

Investment Strategy Based on the Fama-French Three-Factor Model and Risk Parity in the A-Share Market

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Abstract: Changes in the global landscape, including epidemics and wars, have led to dramatic shifts in the global economic situation. In the current domestic economic situation, economic development is facing a series of challenges and opportunities. Therefore, as an investment, an appropriate strategy should be adopted to balance the benefits and risks. This paper aims to verify the feasibility of an investment strategy that can balance risk and return in the A-share market. Previous academic research has rarely explored and validated this method for the A-share market, thus presenting an opportunity to address this gap and inspire further research. This paper combines the multi-factor model with the principle of risk parity, and verifies and analyzes it mainly in the A-share market. This paper will validate this investment strategy using past data and then illustrate that this investment strategy has certain feasibility and practical value in the A-share market.

Keywords: Fama-French Model, Risk Parity, Investment, Finance.

1. Introduction

The research of this paper mainly focuses on verifying a multi-factor risk parity model, which has certain practicability in the actual investment field. Previous research indicates that the multi-factor model represents an optimization of the traditional CAPM model based on real-world conditions, while the principle of risk parity is a common allocation method in investment portfolio. However, at present, there are few researches combining the two to analyze the A-share market in China, and there is a certain gap in this field. Similar studies include the risk parity investment strategy and empirical research based on risk factors conducted by Professor Zheng Zhiwei of Jinan University. However, his research is the consideration of the global comprehensive market, and does not focus on the Chinese securities market. Therefore, this paper aims to demonstrate the feasibility of this method using actual data from the A-share market and to provide insights for other researchers. In addition, the paper will validate the model's effectiveness through theoretical analysis and practical data. The goal is to integrate the traditional multi-factor model into contemporary investment methods and provide theoretical support for the multi-factor model and the risk parity principle. However, this investment strategy still has some room for progress in the selection of factors and the proportion of risks. These problems will be solved gradually in the future.

2. Current Situation of A-share Market

2.1. Risks of A-share Market Investment

In the A-share market, the proportion of retail investors is relatively large and the number of institutional investors is small. The global epidemic and geopolitical tensions have exerted pressure on China's and even the global economic development, contributing to significant volatility in the A-share market. Therefore, effective risk management is crucial to achieving high returns while navigating this volatility.

The A-share market is characterized by its reliance on scientific and technological innovation for medium- and long-term growth, but it is easily affected by hot events in the short term. Therefore, managing market volatility remains a critical concern for A-share investors.

From the perspective of the first half of the year, the main index bottomed out and then met a correction, and the market rose and fell so that investors repeatedly experienced a "roller coaster". Affected by the tightening of the IPO rhythm, the number of new shares issued this year has dropped significantly, but the money-making effect of new shares has recovered. For the "second half" market, the outlook of market institutions believes that the probability of shock in the second half of the year is greater[1].

2.2. The Investment Trend of A-share Market

The asset side has formed support under the moderate recovery of the economy, while the debt side is still under certain pressure. The market is expected to shake up in 2024. In this context, two notable trends are emerging. For the first trend, it is still difficult for valuations to improve systematically. However, as the US interest rate hike is coming to an end, the pace of foreign capital outflows is expected to slow, potentially providing a positive impact on A-shares. For the second trend, style value continues to outperform growth, but it is expected to form a switch from small to large, central state-owned enterprises accounted for a high proportion of market value and dividends and other styles may have trend opportunities[2].

In the current economic environment, it can be seen that investors are still full of confidence in A-shares and trust in the overall upward trend. However, based on the special situation of A-shares, short-term shocks will continue to occur, which also requires short-term investors to balance the relationship between risk and return. Investors can achieve sound investment results through integrated and real-time strategies.

3. Constitution of the Integrated Strategy

In 2022, Ray Dalio, founder of Bridgewater Associates, LP, said that in now increasingly challenging macro environment, diversification is critical[3]. T. Roncali & G. Weisang analyzed an investment group by decomposing portfolio risk into risk factor contributions, combining diversification methods, and determining the weight of each asset in the portfolio[4]. Therefore, investment diversification has become a key focus in the A-share market. This investment strategy aims to diversify the portfolio and reduce total risk.

3.1. Fama-French Model

In 1992, Fama and French studied the factors influencing the return rates of different stocks in the American stock market. They found that the beta value of the stock market could not fully explain the differences in stock return rates, and identified that the market value, book-to-market ratio, and price-to-earnings ratio of listed companies could explain the difference. Fama and French argued that

the excess returns in these factors are compensation for risk elements not captured by beta in the Capital Asset Pricing Model (CAPM).

The model holds that the excess return of a portfolio (including individual stocks) can be explained by its exposure to three factors: market asset portfolio (MKT), market capitalization factor (SMB), and book-to-market ratio factor (HML).

This multi-factor equilibrium pricing model can be expressed as:

$$r_t = \beta_{MKT} \times MKT + \beta_{SMB} \times SMB + \beta_{HML} \times HML$$

The adoption of the three-factor model in this paper is due to its operational efficiency. In addition, in practice, there may be multiple factors that normally generate risk. Principal Component Analysis (PCA) can be employed to orthogonalize these factors, thereby reducing their correlation[5].

3.2. Risk Parity

Risk parity is an advanced portfolio technique often used by hedge funds. This allocation seeks to generally target a hypothetical risk level graphed at the intersection of the efficient frontier and capital market line. In simplified allocation strategies using just stocks and bonds, allocations are usually more heavily weighted towards equities for investors willing to take on more risk. Risk-averse investors will typically have a higher weight in bonds for capital preservation. This performance can also be seen as an attempt to make asset risk as equal as possible.

In the simplest approach, a risk-parity portfolio is based on a set of assets. Approximately $1/\sigma_i$ will be allocated to each N asset class. Intuitively, the method subtracts less portfolio weight is assigned to stocks, thus assigning more of the total variance to other sources of risk. However, this approach overlooks the correlation between the variances of the selected asset classes. A more sophisticated concept of risk parity, developed by Goldman Sachs, is based on risk factors. This approach involves creating a set of risk factors and then decomposing and optimizing the assets in the portfolio according to these factors. The core of this strategy is balancing the risk factors contained within the assets. Therefore, this paper considers the correlation between underlying assets, studies the weight scores of each asset, and performs a historical back testing on the combinations. However, there are few studies on risk quantification in China.

4. Comprehensive Strategy

4.1. Content of Strategy

The strategy combines the multi-factor model with the principle of risk parity, utilizing the risk relationships between the factors to achieve stable portfolio returns. This is a real-time change strategy that requires real-time data related to the stocks in the portfolio and ultimately solves the overall problem of the investment ratio.

(1) The first is to calculate the residual required for the investment strategy.

$$\sigma_{MKT} = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (MKT_t - \overline{MKT})^2}$$

$$\sigma_{SMB} = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (SMB_t - \overline{SMB})^2}$$

$$\sigma_{HML} = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (HML_t - \overline{HML})^2}$$

(2) The second is to calculate the marginal risk contribution of the portfolio.

$$mrc_i = \sum_{j=1}^n \omega_j \sigma_{ij}$$

ω_j : The weight of stock j

σ_{ij} : Covariance of stock i and j

(3) Third, to calculate the areal risk contribution of a factor within the portfolio.

$$rc_{Factor} = \sum_{i=1}^n \omega_i \beta_{i,Factor} \sigma_{Factor}$$

ω_i : The weight of stock i

$(\sum \omega)_i$ & $(\sum \omega)_j$: Marginal risk contribution of assets

(4) Fourth, to determine the optimal weights.

$$\min_{\omega} \sum_{i=1}^n \sum_{j=1}^n (\omega_i (\sum \omega)_i - \omega_j (\sum \omega)_j)^2$$

n: The number of assets

ω : A weight vector for an asset

$(\sum \omega)_i$ & $(\sum \omega)_j$: Marginal risk contribution of assets i and j (mrc)

Based on the practical data, the strategy demonstrates substantial revenue in a stable overall market trend with minor changes. However, when some special market changes occur, the utility of this model often has a certain lag. The portfolio is characterized by low volatility and is suitable for a stable and rising overall market environment. However, this investment strategy may not yield as good short-term returns as other portfolios[6].

China's A-share market conforms to the characteristics of an adaptive market, but from Hu Hao's research, the applicability of the three-factor model still has certain deficiencies[7].

4.2. Adjustments Based on Facts

Based on the comparative analysis of specific data, it can be noted that the traditional three-factor model has some disadvantages in the fitting ability of valuation. Therefore, the principal component analysis method is introduced to update the model. Assume that there are n types of configurable assets, the return rate of asset I is $r = [r_1, r_2 \cdots r_n]^T$; the volatility of asset I is $\sigma = [\sigma_1, \sigma_2 \cdots \sigma_n]^T$; the covariance matrix of asset I is $\Sigma = (\sigma_{ij})_{n \times n}$; the proportion of investment is $\omega =$

$[\omega_1, \omega_2 \cdots \omega_n]^T$. Therefore, the rate of return of the portfolio is $r_p = \omega^T r$ and the standard deviation is $\sigma_p = \sqrt{\omega^T \Sigma \omega}$. Decompose Σ into N orthogonal eigenvectors $\Sigma = E \Lambda E^T$, and the Λ is the diagonal matrix constructed of the eigenvalues of Σ , E is the eigenvector matrix of sigma.

The weight of the original combination is ω , the weight of the macro factor combination is $E^T \omega$. The risk contribution of each macro factor to the macro portfolio is:

$$RC_i = (E^T \omega)_i \frac{(\Lambda E^T \omega)_i}{\sqrt{\omega^T E \Lambda E^T \omega}}$$

For this comprehensive risk parity model, the contribution level of factors to the total risk should be consistent. It is also necessary to carry out quadratic optimization to obtain the optimal weight as mentioned above. The risk parity model of the principal component analysis method mainly shows excellent volatility control in the performance of specific markets, and the principal component analysis method gives it the possibility of efficient use of factors[8].

The application of principal component analysis can be seen as an expansion of the traditional CAPM model, which is more suitable for the current investment market.

4.3. Room for Improvement

As for the setting of risk weights, there are also weighted integration and elimination methods, which can establish a feasible risk appetite model. Relevant research outputs have been produced, including those by authors Tian Jun and Huang Dengshi.

What's more, traditional portfolio construction methods based on data analysis use simple statistical models, which are not only difficult to find market rules, but also inefficient in processing large amounts of data. The deep reinforcement learning algorithm has powerful data processing and analysis capabilities. These algorithms can adaptively adjust strategies, extract effective information from massive financial data, deal with complex and changeable market environments, and provide scientific advice for investment decisions.

There are already researchers using deep learning and artificial intelligence to incorporate these 21st century novelties into quantitative investing. Therefore, continuous efforts and breakthroughs are essential for exploring models and methods. In the foreseeable future, it is anticipated that more effective approaches will emerge for determining factors, adjusting stock selection, and optimizing weights, ultimately leading to improved investment returns.

5. Discussion of Integrated Strategies

The Capital Asset Pricing Model (CAPM), as the seminal asset valuation framework, has long been revered for its epoch-making contributions to financial theories and practices. Despite its profound impact, the model's straightforward assumptions often fall short when confronted with the complexities of real-world market environments. To address these limitations and enhance its practical applicability and adaptability, we have integrated the risk parity investment model with the foundational principles of the CAPM.

The approach utilized in this paper leverages the risk parity model to more effectively apply factor analysis within the CAPM framework. The empirical results of this integration have demonstrated significant practical value, particularly in terms of controlling the volatility of investment returns in the A-share market. Unlike traditional neutral investment strategies such as the 60/40 portfolio—which typically allocates 60% to equities and 40% to bonds—this method transcends the mere broad

categorization of asset classes. It derives critical investment factors from quantifiable data, allowing for a dynamic and data-driven adjustment of portfolio weights based on these factors[9].

Building on the success of this innovative strategy, further refinement was achieved by incorporating Principal Component Analysis (PCA) and integrating macroeconomic factors. PCA is a statistical technique that simplifies the complexity of high-dimensional datasets by identifying the most influential variables, thereby facilitating more accurate market analysis and prediction. Insights from PCA and macroeconomic indicators enable more agile portfolio adjustments in response to varying economic cycles and market conditions [10].

6. Conclusion

Real-world applications confirm that this enhanced strategy—combining risk parity, PCA, and macroeconomic analysis—has yielded substantial benefits in both risk control and performance metrics. This novel approach not only enhances the stability of the investment portfolio but also delivers superior returns, even amid fluctuating market environments.

In conclusion, the integration of the risk parity model with CAPM, augmented by PCA and macroeconomic factors, represents a significant innovation in asset valuation and investment strategy. This comprehensive approach overcomes the limitations of traditional investment models, offering a more flexible and effective method for portfolio management. It provides investors with robust tools to achieve stable and optimal returns, particularly in the dynamic context of the A-share market.

References

- [1] Sun Jie. *The A-share market "first half" ended* [N]. *Beijing Daily*, 2024-06-29(007). DOI: 10.28033/n.cnki.nbjrb.2024.003680.
- [2] Li Yang (CN). 2024. *Outlook for the A-share market strategy in 2024: from the theme to the main line*. https://data.eastmoney.com/report/zw_strategy.jshtml?encodeUrl=dbhwU9AftoiKTx+7XWReDrVC4kDbSDnii9iQm6QCCAY=
- [3] Zhou Ailin. *Bridgewater founder Dalio: All-weather strategy to allocate Chinese assets* [N]. *China Business News*, 2022-01-11(A07). DOI: 10.28207/n.cnki.ndycj.2022.000094.
- [4] Roncalli T, Weisang G. *Risk Parity Portfolios with Risk Factors*[J]. *Quantitative Finance*, 2016, 16 (3): 377-388
- [5] Guo Shangzhi, Liao Xiaofeng, Li Gang, et al. *Application of big data dimensionality reduction based on PCA* [J]. *Computer Simulation*, 2024, 41 (05): 483-486.
- [6] Zheng Zhiwei. *Risk parity investment strategy and empirical research based on risk factors* [J]. *Modern Business*, 2024, (08): 103-106. DOI: 10.14097/j.cnki.5392/2024.08.030.
- [7] Wang Xi. *Study on the adaptability of China's A-share market based on the Fama-French three-factor model* [J]. *China Market*, 2023, (21): 10-14. DOI: 10.13939/j.cnki.zgsc.2023.21.010.
- [8] Fang Fang, Dong Zhiyuan. *How to choose the allocation ratio of major asset classes?* [J]. *Modern Commercial Bank*, 2024, (06): 56-61.
- [9] Tian Jun, Huang Dengshi, Guo Yaohuang. *Weighted integration method for optimal decision-making of multi-factor securities portfolio investment* [J]. *Systems Engineering - Theory and Practice*, 2001, (08): 87-91+110.
- [10] Li Bin, Pan Qiao, Yan Xiping. *Portfolio construction method based on deep reinforcement learning* [J]. *Intelligent Computers and Applications*, 2024, 14 (08): 85-90. DOI: 10.20169/j.issn.2095-2163.240814.