Comprehensive Study on Stock Investment Behavior and Risk Based on Artificial Intelligence, Big Data and Multiagent Simulation

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Abstract. In the context of the rapid development of science and technology in the 21st century, artificial intelligence has become a key factor in global competition and has promoted profound changes in the financial field. This article reviews the current status and trends of artificial intelligence applications in the financial field, especially in stock investment, and focuses on analyzing the impact of individual investors' trading behavior on market fluctuations in the Chinese market. This paper aims to provide support for investment decision-making and risk management by exploring the use of big data, machine learning, and multi-agent simulation technology to collect and analyze multi-source information (including investor trading records, social media data, and market news), as well as multi-agent models to simulate investor behavioral interactions and evaluate the impact of financial technology on information dissemination. At the same time, this article deeply studies the practicality of artificial intelligence, big data, and multi-agent simulation, provides a new perspective for stock investment research, promotes the development of financial technology, and promotes market intelligence, efficiency and stability.

Keywords: Artificial Intelligence, Big Data, Multi-agent Simulation, Stock Investmen, Risk Analysis.

1 Introduction

Since the 21st century, with the acceleration of global economic integration, the stock market has become increasingly important as a core barometer of economic activities and a key platform for capital flows. The study of stock investment behavior and risks plays an irreplaceable role in maintaining financial stability and promoting healthy economic development. Traditional research mainly relies on historical data analysis and theoretical model derivation. Although it has achieved certain results, it has obvious limitations: on the one hand, traditional data analysis methods are difficult to handle massive and complex market data; on the other hand, there are deviations between theoretical model assumptions and the actual market environment, which limits the accuracy of risk assessment and investment decisions.

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At present, the wave of scientific and technological revolution is sweeping the world, and artificial intelligence, big data and multi-agent simulation technologies are booming. With its powerful pattern recognition and prediction capabilities, artificial intelligence can deeply explore the hidden information in stock market data; big data technology can integrate multi-source heterogeneous data to provide a comprehensive and real-time perspective on market dynamics; multi-agent simulation technology can simulate the complex and changeable behavior patterns of market participants and reveal the intrinsic connection between the market's micro-mechanisms and macro-performance. The innovative application of these technologies in the financial field has provided new ways to break through the bottleneck of traditional research and is gradually changing the landscape of stock investment research.

This study focuses on the field of stock investment, and uses artificial intelligence, big data and multi-agent simulation technology to deeply analyze stock investment behavior and risks. Specifically, this study first comprehensively summarizes the research results of quantitative application and price prediction of artificial intelligence in stock investment, then deeply explores the advantages of big data technology in multi-source information integration in investment decision-making and then elaborates on the simulation effect of multi-agent simulation technology on investor behavior and market dynamics. Finally, through empirical research, it verifies the actual value of relevant technologies in improving the scientific nature of investment decisions and the effectiveness of risk management, aiming to provide investors with more accurate decision-making support and provide financial institutions and regulatory authorities with innovative tools and methods to optimize risk management.

2 Uniqueness and Challenges of China's Stock Market

2.1 Individual Investor Behavior Characteristics and Their Impact

Individual investors account for a high proportion in China's stock market. Their behavior is influenced by multiple factors such as market information, psychological factors, and social interaction. They are characterized by a strong tendency to follow the trend and frequent transactions, which can easily lead to market fluctuations and systemic risks. For example, during the abnormal volatility of China's stock market in 2015, concentrated selling by individual investors exacerbated the market decline [1].

Liu Cuihua pointed out that the behavior of individual investors in China's stock market is complex and changeable, and is influenced by a combination of multiple factors such as market information, psychological factors, and social interactions. These behaviors may trigger systemic risks through complex network structures [1]. Market volatility risk is one of the important factors affecting stock market investment returns. It is driven by a variety of complex factors, including changes in economic cycles, policy adjustments, and fluctuations in market sentiment. These behavioral characteristics of individual investors may lead to unexpected market fluctuations, thus posing huge challenges to the preservation and appreciation of asset value.

2.2 Challenges of Market System and Regulatory Environment

The Chinese stock market differs from mature markets in terms of trading systems, information disclosure, and regulatory policies, which pose challenges to investment decisions and risk management. Specifically, in terms of the trading system, although the daily price limit system can prevent excessive market fluctuations, it also limits the efficiency of price discovery and affects the effectiveness of investment strategies. In terms of information disclosure, insufficiency and asymmetry lead to unfair competition among market participants, allowing some investors to use their information advantages to obtain excess returns, while other investors face greater risks. In terms of regulatory policies, they need to be continuously improved to adapt to market development and balance innovation and risk prevention.

3 Application of Artificial Intelligence, Big Data and Multi-agent Simulation Technology in Stock Investment

3.1 Application of Artificial Intelligence in Stock Investment

The application of artificial intelligence in stock investment mainly focuses on two directions: quantitative investment and price prediction. In terms of quantitative investment, early artificial intelligence achieved excess returns by building mathematical models and identifying stock price patterns, which strongly promoted the development of quantitative investment funds and enabled them to use big data and artificial intelligence technologies to explore potential arbitrage opportunities. In terms of price prediction, machine learning, especially deep learning algorithms, has significantly improved the accuracy of stock price predictions with their excellent nonlinear fitting capabilities. In terms of price prediction, machine learning, especially deep learning algorithms, has significantly improved the accuracy of stock price predictions with their excellent nonlinear fitting capabilities. For example, Fang Yi et al. introduced 20 indicators covering value, technology, momentum, sentiment reversal, etc. and 8 machine learning algorithms to predict the stock returns of the Shanghai and Shenzhen stock markets. The results showed that the deep neural network had the best prediction effect, followed by the regularized linear machine learning model [2]. In addition, the CEEMD-LSTM-BLS prediction model proposed by Zhang Dong uses complementary ensemble empirical mode decomposition (CEEMD) to perform non-stationary processing on closing prices and combines the breadth learning system (BLS) with the long short-term memory network (LSTM), effectively improving the accuracy of stock price prediction [3].

3.2 Application of Big Data in Stock Investment

Big data technology can collect and integrate massive amounts of multi-source information, including investor transaction records, macroeconomic data, and social media data, thereby providing a rich data foundation for investment decisions. For example, Geng Sujuan used big data technology to crawl the stock review texts of the Shanghai Stock Exchange 50 component stocks in the Oriental Fortune Stock Forum, calculated

the network public opinion index, and constructed a bivariate VAR model to study the dynamic relationship and causal relationship between network public opinion and stock returns [4]. The study found that there is a long-term dynamic relationship between stock returns and online public opinion, and the two Granger cause each other. In addition, He Dongxin designed and implemented a comprehensive stock information platform based on artificial intelligence algorithms. The platform uses a variety of methods to obtain different types of data, providing data sets for the design and implementation of relevant analysis algorithms [5]. The platform also uses time series prediction methods such as Facebook Prophet, ARIMA, and Holt-Winters, as well as natural language processing algorithms such as Text Rank, TF-IDF, Bert, BiLSTM, and CRF to perform keyword extraction, event subject extraction, and market sentiment analysis on news text information, company announcement information, and market investor opinion information, thereby helping users quickly understand market information and make auxiliary decisions. In practical applications, the platform can significantly improve the efficiency and accuracy of investment decisions, enabling investors to better grasp market dynamics, optimize investment portfolios, and thereby obtain better investment returns in the highly competitive stock market.

3.3 Application of Multi-agent Simulation Technology in Stock Investment

The application of multi-agent simulation technology in the field of stock investment is mainly reflected in the simulation of investor behavior and interaction impact. By building intelligent agents that include different types of investors, such as institutional investors, individual investors, etc., can simulate their decision-making process and trading behavior in the market, and then analyze market dynamics under information dissemination. Yang Nian's research has provided an important technical foundation for this field [6]. The goal-driven intelligent agent designed in his research can autonomously perceive the environment and make decisions, and its behavior is driven by the goal. In stock investment simulations, this agent can simulate the behavioral patterns of different investors in the market. For example, institutional investors may focus more on long-term value investments, while individual investors may be more inclined to short-term speculation. In addition, path planning algorithms (such as the A* pathfinding algorithm) can be applied to simulate investors' trading strategy selection in a complex market environment. For example, when the market fluctuates greatly, the intelligent agent can use algorithms to find the optimal buying and selling times and prices to maximize profits. Motion navigation mechanisms (such as navigation meshes) can help intelligent agents perceive the market environment more effectively, such as by analyzing market trends and sentiment and adjusting their investment strategies. The application of this simulation technology helps to gain a deeper understanding of the complex relationship between investor behavior and market dynamics, and provides theoretical support for the formulation of investment strategies. The research of Li Zhicheng et al. shows that multi-agent simulation technology can reveal the impact of risk preference transfer and communication barriers on decision-making efficiency in team decision-making. Similarly, this technology can also be used to analyze the be-

havioral characteristics and decision-making efficiency of investor groups under different market conditions, further enriching the research perspective of stock investment behavior [7].

4 Risk Analysis of Artificial Intelligence, Big Data and Multi-agent Simulation Technology in Stock Investment

4.1 Technical Risks

The application of artificial intelligence and big data technologies in the field of stock investment faces many technical risks such as data quality, model bias and algorithm black box, which may directly lead to investment decision-making errors. In terms of data quality, in addition to data sample bias, problems such as missing data and data errors cannot be ignored. For example, missing data may lead to insufficient model training and failure to accurately capture the full picture of market fluctuations, while data errors may introduce noise, causing the model's prediction results to deviate from the actual market situation, thereby misleading investment direction.

Model bias is also an important factor affecting investment decisions. When the model is overfitted, it may over-adapt to the occasional fluctuations in historical data, resulting in invalid predictions in the new market environment; while when the model is underfitted, it may not be able to fully learn the complex patterns in the data, reducing the accuracy of the prediction. In his empirical study on the extreme risk early warning model of the stock market based on artificial intelligence methods, Li Qinghang pointed out that the data in the stock market has complex nonlinear relationships, which pose a challenge to the establishment of an extreme risk early warning model [8]. Although artificial intelligence methods can better handle nonlinear problems in data, the stability and effectiveness of the model stineedseed further evaluation and verification.

The algorithm black box problem further exacerbates technical risks. Since the decision-making process of many artificial intelligence models (such as deep learning models) is difficult for humans to intuitively understand, investors may not be able to accurately assess the reliability and limitations of model predictions. Zhang Dong pointed out that deep learning prediction models often encounter problems such as gradient vanishing and time lag when facing large sequence fluctuations, resulting in insufficient prediction accuracy [9]. This shows that although current artificial intelligence technology has achieved certain application effects in stock investment, its technical limitations still need to be continuously optimized and improved to reduce the negative impact of technological risks on investment decisions.

4.2 Market Risk

While the application of new technologies can improve the efficiency of the stock market, it may also exacerbate market volatility and trigger systemic risks. Taking quantitative investment as an example, the homogeneity of its strategies may lead to a "flash crash" in the market under certain conditions, causing huge losses to investors, which highlights the potential threat of new technologies to market stability. From the per-

spective of investor behavior, when many investors adopt similar quantitative investment strategies, the market's group behavior patterns will change, and concentrated adjustments to strategies may trigger a chain reaction, exacerbating market volatility. Cui Xinyi found in her research on stock pledge risk prediction that the risks hidden in the stock pledge business will have a serious impact on the stability of the financial market. By using advanced algorithms such as machine learning and empowering technology to establish and improve a risk monitoring and early warning system, and improve the infrastructure for risk supervision, it will help strengthen the supervision and management of stock pledge business risks [10]. In addition, from the perspective of the matching of technology and market structure, market volatility risks are driven by a variety of complex factors. Although the application of new technologies can improve market efficiency, it may also lead to an increase in market instability. In the process of changing the market structure and operating logic, it may trigger new risk points, thereby affecting market stability.

4.3 Information Security Risks

In the process of information dissemination, the application of big data and financial technology poses challenges to information security. Investors' personal information and transaction data are easily leaked and abused, which harms investors' interests. Chen Ruoxin mentioned in his research on the correlation between financial news and stock indexes that with the rapid development of the Internet, the speed and scope of financial news dissemination are constantly expanding, but the authenticity and reliability of information are difficult to guarantee, which may mislead investors and affect market stability [11]. Although the comprehensive stock information platform designed by He Dongxin uses a variety of natural language processing algorithms to analyze market information, it also faces information security challenges [5]. Because the platform needs to process a large amount of investor personal information and transaction data, once this data is leaked or abused, it will not only harm the interests of investors but may also trigger a crisis of confidence in the market, and thus affect the stable operation of the entire financial market.

5 Conclusion

This article summarizes the application status and risk challenges of artificial intelligence, big data and multi-agent simulation technology in the field of stock investment, and proposes coping strategies based on the uniqueness and difficulties of the Chinese stock market. Build an intelligent risk management system, use relevant technologies to monitor, evaluate, and predict risks in real time, and formulate response measures in advance; strengthen investor education and market cultivation, improve the financial literacy and risk awareness of individual investors, and create a good market environment; promote technological integration and interdisciplinary cooperation, improve the accuracy and explanatory power of comprehensive stock investment models, strive to promote the development of financial technology, and promote the intelligence, efficiency and stability of the stock market.

Given that existing research has problems such as insufficient depth and breadth of technology application and the need to improve risk assessment models, future research should further strengthen interdisciplinary cooperation, explore the potential of artificial intelligence, big data and multi-agent simulation technology, expand the scope of application of technology in the field of stock investment, and optimize investment strategies and risk management systems. At the same time, well continue to pay attention to the dynamic changes of the Chinese stock market, constantly improve the risk assessment model considering market characteristics, contribute to the healthy development of the stock market, help make stock investment decisions more scientific and accurate, and promote the stock market to develop in a more stable and prosperous direction.

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