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Analysis on the Differences between the Four-Factor Model of Chinese and International Markets and Research on Optimization Paths

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Abstract: This study focuses on the four-factor model of the Chinese market and the international market, and deeply analyzes the differences between the two. By combing the development context and constituent elements of the four-factor model, combined with the particularity of A-shares, a Chinese version of the model is constructed and compared with the international market model to analyze the factor performance and model effect. The study found that the models of the two markets have commonalities in development and composition, but there are significant differences in market environment, factor performance, etc., and each has its own advantages and disadvantages in explaining stock returns. Based on this, the direction of model optimization, cross-market analysis and method improvement is proposed for subsequent research, in order to provide reference for investors and market research.

Keywords: Four-factor model; Chinese market; International market.

1. Introduction

In finance, determining stock portfolio returns is crucial. Theoretically, from the capital asset pricing model to Fama and French's three-factor model, and then Carhart's four-factor model, each step deepens our understanding of the stock market. The four-factor model is widely used internationally, explaining over 90% of portfolio changes and serving as a key standard for assessing fund returns and investment managers' abilities.

However, China's securities market has unique features like "shell pollution," complex IPOs, and low approval rates. Many small-cap company stocks are influenced by "shell value," which is disconnected from their operating conditions. This interferes with traditional model backtesting and market anomaly explanations. Additionally, China's investor structure impacts asset pricing. Thus, comparing China's and international markets' four-factor models is highly significant for model optimization, investment decisions, market regulation, and academic research. This study aims to comprehensively compare these models, analyzing their similarities and differences in development, composition, factor performance, and effects, to provide a valuable reference for model optimization and application.

2. Theoretical Basis of The Four-Factor Model

2.1. Development History

The four-factor model was developed based on the three-factor model. The three-factor model proposed by Fama and French covers market factors, scale factors and book-to-market factors, and builds an important framework for explaining stock returns. Subsequently, Carhart observed the key role of momentum effect in investment decisions, incorporated momentum factors into the model, and constructed a four-factor model. This expansion enables the model to more comprehensively control market risks and other systemic risks, improves the ability to explain the abnormal returns of investment portfolios, and gradually becomes an industry standard in the international financial field.

Many empirical studies have shown that in the regression analysis of the return of hybrid open-end funds based on the four-factor model, the modified R^2 is mostly greater than 0.90, and the excess returns of most funds are not significant. The explanatory power of Fama's three-factor model in developed countries and regions has reached 95%, confirming the effectiveness of the four-factor model in the international market.

2.2. Model Composition

The four-factor model consists of market factor, size factor, book-to-market ratio factor and momentum factor.

Market factors reflect the impact of overall stock market fluctuations on individual stock returns. When the market rises or falls, individual stock returns are usually affected in the same direction.

The size factor is the difference between the average returns of a small-scale stock portfolio and a large-scale stock portfolio, reflecting the impact of stock size on returns. Although small-scale stocks have higher risks, they may have higher growth potential. In contrast, large-scale stocks tend to be more stable.

The book-to-market ratio factor is the difference between the average returns of high and low book-to-market ratio stock portfolios, reflecting the differences in investors' preferences for value and growth stocks. Stocks with high book-to-market ratios are mostly value stocks, while stocks with low book-to-market ratios tend to be growth stocks.

The momentum factor reflects the momentum effect of stocks. The momentum effect captures the characteristic that stock prices continue to follow the original trend over a period of time. If the stock has performed well in the past, it may continue to rise in the future, otherwise it may fall.

3. Analysis of the Characteristics of China's A-Share Market

3.1. "Shell Pollution" Problem and Its Impact

China's A-share market is seriously "shell-polluted". IPOs are cumbersome and have a low approval rate, which has led to backdoor listings, such as SF Express's backdoor listing of Dingtai New Materials. Many small-cap companies have "shell value", and their stock prices and earnings are decoupled from the company's actual operating conditions. This phenomenon interferes with the accuracy of model backtesting. In order to reduce the impact of "shell pollution", in subsequent research, this study excluded the smallest 30% of A-share market capitalization stocks, which account for about 7% of the total market value.

3.2. IPO Complexity and the Prevalence of Backdoor Listings

The complexity and low approval rate of IPOs in China have led to the widespread phenomenon of backdoor listings. This special market condition makes the A-share market significantly different from mature markets such as the United States. Some market anomalies are difficult to explain with the traditional three-factor model, which also prompted this study to conduct in-depth exploration and improvement of the four-factor model applicable to the Chinese market.

4. Research Methods

4.1. Data Selection

This study selected the A-share market data of mainland China from January 1, 2000 to December 31, 2016, and the data came from the Wind database. The data after 2000 were selected because the accounting system in China was imperfect before 2000, and the financial data of listed companies were poorly comparable and small, which could not meet the sample size requirements. During the data processing, the 30% of stocks with the smallest market value were eliminated to reduce the interference of "shell pollution" on the research results.

4.2. Model Construction

4.2.1. Quantification of Chinese Market Value Factors

Following the research path of Fama and French, the value factor of the Chinese market is defined as the difference between the average returns of a portfolio of stocks with a high book-to-market ratio and a portfolio of stocks with a low book-to-market ratio. In data processing, in addition to eliminating stocks affected by "shell pollution", we also draw on relevant research to introduce investor sentiment factors to optimize the construction of value factors. The investor sentiment factor is constructed by principal component analysis, selecting sentiment proxy variables such as closed-end fund discount rate, number of new A-share accounts, turnover rate, number of IPO issuances, and price-earnings ratio.

4.2.2. Construction of the Chinese version of the three-factor model CH-3

The Chinese version of the three-factor model CH-3 is an improvement on the Fama and French three-factor models. In the construction process, the 30% of companies with the smallest market value are first eliminated to reduce the impact of shell value pollution; secondly, the earnings price ratio (EP) is used to replace the book-to-market ratio (BP) to construct the value factor. Existing studies have shown that EP has a stronger ability to explain stock returns.

4.2.3. Construction of CH-4 model with emotional indicators

The investor sentiment factor constructed through principal component analysis is added to the CH-3 model to form the CH-4 model. This model aims to better capture the impact of investor sentiment in China's A-share market on stock returns and enhance the model's ability to explain the market's excess returns.

4.3. Comparative Analysis Method

By calculating factor returns and conducting correlation analysis, the performance differences of each factor in the four-factor model between the Chinese market and the international market are compared. Using regression analysis, the significant changes in the model before and after the addition of the momentum factor, as well as the performance differences of the related factors constructed based on the four factors in the two markets, are compared to evaluate the model's ability to explain stock returns.

5. Model Empirical Results and Analysis

5.1. Factor Performance Differences

5.1.1. Momentum Factor Reversal Characteristics

In China's A-share market, the momentum factor shows a significant reversal effect, which is different from the usual positive momentum performance in the international market. The A-share market investors are mainly individuals and are highly speculative, which makes the stock price trend unique. In the Carhart four-factor model A-share empirical study, the return curve shows that the momentum effect of A-shares is not obvious, the reversal characteristics are prominent, and the reversal factor returns are concentrated in the short position. In addition, the short-selling restrictions in the A-share market have also exacerbated the asymmetry of the reversal.

5.1.2. Momentum Factor Correlation

In the A-share market, the momentum factor has a low correlation with the market factor, size factor, and book-to-market ratio factor, indicating that their performance is relatively independent and may be driven by different factors. This low correlation is different from the international market situation, further reflecting the uniqueness of the performance of factors in the Chinese A-share market.

5.1.3. Explanatory power of CH-3

The improved Chinese version of the three-factor model CH-3 has a certain ability to explain stock returns. From the perspective of value factors, Liu, Stambaugh, and Yuan (2018) showed that after excluding the smallest 30% of stocks by market value, using EP to replace BP to construct value factors has stronger explanatory power. Introducing sentiment factors can optimize the model. This factor is constructed through relevant proxy variables, which can better capture market dynamics and improve the ability to explain excess returns.

Market factors, scale factors and momentum factors also provide support for the CH-3 model. However, the CH-3 model has limitations, the "shell pollution" problem still interferes, and the market differences caused by the

complexity of IPOs make some anomalies difficult to explain. Further improvement is needed to adapt to the Chinese market.

5.2. Comparison of Model Effects

5.2.1. Impact of Momentum Factor on Model Significance

In the Chinese market, after adding the momentum factor, the momentum coefficient is negative in most regressions, mainly due to the reversal contribution. However, the p-value of the four-factor regression coefficient shows that the addition of the momentum factor does not reduce the significance of the coefficient, indicating that it can add new information to the three-factor model and improve the model effect. In the international market, the four-factor model has a strong ability to explain fund returns, and the modified R^2 is mostly greater than 0.90, which can effectively explain changes in the investment portfolio.

5.2.2. Effect of Correlation Factor Construction Based on Four Factors

In the Chinese market, analogous research has been conducted to construct correlation factors based on the four factors, but the effect has not been significantly improved. In the international market, the four-factor model is widely used in yield forecasting, risk management, fund performance evaluation, etc., and the long-short strategy backtesting has excellent performance, but it also faces problems such as the limited number of A-shares that can be shorted and transaction costs affecting returns.

6. Research Conclusion

6.1. Model Similarities

The four-factor model has the same development roots in the international market and the Chinese market. Both are expansion results of incorporating momentum factors into the three-factor model. This evolutionary model has improved the ability of the models in both markets to explain portfolio changes, providing a more comprehensive analytical framework for investors and market researchers. In terms of model components, the basic definitions and functions of market factors, size factors, book-to-market factors, and momentum factors are similar in both markets. The market factor reflects the systematic impact of overall market volatility on individual stock returns, the size factor reflects the difference in returns between large and small-cap stocks, the book-to-market factor measures the difference in investors' preferences for value and growth stocks, and the momentum factor captures the continuity of stock price trends. They jointly build a theoretical foundation for explaining stock returns from different dimensions, which provides a basic framework for cross-market comparative studies and model applications.

6.2. Model Differences

A - share market has prominent "shell pollution", so researchers need to exclude certain stocks to reduce interference. The international market doesn't have this problem. The complex IPO process and low pass rates in China's A - share market lead to widespread backdoor listing. This impacts the market's traits and model suitability. Traditional three - factor models struggle to explain market anomalies here. Also, the momentum factor in China's A - share market has a significant reversal effect, differing from the positive momentum effect in international markets. It has low correlations with other factors and acts more independently. This reflects differences in investor behavior and market structure between the two markets.

6.3. Explanatory Power of Stock Returns

In China's market, adding momentum factors enhances the three-factor model's explanatory power for stock returns, but issues like "shell pollution" limit the CH-3 model, making some market anomalies hard to fully explain. The international four-factor model explains over 90% of portfolio changes and is widely applied. Yet, it's not flawless and faces challenges such as ineffective long-short strategies in rising markets and return impacts from transaction costs.

In summary, the Chinese and international four-factor models differ significantly. Practitioners must consider these differences and tailor the model to each market's characteristics. Investors should align model use with the market environment and their risk profiles to devise investment strategies. Market researchers, by examining these differences, can enhance asset pricing theory and bolster market development.7. Research Prospects

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7.1. Model Improvement Directions

In model improvement, for value factors, we've explored multi - dimensional data to find suitable indicators for China's market, and enhanced model stability and adaptability.

Moreover, we've integrated macroeconomics and industrial policies into the model and utilized big data to mine social media and news for investor sentiment monitoring. We've also constructed four - factor models by industry and sector, expanded the sample data's time span and diversity, and employed cross - validation to boost the model's applicability and stability.

7.2. Cross-Market Research Directions

Contrast international and Chinese markets. Examine the four-factor model differences in market structure and investor behavior. This supports Chinese market reform and informs global asset allocation. Also, analyze major events' impact on the model across markets to improve risk management and investment decisions.

7.3. Improvement Directions of Empirical Research Methods

Leverage big data to mine market data, boost construction efficiency and enhance model prediction accuracy. Process data scientifically by removing outliers and determining the optimal data frequency. Establish a robust model validation and evaluation system, and assess model performance using out - of - sample forecasting and cross - validation.

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