier) is identified to determine the optimal risky portfolio. The CSI 300 index's three-year average investment return serves as the passive investment benchmark for portfolio evaluation. The findings aim to provide investors with more precise risk assessments and return forecasts, facilitating better identification of investment opportunities.

2. Literature review

In recent years, with the inclusion of the low-altitude economy in national strategic planning, academic research on it has deepened but remains unbalanced [3]. In the past three years, studies have focused on policy support systems and industrial chain structures. Some scholars have conducted systematic research on policies related to the overall architecture of low-altitude airspace and boosting productivity, emphasizing the catalytic role of policy innovation on industrial ecology [4,5]; others have used qualitative methods to explore the applications of low-altitude aircraft manufacturing, intelligent navigation systems, etc., and analyzed their synergistic effects with smart logistics, emergency rescue, etc. [6,7]. Current research has limitations: firstly, empirical analyses mostly rely on cross-sectional data, lacking dynamic tracking of long-term returns of investment targets; secondly, there's little research on the applicability of modern portfolio theory (such as the Markowitz model) in the low-altitude economy, with risk premium estimation and asset allocation strategies lacking theoretical support. Based on previous research, this paper constructs and empirically tests a five-asset allocation strategy for China's low-altitude economy based on modern portfolio theory.

3. Date collection

This study selects five stocks from the low-altitude economy sector in China with positive average returns from Dec. 2021 to Dec. 2024. Their monthly closing prices are exported to calculate monthly returns. The data is shown in Figure 1 [8].

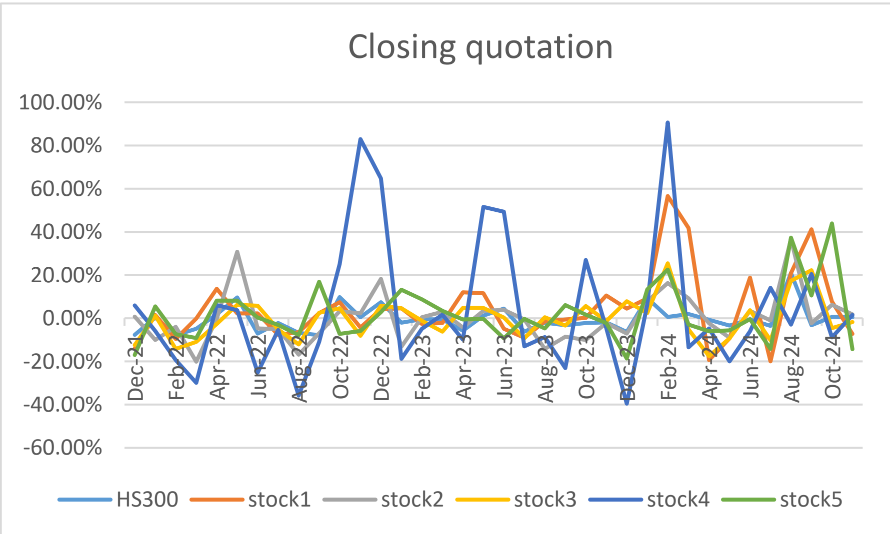

Figure 1: Raw data (closing quotation)

By analyzing these data, this paper calculated each stock's average return, variance, and standard deviation, laying a foundation for follow-up portfolio analysis.

The formula for calculating the monthly return is as follows:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{1}$$

Here, Pt and Pt−1 represent the stock's closing prices in month t and month t−1, respectively.

The formula for the average monthly return is:

$$\overline{R} = \frac{\sum_{i=1}^{n} R_i}{n} \tag{2}$$

where, $\overline{R}$represents the average return, R_i indicates the stock return for month i, and n denotes the total number of months (36 in this case).

Variance calculation formula:

$$s^2 = \frac{\sum_{i=1}^{n}(R_i - \overline{R})^2}{n-1} \tag{3}$$

where, s^2 denotes the sample variance.

Standard deviation:

$$s = \sqrt{s^2} \tag{4}$$

where, s denotes the sample standard deviation.

As shown in Table 1 below, the average return (Avg R) is obtained, sample variance (Var), and sample standard deviation (Std) of five low-altitude economy stocks and the CSI 300 over the past three years.

Table 1: Average return, variance, and standard deviation

	CSI300	stock1	stock2	stock3	stock4	stock5
Avg_R	-0.46%	4.28%	0.14%	-0.25%	3.90%	1.82%
Var	0.003621	0.025898	0.013609	0.009043	0.093864	0.017967
Std	0.060178	0.160929	0.116657	0.095093	0.306372	0.13404

Furthermore, this study constructs a covariance matrix using the following covariance formula:

$$\mathrm{Cov}(X, Y) = \frac{\sum_{i=1}^{n}(x_i - \overline{x})(y_i - \overline{y})}{n-1} \tag{5}$$

where, $\mathrm{Cov}(X, Y)$ represents the covariance between two stocks, x_i and y_i, indicating the returns of two stocks in month i, and $\overline{x}$ and $\overline{y}$ denote the average returns of these two stocks (i.e., the aforementioned $\overline{R}$).

Table 2 presents the constructed covariance matrix.

Table 2: Covariance matrix

Cov	stock1	stock2	stock3	stock4	stock5
stock1	0.025179				
stock2	0.006783	0.013231			
stock3	0.011146	0.004618	0.008792		
stock4	0.014371	0.015196	0.010441	0.091256	
stock5	0.010012	0.006908	0.005991	0.004077	0.017468

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4. Portfolio construction

Next, this study randomly generated 2,000 different weight combinations in Excel, attached to the five stocks to construct diverse portfolios. By calculating the portfolio standard deviation and return, the investable region was plotted.

Portfolio Return:

$$R_p = \sum_{i=1}^{n} \omega_i R_i \tag{6}$$

where, R_p denotes the portfolio return, ω_i and R_i represent the weight and return of asset i respectively.

Portfolio standard deviation:

$$\sigma_P = \sqrt{\sum_{i=1}^{n} \omega_i^2 \sigma_i^2 + 2\sum_{i=1}^{n} \sum_{j=1;j\neq i}^{n} \omega_i \omega_j Cov(X_i\,, X_j)} \tag{7}$$

ω_i and ω_j are the weights of the i - th and j - th assets in the portfolio, σ_i^2 is the variance of the i - th asset.

Figure 2 shows the constructed investable region, with the x-axis representing portfolio standard deviation and the y-axis representing portfolio return.

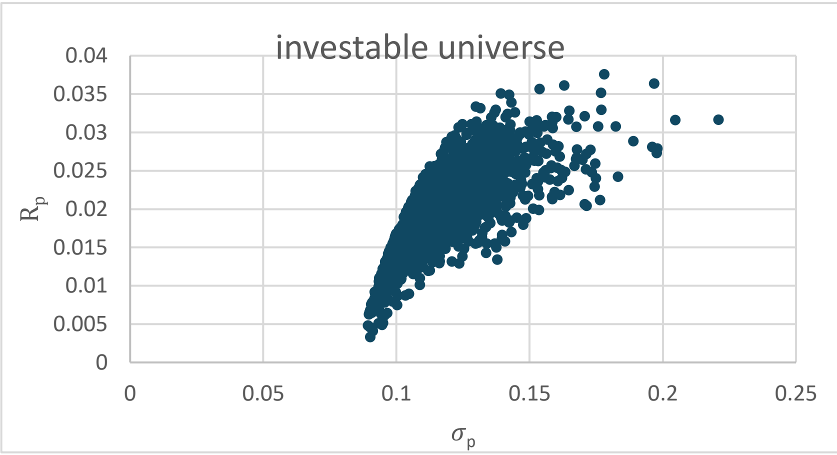

Figure 2: Investable region

Next, the minimum-variance portfolio was identified, and the efficient frontier (Markowitz curve) was plotted based on the principle of maximizing returns for a given standard deviation.

The efficient frontier, a fundamental principle in modern portfolio theory, was initially introduced by economist Harry Markowitz in 1952. It denotes the collection of portfolios that provide the highest anticipated return for a specified degree of risk or the lowest risk for a designated expected return [9]. This frontier is shown as a curve on a coordinate system, with risk (standard deviation) on the x-axis and expected return on the y-axis. Portfolios along this curve are optimal as they yield the most return for a given level of risk.

Figure 3 shows the efficient frontier, with the x-axis representing portfolio standard deviation and the y-axis representing portfolio return.

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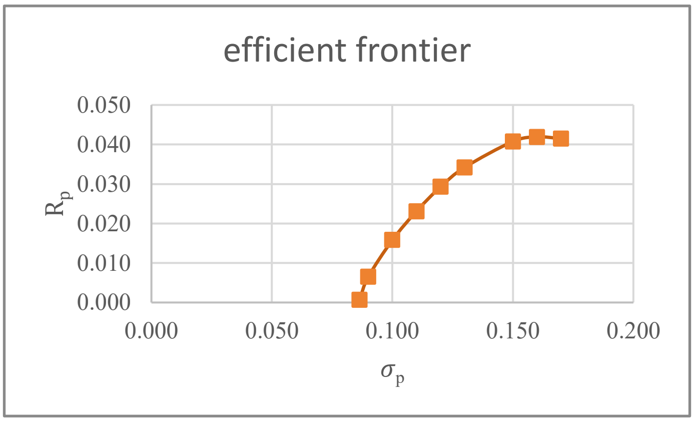

Figure 3: Efficient frontier

This paper utilized a 3-month Chinese government bond as the risk-free return to draw the Capital Allocation Line (CAL), seeking the CAL curve with the maximum Sharpe Ratio, which was the tangent of the efficient frontier. The point of tangency is the optimal risky portfolio.

Capital Allocation Line (CAL):

$$E(R_c) = R_f + \frac{E(R_p) - R_f}{\sigma_p} \cdot \sigma_i \tag{8}$$

$E(R_c)$ indicates the expected return of the portfolio with the risk - free asset, R_f represents the risk - free asset return, and $E(R_p)$ is the expected return of the risky asset portfolio.

Figure 4 below illustrates the CAL.

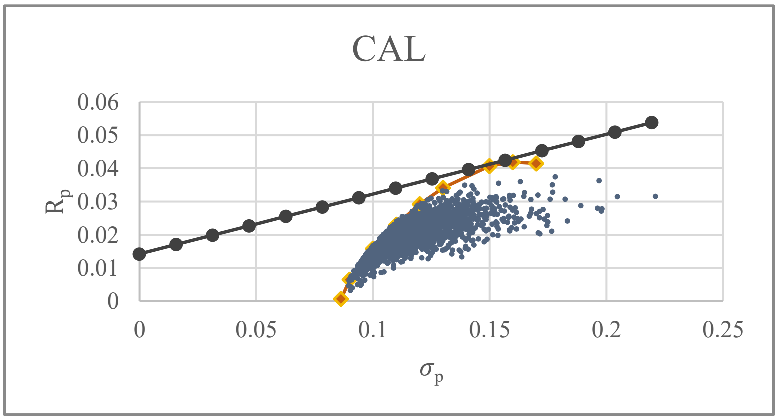

Figure 4: Optimal CAL curve

To ensure adequate portfolio diversification, each asset in the portfolio is restricted to no less than 5%. Using planning and solving methods, the optimal risky investment portfolio is obtained as shown in Table 3 below, where "std" represents the portfolio standard deviation and "Rp" represents the portfolio return.

Table 3: Optimal risky portfolio

stock1	stock2	stock3	stock4	stock5	sum	std	Rp
78.13%	5.00%	5.00%	6.87%	5.00%	100.00%	14.27%	3.70%

Finally, this study obtained the weights of each stock in the asset class and the portfolio's variance and expected return. Using the CSI 300's average return (-0.46%) over the past three years as a passive investment benchmark, the portfolio's return (3.70%) outperforms the passive investment.

5. Discussion

This study validates the relevance of modern portfolio theory in the nascent low-altitude economy by developing a five-asset portfolio. However, there are two limitations. (1) The sample time span (2021.12-2024.12) does not cover a complete technology cycle [10,11]. Future research could extend the observation window (e.g., 2015-2030). (2) Future studies should focus on the impact of technology cycle turning points and relevant policies, such as the landing of airworthiness certifications for multiple companies after 2024 and the opening of eVTOL pilots in Hefei, Hangzhou, Shenzhen, Suzhou, Chengdu, Chongqing, etc. (3) This study constructs a single -asset- class portfolio and does not include cross-industry assets. The correlation between assets in the investment class is high, so it is recommended that investors combine other less correlated asset classes to better reduce non-systematic risk (β) during investment [12].

6. Conclusion

By constructing and analyzing a five-asset portfolio in China's low-altitude economy, this study offers investors a scientific tool for risk assessment and return forecasting. Compared to the CSI 300, this portfolio has achieved higher returns, highlighting the investment potential in the low- altitude economy. The optimal risk portfolio, identified through the efficient frontier and CAL, provides the highest expected return on a risk-adjusted basis. Future research can enhance covariance estimation with high-frequency data, incorporate dynamic factor models to capture the impact of technological change on asset pricing, and explore cross-sector allocation strategies with new energy and AI. These improvements would contribute to the robustness and adaptability of the portfolio.

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