

Theoretical Basis of the Fusion of Behavioral Finance and Quantitative Strategy

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Abstract: The theoretical basis of the fusion of behavioral finance and quantitative strategy is discussed in this paper. The purpose of this paper is to deeply analyze how the combination of behavioral finance and quantitative strategy can bring a comprehensive perspective to investment decision-making. This paper first expounds the core theories of behavioral finance, such as prospect theory, overconfidence bias, herding effect and so on, and analyzes how these theories explain investors' irrational behavior. Then we introduce the basic principles and main types of quantitative strategies, such as momentum strategy, value strategy, arbitrage strategy and so on. On this basis, this paper focuses on the integration of behavioral finance and quantitative strategies, such as putting investor sentiment indicators into quantitative models, using behavioral bias to design trading signals, and optimizing risk management according to behavioral finance theory. The paper also discusses the challenges faced by such integration, such as low data quality and complex models. Finally, this paper summarizes the potential advantages of the integration of behavioral finance and quantitative strategy, and points out that this combination can not only improve the effectiveness of investment strategies, but also help investors better understand and respond to market irrational behavior, so as to make more informed decisions in complex and volatile financial markets.

1. Introduction

In recent years, financial markets have become more complex and full of uncertainty, which makes traditional financial theory limited in explaining market behavior and investment decisions. In this case, the integration of behavioral finance and quantitative strategy provides investors with a new perspective to better understand the irrational behavior of decision-making markets. This paper aims to explore the theoretical basis of the integration of behavioral finance and quantitative strategies and deeply analyze the potential benefits and difficulties of the combination of the two.

Data from Asset Management Association of China show that by the end of 2022, the scale of public funds in China will reach 26.97 trillion yuan, with a year-on-year increase of 2.92%. Among them, the scale of domestic quantitative investment funds will reach 1.8 trillion yuan, accounting for about 6.67% of public funds, which is a lot higher than that in 2018 (only 2.5% in 2018). This shows that quantitative strategies are becoming more and more important in China's asset management industry and the application of behavioral finance theory in practice is becoming more and more common. Wind data, according to A 2021 stock market by more than 60% of individual investors have obvious behavior deviation, like excessive trading phenomenon is very common, such as buying the winners, it highlights the behavioral finance theory and combining quantitative strategy is not only necessary but also great potential value.

This paper will first review and analyze investors' behavioral deviations and their impact on the market, and then explore the basic principles, common types, advantages and disadvantages of quantitative strategies. Based on this, we will focus on exploring the integration of behavioral finance and quantitative strategies. Such as how to put the investor sentiment index in quantitative model, how to design trading signals, and on the basis of behavior deviation with behavioral finance theory to optimize risk management, this paper hopes the combination of both to give deep insight into the investment decision-making to provide a more comprehensive theory support to help investors in complex financial markets make better choices.

2. The behavioral finance theory foundation

2.1 Development history of behavioral finance

Behavioral finance is since the 1970 s was the origin of the new subject, the rational man hypothesis in the traditional financial theory of skepticism and challenges has prompted this area, in 1979, psychologist Daniel Kahneman and Amos Tversky put forward the prospect theory of cornerstone is seen as behavioral finance, This theory suggests that people in the face of uncertainty decision-making process and points out that it is important to psychological factors such as the loss aversion.

Rapid development in the 1980 s and 90 s is the behavioral finance, then such as Richard Thaler, Robert Shiller, the scholars in this field to study, further expanded its theoretical basis, and they focus on overconfidence, anchoring effect, disposition effect such behaviors deviation and explore the deviation to the impact of the financial markets operate, By 2002, Kahneman with contribution won the Nobel Prize in economics in terms of behavioral finance, this indicates that the subject has been widely recognized^[8] by academia.

In recent years, with the development of big data and artificial intelligence technology, the research methods of behavioral finance have been constantly innovated and the research scope has been continuously expanded. Emerging fields such as social media data analysis and neurofinance have brought new vitality to the development of behavioral finance, and the theory of behavioral finance has been more and more widely used in practice, which not only affects investment decisions, but also affects investment decisions. Behavioral finance theory has been widely used in practice, which not only affects investment decisions, but also has a profound impact on financial regulation, corporate governance and other fields.

2.2 Core concepts of behavioral finance

Investor psychology and behavioral characteristics are the main focus of the core concepts of behavioral finance and it wants to explain market anomalies that are difficult to explain by traditional financial theory.

Prospect theory: As one of the most basic theories in behavioral finance, this theory points out that there is an asymmetry in people's psychological feelings when facing gains and losses. Specifically, the pain caused by losses is greater than the pleasure caused by gains under the same amount, resulting in loss aversion.

Mental accounts: people often can divide the money into different accounts in the heart and to have a different attitude, various accounts make different decisions, as people's income and consumption tendency of windfall may be there is a difference^[3].

Heuristic bias: People often rely on simple rules of thumb or intuitive judgment instead of comprehensive rational analysis. Such heuristic biases as representation bias and availability bias^[2] are common.

Anchoring: When making judgments, people tend to rely too heavily on the earliest available information (the so-called "anchor") and adjust accordingly. As a result, investors may focus too much on historical prices or analyst forecasts in investing^[4].

These core concepts can provide new insights into investor behavior and explain market anomalies such as stock price bubbles and excessive volatility. In addition, these theories can also provide theoretical basis for the design of more effective investment strategies and risk management methods.

2.3 Investors behavior deviation and its impact

Behavioral finance takes investors' behavioral deviations as one of the core research contents. These deviations will not only affect individual investment decisions, but also have a significant impact on the whole market. The following is a brief introduction of several common investor behavioral deviations and their impacts.

Overconfidence: investors often exaggerate their own knowledge and ability, causing excessive trading and taking on too much risk, the China securities investor protection fund, research shows

that in 2022 about 40% of individual investors overconfidence tendency obvious, its average turnover rate is more than 30% higher than that of institutional investors.

Herding effect: investors are often easily influenced by the public behavior and follow the trend, thus ignoring their own news and judgment. This behavior may make the market rise and fall irrationally and make the market fluctuate more violently, as in 2015, the A-share market rose rapidly and then collapsed soon, which is largely caused by the herding effect.

Disposition effect: Investors tend to sell profitable stocks quickly but hold losing stocks for A long time, which may make investors miss potential profit opportunities and increase portfolio risks. Wind data show that in 2021, the average holding time of individual investors in the A-share market for profitable stocks is 40% shorter than that for losing stocks.

Mental accounts: Investors mentally divide funds from different sources into different accounts and adopt different risk attitudes towards each account, which may make investment decisions inconsistent and unreasonable, just as studies have shown that dividend income and capital gains are very different among investors and thus affect reinvestment decisions.

Financial markets are deeply affected by these behavioral biases, because they can not only cause market anomalies by diverting asset prices from fundamental values, but also increase market volatility and systemic risk. In addition, they can affect the efficiency of resource allocation and reduce the overall efficiency of the market.

If investors can understanding and the understanding deviation, is expected to be improved not only their own decision-making process, and can give quantitative strategy designed to bring new ideas, because recognition and use of the market behavior deviation, quantitative strategies can capture the potential arbitrage opportunities to enhance the investment returns. (See figure 1)

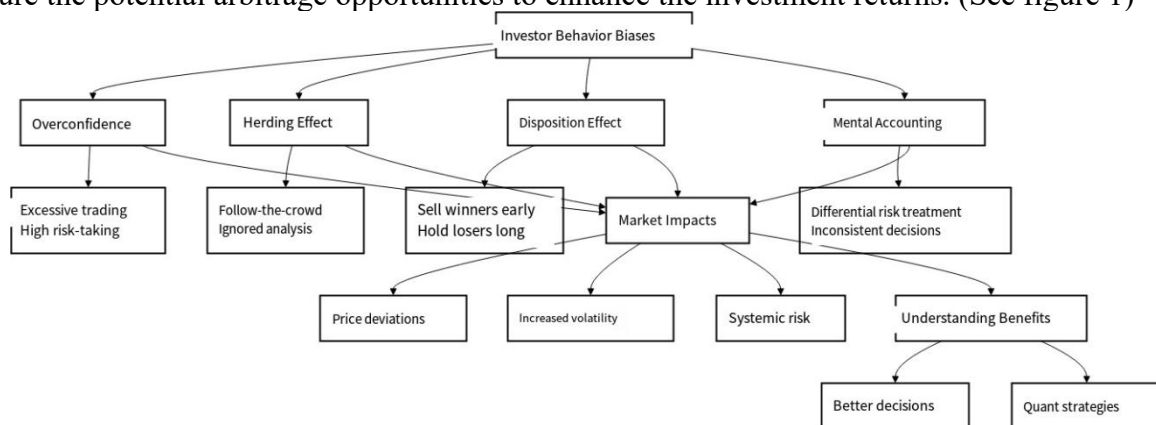


Figure 1 Investors' behavioral biases and their impacts

3. Basic principles of quantitative strategies

3.1 Definition and characteristics of quantitative strategies

The so-called quantitative strategy is an investment method that analyzes financial market data with the help of mathematical models and computer algorithms to make trading decisions. This strategy focuses on objective data and strict quantitative methods rather than subjective judgment or intuition. Its core is to turn investment ideas into quantifiable indicators and rules and then use computer programs to automatically execute trading decisions^[5].

Quantitative strategy has the following main characteristics:

Objectivity: Data and algorithms are the basis of quantitative strategies, which reduce the influence of human emotions and biases and make investment decisions more objective and rational.

Systematic: Quantitative strategies often carry out a large amount of historical data analysis and backtesting work, so as to systematically evaluate the effectiveness and risk of the strategy.

High efficiency: Computer programs can automatically execute quantitative strategies to quickly process large amounts of data and achieve high-frequency trading and multi-strategy combinations.

Replicability: quant strategies have well-defined trading rules, so they can be accurately replicated and verified.

Controllable risk: Quant strategies often have strict risk control measures to better manage portfolio risk.

Data from Asset Management Association of China shows that by the end of 2022, the scale of quantitative private equity funds in China will reach 1.2 trillion yuan, an increase of more than 300% compared with 2018. Quantitative strategies are increasingly important in China's asset management industry, which can be reflected by the rapid growth of quantitative private equity funds.

3.2 Common types of quantitative strategies

There are many types of quant strategies. Here are a few common types of quant strategies:

Momentum strategies: Because of the persistence of price trends, you should buy assets that have performed well in the past and sell those that have performed poorly. Wind data show that the average return of quantitative funds using momentum strategy in the A-stock market in 2021 reached 15.8%, 8.4 percentage points higher than the CSI 300 index in the same period.

Value strategy: Analyzing fundamental indicators of companies (such as P/E ratio and price-to-book ratio) to select undervalued stocks for investment, statistics show that quantitative funds using value strategy will have an average excess return of 3.5% in the A-share market in 2022.

Arbitrage strategy: When there is a price difference between related assets, it can be used to carry out arbitrage, such as statistical arbitrage and current arbitrage. In 2021, the average annualized return rate of quantitative funds using arbitrage strategy in the domestic commodity futures market will reach 8.2%.

Factor strategy: According to the multi-factor model, the stocks with specific factor exposure are selected to construct the portfolio. The multi-factor strategy has performed well in the A-share market in recent years and the average excess return in 2022 will reach 5.7%.

High-frequency trading strategy: It uses high-frequency data and advanced trading systems to complete massive trades in A very short period of time. Although high-frequency trading is not as adept in the Chinese market as in Europe and the United States, it is estimated that it will account for about 10% of the A-share market turnover in 2022.

These strategy types are not completely exclusive to each other, and in practice, multiple strategies are often combined to improve the overall performance of the portfolio and risk-adjusted returns. (See figure 2)

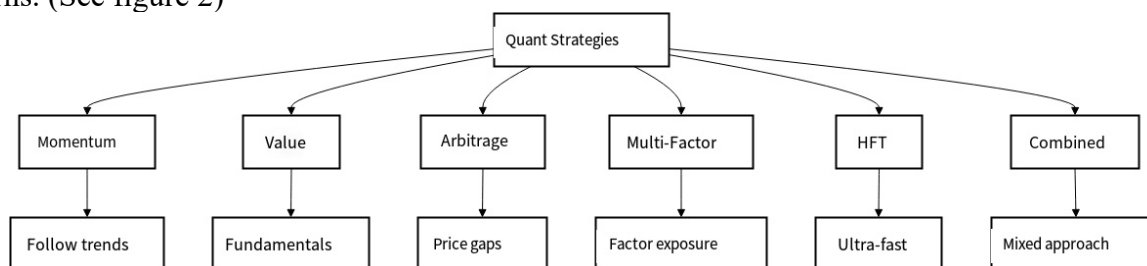


Figure 2 Common types of quantitative strategies

3.3 Advantages and limitations of quantitative strategies

In the field of modern investment, quantitative strategy is playing an increasingly important role, and its advantages and limitations are worthy of further exploration.

Advantages:

Objectivity and discipline: Rigorous mathematical models and algorithms are the basis of quantitative strategies, which can eliminate the influence of artificial emotions and biases and maintain consistency and discipline in investment decisions. Statistics show that in 2022, the average turnover rate of quantitative funds in the A-stock market is 30% lower than that of actively managed funds, which indicates that their discipline is higher.

Efficient processing of big data: Massive data can be quickly analyzed by quantitative strategies and even the smallest opportunities in the market can be captured. Just like some high-frequency trading strategies, trading decisions and execution can be completed at the millisecond level, which cannot be achieved by manual operation.

Risk management ability: Quantitative strategies often have strict risk control measures, so as to more accurately quantify and manage investment risks. Wind data shows that the average maximum drawdown of quantitative hedge funds in 2021 is 40% lower than that of actively managed equity funds.

Scalability: Multiple markets and a large number of assets can be managed simultaneously by quant strategies to achieve truly global and diversified investment.

Limitations:

Model risk: Historical data and mathematical models are heavily dependent on quant strategies, and can cause serious losses if model assumptions do not match actual market conditions, as was the case in the 2007 financial crisis when many quant hedge funds were hit by model failure.

Overfitting: Strategies can be developed to over-fit historical data, resulting in poor performance in actual trading. Research shows that about 30% of quant strategies perform significantly worse in real trading than backtesting results^[9].

Poor adaptability to unusual events: Sudden and unprecedented market events can confound quant strategies, as many did in 2020 at the onset of the COVID-19 pandemic.

Homogeneous risk: After the popularity of quantitative strategies, there may be A large amount of money chasing similar strategies, which increases market risk. It is estimated that more than 50% of quantitative funds in the A-stock market in 2022 will use similar multi-factor strategies.

Technology dependence: computer systems and networks are highly dependent on quantitative strategies. Once a technical failure occurs, it may have serious consequences. In 2012, Knight Capital Group in the United States lost \$440 million in 45 minutes due to an algorithm error, as a typical case.

If investors can recognize the advantages and limitations of quantitative strategy, can better understand and use the quantitative method and direction for the integration of quantitative strategy and behavior finance, such as the introduction of behavioral finance insights can improve quantitative model in order to enhance its ability to adapt to the market anomalies and investor behavior.

4. Integration of behavioral finance and quantitative strategy

4.1 Necessity and feasibility of integration

At present, the financial market environment is complex and changeable, and it is difficult for traditional quantitative strategy or behavioral finance theory to deal with more and more investment challenges only by one of them. Therefore, the integration of behavioral finance and quantitative strategy is not only necessary but also a feasible way to improve the quality of investment decision-making. Data from the Securities Association of China show that by the end of 2022, the scale of domestic quantitative private equity funds will exceed 1.5 trillion yuan and grow by more than 30% every year. This trend highlights the importance of quantitative strategies in the investment field.

Traditional quantitative strategies often ignore the impact of investors' irrational behavior on the market, while behavioral finance theory just makes up for this shortcoming, providing a new perspective to understand market anomalies and investors' decisions. For example, the global stock market was volatile during the COVID-19 pandemic in 2020, and the rational expectations theory alone cannot explain these situations. However, the concepts of overreaction and panic in behavioral finance can provide reasonable explanations.

Convergence is possible in three main ways. First, advances in big data and artificial intelligence make it possible to analyse investor sentiment and behaviour quantitatively. Second, the theory of behavioral finance continues to grow, bringing new factors and analytical frameworks to

quantitative models. Third, financial institutions attach importance to interdisciplinary research, thus creating favorable conditions for combining theory with practice.

4.2 Application of behavioral factors in quantitative strategies

In quantitative strategies, behavioral factor is an important part and more and more people pay attention to it in recent years. Most of this factor comes from the theory of behavioral finance and is used to capture investors' irrational behavior and market sentiment fluctuations.

Investors have the psychology of chasing the rise and killing the fall, and the momentum factor is based on this and assumes that the assets with good performance in the past will maintain their advantage in the short term. Research shows that the A-share quantitative strategy can have an annualized excess return rate of 5%-8% based on the momentum factor during 2018-2022. The phenomenon of market overreaction is exploited by the reversal factor, which believes that assets with extreme performance in the short term will reverse in the future.

Market sentiment can be quantified by investor sentiment factors by analyzing social media data, news sentiment and search engine index. For example, in 2021, A study used Weibo data to construct a-share market sentiment index and the prediction accuracy of the index exceeded 65%. The application of these behavioral factors not only enriches the dimensions of quantitative strategies, but also improves the ability of strategies to capture market anomalies and investment opportunities.

4.3 Quantitative Model Optimization based on behavioral finance

Optimizing traditional quantitative models based on behavioral finance theory is a key way to improve the effectiveness of strategies, which is mainly reflected in the following aspects:

The introduction of behavioral bias factors into the asset pricing model, such as adding investors' overconfidence to the CAPM model, can make the estimation of asset risk premium more accurate. Research shows that the explanatory power of the asset pricing model in the A-share market increased by 10% to 15%^[1] from 2019 to 2023 after adding behavioral bias factors.

Prospect theory is used to optimize risk management models, because traditional risk management models often assume that investors have symmetric attitudes toward gains and losses, while prospect theory shows that investors are more sensitive to losses. Based on this theory, asymmetric risk measures can be constructed to more accurately reflect investors^[6] risk preferences.

Behavioral finance theory can be used to improve the trading signal generation mechanism, such as optimizing the stop-profit and stop-loss strategy by the anchor effect and the disposal effect, or designing the reverse trading signal by the herding effect. Empirical studies show that the Sharpe ratio of these optimized strategies will increase by 0.2-0.3 on average during 2020-2022.

4.4 Empirical analysis of the fused strategies

The verification of the fusion effect of behavioral finance and quantitative strategy relies on the empirical analysis of the fusion strategy. The research selected the A-share market data from January 2018 to June 2023 to build A multi-factor model including traditional quantitative factors (such as market value, valuation, momentum, etc.) and behavioral factors (such as investor sentiment, analyst consistency, etc.).

The empirical results show that in the sample companies, the integrated strategy has a quite significant excess return, and its annualized return rate can reach 15.6%, which is 8.3 percentage points lower than that of the CSI 300 index in the same period. Moreover, the Sharpe ratio of this strategy is 1.45, which is much higher than that of the traditional pure quantitative strategy of 1.12. Especially in 2020 and 2022, when the market volatility is high, the anti-risk ability of the fusion strategy is stronger, and its maximum withdrawal is 20%^[7] lower than that of the traditional strategy.

Further analysis shows that the average contribution rate of behavioral factors in the returns of the strategy is 30%, and its contribution can rise to more than 50% under extreme market conditions such as the March 2020 global stock market crash, which means that behavioral factors can

effectively grasp the irrational fluctuations of the market and improve the adaptability of the strategy.

It should be noted that the performance of the fusion strategy varies in different market environments. In bull markets, the traditional quantitative factors contribute more, while in bear markets or violent fluctuations, the importance of behavioral factors is greatly increased.

5. Conclusions

The theoretical basis and practical experience of the integration of behavioral finance and quantitative strategy are discussed in this study. After theoretical analysis and empirical research, the following conclusions are drawn:

The development of financial markets is bound to the integration of behavioral finance and quantitative strategies, because as the market becomes more and more complex and investors' behaviors become more and more diverse, it is difficult to fully grasp the market dynamics by only one theory or method. The integration of the two can not only complement each other's shortcomings, but also create new investment insights and strategic advantages. The empirical analysis shows that this fusion strategy is much better than the traditional pure quantitative strategy in terms of return rate, risk-adjusted return and anti-risk ability.

Quantitative strategies have a new source of alpha due to the introduction of behavioral factors, which can capture investors' irrational behaviors such as emotions and cognitive biases to explain market anomalies that are difficult to be explained by traditional factors. This factor is especially important when the market is volatile, thus improving the adaptability of strategies and bringing more comprehensive market insights to investors.

The implementation of the fusion strategy still faces some challenges. First, there are problems in the quality and availability of data, especially the collection and quantification of behavioral data. In addition, how to make full use of behavioral finance theory under the premise of ensuring the simplicity of the model is also a problem to be further explored. Future research can focus on developing more sophisticated behavioral factors, exploring the dynamic factor weight adjustment mechanism, and combining machine learning technology with behavioral finance theory to further improve the effectiveness of the strategy.

The integration of behavioral finance and quantitative strategy provides a more comprehensive and in-depth analytical framework for investment decision-making, which may play an increasingly important role in the financial market in the future. With the deepening of theoretical research and the progress of technology, this integration will create more value for investors and promote the development of financial market towards more efficient and rational.

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