Behavioral finance studies of irrational investor behavior: theoretical evolution and future directions

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Abstract. Behavioral finance is an interdisciplinary field that integrates psychology, economics, and neuroscience to better understand irrational investor behavior and its impact on financial markets. This paper reviews foundational theories such as prospect theory, mental accounting, overconfidence, and herding, while also highlighting the explanatory value of dual systems theory and social identity theory. It explores advancements in methodologies, including experimental economics, neuroeconomics, computational models, and natural experiments, to assess how behavioral biases influence asset pricing, volatility, and liquidity. Empirical evidence points to phenomena like overtrading, information neglect, and emotion-driven decision-making, which challenge market efficiency and stability. The paper also critiques current limitations in cross-cultural relevance, theoretical coherence, policy application, and methodological flexibility. It calls for the development of integrated bias models, expanded use of AI, and enhanced cross-market and interdisciplinary research to advance the theoretical and practical contributions of behavioral finance. This research deeply explore the shortcomings of existing theories and methods, and clearly propose the development direction of future research.

1 Introduction

Traditional financial theory is centered on perfect rationality and efficient market hypothesis, assuming that investors can always maximize their utility. However, over the past few decades, major abnormal events have occurred frequently in the financial market, such as the U.S. stock market crash in 1987, the Asian financial crisis in 1997, the bursting of the Internet bubble in 2000 and the global financial crisis in 2008. These events clearly highlight the difficulty of traditional theories in accurately explaining and predicting market fluctuations. This indicates that the actual behavior of investors is profoundly affected by a variety of irrational factors such as cognitive biases, mood swings and social interactions. As a result, behavioral finance has gradually emerged to explore the complexity and diversity of investor decisions and to reveal the irrational mechanisms by which market prices deviate from fundamentals. The purpose of this paper is to systematically review and analyze the latest

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research progress of behavioral finance, deeply explore the shortcomings of existing theories and methods, and clearly propose the development direction of future research.

2 Literature review

2.1 Theoretical foundations and key ideas

The theoretical roots of behavioral finance can be traced back to the Prospect Theory proposed by Kahneman and Tversky [1], which is widely regarded as one of the foundational achievements of behavioral finance. Prospect Theory breaks the rationality assumption of "maximizing expected utility" in traditional utility theory, and points out that investors' risk attitudes in the face of gains and losses are asymmetric, which is manifested as loss aversion: that is, people's painful feelings towards losses are usually greater than the satisfaction of equivalent gains. This asymmetry leads investors to be more inclined to take high risks in loss situations and to be conservative in profit situations, which in turn affects their portfolio allocation and liquidation behavior.

Subsequently, the Mental Accounting theory proposed by Thaler further reveals that human beings are not entirely rational in dealing with money but tend to divide funds into different "mental accounts" and manage them separately [2]. For example, there are psychological barriers to switching between daily expense accounts, investment accounts and emergency savings accounts. This psychological mechanism makes it possible for investors to deviate from rational allocation by refusing to stop losses in losing accounts due to account labeling effects, or by blindly investing more because of account "surpluses".

Barber and Odean empirically examined the existence of overconfidence (Overconfidence) based on trading data [3], pointing out that investors, especially male investors, tend to overestimate their own judgment and information mastery, resulting in an increase in the frequency of transactions and a decline in overall investment returns. This study reveals how cognitive biases systematically affect market participation behavior. They further proposed the Herding Effect theory, which emphasizes that investor behavior is susceptible to the influence of others and convergence, especially when information asymmetry or market sentiment is high. This herding behavior may lead to asset prices deviating significantly from the fundamentals in the short term, exacerbating the risk of market bubbles and financial instability [4].

In recent years, behavioral finance theories have been further expanded to include decision-making neural mechanisms and social behavior dimensions. For example, Dual-process Theory distinguishes the human thinking process into two paths: "System One" (fast, intuitive) and "System Two" (slow, rational), pointing out that in high-stress, high-uncertainty situations, System One dominates the decision-making process [5]. It is pointed out that in high stress and high uncertainty situations, system one dominates decision making and is more likely to lead to bias. At the same time, Social Identity Theory emphasizes that individuals shape their behavioral patterns in the context of group identity, suggesting that in financial markets, investors tend to give up their independent judgments driven by a sense of group affiliation, thus exacerbating herd behavior and market consensus expectations.

Taken together, these key theories build the logic underlying behavioral finance: investor behavior that deviates from rationality is not an episodic phenomenon, but stems from deep psychological structures, emotional reactions and social interaction mechanisms.

2.2 Comprehensive theoretical framework

Based on years of theoretical accumulation and empirical exploration, behavioral finance has gradually constructed a relatively systematic theoretical framework system, covering cognitive, emotional and social dimensions of behavioral deviation, and forming several sub-theories with explanatory power.

(1) Cognitive bias dimension

Cognitive bias mainly involves the systematic errors generated by investors in the process of information processing [6], typical examples are:Anchoring Bias: i.e., individuals rely excessively on initial information or reference points when making decisions, and find it difficult to adjust their judgment based on new information. For example, investors often use the historical high price as a psychological anchor point and are reluctant to sell at a low price.Representativeness Heuristic: Investors tend to generalize a small number of events into a general rule, such as believing that a stock's recent rise means it will continue to rise in the future, thus creating bubble trading. Availability Bias: Investors are susceptible to recent events or highly exposed information, e.g., media hype can magnify the attention of a certain asset class, leading to investment errors.

(2) Emotion-Driven Dimensions Emotions play an integral role in financial decision making. For example: Over-optimism/Pessimism (Optimism/Pessimism Bias) can lead to an imbalance in risk expectations, creating an over- or undervaluation of prices; Fear and Greed as an important psychological source of market volatility, in the extreme market common “selling wave” and “rush to buy” collective behavior [7]; Loss aversion and disposition effect also reflect the typical reaction path of investors driven by emotions against rational choice.

(3) Psychosocial Dimension

Individual behavior is often influenced by social interaction and group behavior, and this dimension can be analyzed through the following theories: Herding: This is caused by the individual's imitation of others' behavior under uncertain conditions, which may amplify the market fluctuations caused by information asymmetry [8]; Informational Cascade: Early investor behavior becomes “information” for subsequent investors, and even if the initial judgment is wrong, a “false consensus” may be formed; Social identity reinforces the consistency of behavior between individuals and groups, and inhibits independent analysis.

(4) Comprehensive Path Analysis

Under the macro perspective of behavioral finance, cognitive biases and emotional mechanisms at the individual level gradually spread through group interactions, thus affecting the overall performance of the market [9], such as changes in liquidity, price deviations, and the rise of systemic risk. The process can be summarized as: Psychological bias → irrational decision-making → group imitation/diffusion → market volatility and resource mismatch.This logical chain becomes the key to distinguish behavioral finance from traditional financial theory. It emphasizes that the financial market is not a static rational system, but an “emotional market” or “behavioral ecosystem” constantly shaped by the complexity of human behavior. Diversified Development of Methodology With the evolution of the research paradigm and the improvement of scientific and technological means, behavioral finance presents a significant diversification trend in methodology. These methods not only complement each other in theoretical verification, but also form a linkage effect in data acquisition, model construction and causal inference, which promotes the development of the field to a higher dimension of accuracy, dynamics and practicality. The main research methods can be summarized into the following four categories

3 Review of research methods

3.1 Experimental economics: a tool for causal identification of behavioral biases

Experimental economics, with controlled variables and randomized grouping as its core methodology, emphasizes the mechanisms of investor behavioral biases revealed through well-designed experimental settings [10]. For example, the use of virtual investment mandates or asset trading platforms in the laboratory allows for the observation of investors' behavioral responses in the face of different gain-loss structures, information revelation rhythms, or group pressures. By controlling the experimental conditions, researchers are able to effectively identify the specific manifestations and influence paths of biases such as loss aversion, anchoring effects, and overconfidence.

For example, scholars such as Camerer and Loewenstein have designed several experiments to test the effects of trading frequency, information heterogeneity, and expectation bias on asset price volatility. Such studies reveal that even in an environment of highly rational participants, the market may still generate bubbles, indicating that irrational mechanisms are endogenous.

However, experimental economics also faces certain limitations and is particularly challenged in terms of external validity. The experimental participants, who are mostly student samples, lack investment experience and face limited incentives, may not accurately represent the behavior of professional investors in real markets. In addition, the highly simplified nature of the experimental scenarios undermines the ability to model complex market environments. Therefore, although the method is highly persuasive in causal reasoning, its findings need to be further tested in real market data.

3.2 Neuroeconomics: revealing the brain mechanisms behind decision making

Neuroeconomics is a cross-discipline that has emerged in recent years, integrating neuroscience and behavioral economics to explore the neural activity patterns of investors in the decision-making process with the help of brain imaging techniques (e.g., fMRI, EEG). It has been found that the activation level of specific brain regions is significantly associated with investors' risk aversion, impulsive trading or irrational choices. For example:

Prefrontal cortex (prefrontal cortex): associated with long-term planning and inhibiting impulses;

Anterior insula (insula): highly sensitive to risk and loss;

Amygdala (amygdala): active in dealing with fear and market uncertainty.

Neuroeconomics not only reveals the biological basis of irrational behavior, but also provides new perspectives on the distinction between “innate behavioral biases” and “acquired information learning”. For example, the activation of different neural pathways in risky asset selection leads individuals to favor high-risk or low-risk options, and that this mechanism explains the occurrence of “emotional trading”.

However, there are practical obstacles to this approach. Firstly, the experimental cost is extremely high and the sample size is limited, which makes it difficult to promote it on a large scale; secondly, the interpretation of brain data needs to be cautious because the mapping relationship with external behavioral data is highly complex; and lastly, it has not yet been widely applied to financial decision-making research at the policy or institutional level, and its practical value is still in the exploratory stage.

3.3 Computational behavioral finance: a new paradigm of behavioral modeling driven by technology

With the development of Big Data and Artificial Intelligence, Behavioral Finance has gradually introduced computational methods to portray investor behavior, predict market sentiment, and build dynamic behavioral models. This trend is collectively known as Computational Behavioral Finance (CBF).

Typical applications include:

Using machine learning algorithms to uncover non-linear relationships in trading data, such as predicting "herd behavior" in high-frequency trading or identifying potential sentiment overheating bands;

Analyzing investor sentiment in social media (e.g., Twitter, Reddit) or news text using Natural Language Processing (NLP) techniques to construct "sentiment indices" or "sentiment volatility";

Modeling investor social networks using graph neural networks to assess the impact of information diffusion and behavioral mimicry on market prices.

For example, investor sentiment index is used to predict market returns and find that the market tends to be overvalued during periods of high sentiment, followed by a downward revision of returns. In recent years, similar studies have been incorporated into the trading strategies of many financial institutions as part of "behavioral quantitative investing".

Although the computational methods have greatly improved forecasting ability and real-time performance, they still face two core challenges: first, the model results are mostly dependent on "black-box algorithms", which are not highly interpretable in economics; second, the modeling of behavioral variables has not yet formed a unified standard, which leads to a lack of comparability of the results across different datasets. Therefore, how to achieve a balance between prediction accuracy and theoretical explanation is a key issue for computational behavioral finance in the future.

3.4 Natural experiments and quasi-experiments: real-world causal inference tools

Natural experiments have been an important method of causal identification in behavioral finance research in recent years, using exogenous events such as policy changes, natural disasters, or regulatory adjustments as "quasi-stochastic" treatments to infer the causal effect of a variable (e.g., financial disclosure, changes in capital controls) on investor behavior. The causal impact of a variable (e.g., financial disclosure, capital control changes) on investor behavior is inferred.

This approach has the following advantages:

Strong external validity: the research object is real market participants and actual transactions;

Applicable to complex market structures: no laboratory control is required, and long-term variables such as institutional changes and cultural differences can be captured.

For example, researchers can use the event of the abolition of securities transaction tax in a country to analyze the changes in trading frequency, speculative behavior and market volatility, so as to identify the constraining effect of the tax system on irrational behavior. Another example is the dramatic impact of the COVID-19 epidemic on the global financial market, which is also seen as a natural experimental ground for researchers to compare the changes in investor behavior, asset allocation and risk aversion before and after the epidemic.

However, the methodology relies on the occurrence of exogenous events, with fewer research opportunities, and the results tend to be "context-dependent" - i.e., highly event-specific and not easily generalizable to other scenarios. At the same time, data completeness

and the criteria for defining treatment groups may also affect the quality of inferences. Key Findings of the Empirical Study

Through the multiple research methods described above, behavioral finance has achieved significant research results at the individual decision-making and market operation levels. Individual-level studies have found that investors' overconfidence leads to frequent trading, which significantly reduces returns; the anchoring effect causes investors to ignore new information, so that market prices cannot be adjusted in a timely manner; and the disposition effect caused by loss aversion manifests itself in the tendency of investors to sell profitable assets prematurely and to hold losing assets for a long period of time, which harms long-term investment returns. Group-level studies indicate that social interactions and the spread of emotions significantly reinforce herd behavior in the market, leading to increased market volatility and exacerbating the risk of asset bubbles. These irrational behaviours not only have an immediate impact on short-term markets, but also cause sustained damage to long-term market stability and effectiveness.

4 Research limitations and challenges

Although behavioral finance has achieved remarkable results in theory construction, methodological innovation and empirical research, the field is still facing many challenges and development bottlenecks, mainly in the following aspects:

First, existing research is highly focused on mature financial markets in Europe and the United States, ignoring the cultural, institutional and investor behavioral differences in emerging markets such as Asia, Africa and Latin America. This geographic and cultural bias makes the cross-cultural applicability of the theory questionable, limiting the promotion and application of behavioral finance theory on a global scale.

Second, the theoretical models of behavioral finance still show a tendency of fragmentation. Various types of behavioral biases mostly appear in the form of independent theories, and there is a lack of an integrated theoretical framework to systematically explain the interaction mechanism between multiple biases and their comprehensive impact on market outcomes. This theoretical fragmentation is not conducive to model promotion and empirical verification, and also affects the effectiveness of its application in policy design.

Third, although behavioral finance provides new perspectives for policymaking, the path of policy intervention is still unclear, and most of the relevant studies remain at the level of theoretical discussion, lacking systematic and operational intervention mechanisms. For example, how to improve investor decision-making through “behavioral guidance” (nudging) means to enhance the effectiveness of financial education, has not yet formed a unified strategy.

In addition, at the methodological level, high research costs, difficulty in obtaining data, and lack of explanatory models have also seriously constrained the development of the field. Although high-precision methods such as neuroeconomics can reveal the deep mechanism of irrational behavior, its high technical threshold and sample size limitations have reduced the scalability of the research; although computational behavioral finance has strong predictive power, it is still insufficient in the transparency of the model and the interpretability of the theory, which affects its academic and policy influence.

To sum up, behavioral finance still needs to make breakthroughs in the dimensions of theoretical integration, geographical expansion, methodological applicability and policy practice, so as to fully release its academic potential and practical value.

In the future, behavioral finance should maintain the advantages of interdisciplinary cross-disciplinary, promote the deepening of theory and practical transformation, and systematically expand in the following five aspects:

Construct a comprehensive model of multiple deviations and promote the development of theoretical integration. The current deviation models are mostly set in isolation, and in the future, we should construct a unified model framework covering a variety of behavioral deviations (e.g., loss aversion, anchoring, following the crowd, overconfidence, etc.), integrating cognitive, emotional, and social factors, and promoting the transformation of Behavioral Finance into a systematic explanation paradigm of the mechanism of "multi-causes, multi-functions". In addition, we will further develop the "adaptive" modeling framework. In addition, the further development of the Adaptive Market Hypothesis will help bridge the theoretical gap between rational and irrational behavior.

Strengthen cross-cultural and cross-market empirical research to enhance the universality of theories. Aiming at the differences in cultural backgrounds, institutional environments, education levels and financial cognition of investors in different countries and regions, conducting cross-market comparative research to test the applicability of existing theories in different contexts and to explore localized behavioral patterns will help promote the construction of the theory of "Global Behavioral Finance". This will help promote the construction of "global behavioral finance" theory.

Deepen the combination of artificial intelligence and emotion recognition technology. With the help of AI, natural language processing (NLP), graph neural network and other technologies, we will build a real-time and high-frequency market sentiment monitoring system to identify the dynamic impact of investor sentiment changes on market volatility and asset pricing, so as to improve the foresight and timeliness of risk warning and policy intervention. At the same time, the interpretability of the model is improved to enhance the credibility of its application in academic and regulatory scenarios.

Establish a systematic policy intervention mechanism to connect research and practice. Based on the results of behavioral bias identification, we develop targeted intervention strategies, such as optimizing financial product design, adjusting the way of presenting information, improving financial literacy education, and introducing mechanisms such as "default options" to improve the quality of investor decision-making through "soft intervention". Through "soft intervention", we can improve the quality of investors' decision-making and reduce the risk of irrational market fluctuations.

Promote the in-depth integration of psychology, neuroscience, data science and behavioral finance, build a multi-level database containing neural data, behavioral experimental data, and real market behavior, and carry out long-term tracking research to deeply reveal the formation, evolution, and propagation mechanism of irrational behaviors, so as to serve for more dynamic theoretical modeling and policy formulation.

5 Conclusion

Behavioral finance breaks the assumption of "completely rational man" in traditional financial theories, and reveals the significant influence of individual cognitive bias, emotional volatility and social influence on investment decisions. In this paper, we systematically sort out the core theoretical system and main research results in this field, and point out that irrational behaviors widely exist in individual and group decision-making, which affect the price formation mechanism, volatility structure, and resource allocation efficiency of financial markets.

At the theoretical level, this paper presents the development and evolution from prospect theory, psychological account, to dual systems theory and social identity theory, showing the complement and challenge of behavioral finance to traditional theories. On the methodological level, this paper presents the trend of integrating multi-dimensional technological paths from controlled experiments to big data and neural mechanism analysis, providing new tools for causal identification and mechanism revelation of irrational behavior.

The empirical study further validates the path of behavioral biases such as overconfidence, anchoring effect, loss aversion, etc. on trading behavior and market stability.

However, current behavioral finance research still suffers from outstanding problems such as theoretical fragmentation, cultural limitations, insufficient methodological explanatory power, and difficulties in policy translation. In the future, we should focus on integrating various behavioral biases into a unified model framework, developing behavioral finance theories with wide applicability and dynamic adjustment capabilities; realizing real-time monitoring and prediction of market sentiment with the help of new technologies such as artificial intelligence, natural language processing, and social network analysis; strengthening the research on behavioral finance in emerging markets and different cultural contexts to enhance the universality of theories and the effectiveness of policies; and promoting the cooperation between governments, markets, and academics to enhance the effectiveness of policies. The linkage between the government, the market and the academia can realize the efficient transformation from theoretical research to policy intervention.

In summary, behavioral finance has great potential in revealing irrational mechanisms in the market, improving the effectiveness of financial regulation and promoting investor education. Through interdisciplinary integration and technological innovation, the field will continue to promote the evolution of financial market theory and practice, helping to realize a more stable, efficient and inclusive financial system.

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