

The Application of Artificial Intelligence in Financial Risk Prediction

Yanxi Yu^{1,*}

¹Wenhui College, Shanghai University, Shanghai, China

*Corresponding author:
972424638@shu.edu.cn

Abstract:

This paper systematically reviews the relevant research literature of artificial intelligence technology (covering machine learning, deep learning, etc.) in credit risk, market risk and operational risk prediction in the financial field. By comparing the application effects of different artificial intelligence algorithms in various risk prediction scenarios, this paper clarifies the advantages of machine learning algorithms in multi-dimensional data integration, as well as the value of deep learning models in capturing timing dependence and potential risk clues, and summarizes the shortcomings of the two algorithms in scene adaptation and extreme case equivalence. On this basis, this paper deeply discusses the core difficulties faced by technology application: there are some problems at the data level, such as fragmentation, difficult balance between sharing and privacy, and compliance restrictions; At the model level, it highlights the dilemma of lack of explainability caused by the characteristics of “black box”; At the technical level, it is facing challenges such as high adaptation cost and weak robustness. Finally, the future research direction of artificial intelligence in financial risk prediction is prospected to provide a reference framework for follow-up related research.

Keywords: Artificial intelligence; financial risk forecasting; machine learning; deep learning.

1. Introduction

In the context of the deep evolution of global financial markets, digitalization, globalization and uncertainty are intertwined, and the dynamic evolution of financial risks is becoming more and more complex. Traditional financial risk prediction methods, such as logical regression, linear regression and decision tree, are difficult to meet the high demand for risk

perception accuracy in the current financial market due to poor adaptability, insufficient timeliness and limited accuracy. At the same time, artificial intelligence technology is booming under the promotion of computing power, algorithms, data and other factors, which provides a new technical paradigm for solving the pain points of traditional prediction.

At the theoretical level, many studies have enriched the theoretical system of financial risk prediction

from different dimensions, such as Yang et al. Who proposed that deep learning combined with big data algorithms can significantly improve the accuracy of financial risk behavior prediction [1]. Bai and Braganza discussed the advantages and limitations of machine learning algorithms in financial risk prediction [2]. Nan pointed out that while the application of artificial intelligence technology has brought advantages such as data processing to financial risk management, there are also challenges such as program errors and information security [3]. At the practical level, it can provide reference for financial institutions to optimize prevention and control strategies and regulators to improve the regulatory framework of science and technology. Research such as Fu can guide institutions to use artificial intelligence to reduce operational and credit risks and improve the efficiency of risk prevention and control [4]. Xie's model provides a tool for institutions to integrate multi technology in financial risk governance [5]. This study focuses on the application of artificial intelligence in financial risk forecasting, combs the literature, summarizes the results, analyzes the shortcomings and difficulties, and looks forward to the trend of emerging technologies. The research shows that although artificial intelligence has brought technological breakthroughs, it is not only facing the problems of financial data fragmentation, difficult balance between sharing and privacy and compliance data, but also facing the problems of insufficient trust in the „black box“ model and difficult adaptation of interpretable technology, but also constrained by high algorithmic computing requirements, difficult adaptation and iteration of model formats and weak robustness. Therefore, in the process of application, multi-dimensional improvement and innovation are needed, and systematic literature review and analysis will provide guidance for research in this field and deepen understanding.

2. Application of Artificial Intelligence in Various Financial Risk Forecasting

2.1 Application of Artificial Intelligence in Credit Risk Forecasting

Firstly, in terms of machine learning algorithms, logical regression, as an early tool for personal credit scoring, provides a linear modeling idea; Because of its strong generalization ability, support vector machine is suitable for small sample credit risk prediction scenarios; Integrated learning algorithms such as random forest and xgboost are better than single algorithms in enterprise credit risk assessment, and can integrate multi-dimensional data [6]. Tencent finance, J.P.Morgan and other institutions also

widely use machine learning algorithms in risk prediction. Li and Dai combine machine learning and natural language processing technology to explore financial risk prediction and management, further highlighting the potential of integrating multi technology means to improve the efficiency of risk assessment, and from a broader perspective of financial risk management, confirming the value of machine learning algorithms to integrate multi-dimensional elements [7].

Secondly, in the deep learning algorithm, long short term memory (LSTM) and gated recurrent unit (Gru) can capture the time dependence of data; Transformer integrates public opinion text data to improve accuracy; Gen AI model can tap potential credit risk clues.

2.2 Application of Artificial Intelligence in Market Risk Forecasting

In the field of market risk prediction, artificial intelligence algorithms show certain advantages, but there are also obvious limitations. In machine learning algorithms, support vector machines are good at capturing the nonlinear characteristics of the market to assist stock price forecasting. Random forests can integrate multiple factors to improve the performance of interest rate and exchange rate risk forecasting, and have better short-term accuracy and sensitivity to market fluctuations in var calculation [8].

The same is true of deep learning algorithms. Convolutional Neural Network (CNN) can extract trend features from K line graphs. LSTM and Recurrent Neural Network (RNN) can capture the long-term dependence of timing data. Transformer is conducive to integrating multi market data to identify related risks. Gen Artificial Intelligence (AI) model can also achieve more comprehensive analysis and prediction.

2.3 Application of Artificial Intelligence in Operational Risk Prediction

Firstly, when machine learning algorithms are applied, isolated forests can quickly identify abnormal operations; Decision trees are effective in the classification of operational risk events and the estimation of loss probability, can also improve the level of customer risk identification and management, help financial institutions cope with risks, and can achieve active risk identification.

Secondly, in the deep learning algorithm, LSTM can build an early warning mechanism to capture the law of risk evolution; CNN can extract risk characteristics from texts; Gen AI can mine potential risk patterns and integrate internal and external data. Yang et al.'s research shows that with the increasing complexity and dynamics of financial markets, traditional financial risk prediction methods are

becoming more and more difficult to deal with large data sets and complex behavior patterns, and deep learning combined with big data algorithms can significantly improve the accuracy of financial risk behavior prediction [1].

3. Analysis of Difficulties in the Application of Artificial Intelligence in Financial Risk Forecasting

3.1 Data Quality Issues

Financial data naturally has the characteristics of fragmentation, and the internal system data format is often inconsistent. At the same time, the acquisition of external credit investigation and public opinion data is not only expensive, but also limited in authority. In the process of multi source data integration, technical problems such as format conversion and semantic alignment directly affect the effect of model training, and quality problems such as data loss and repetition will greatly reduce the prediction accuracy, which has become the core bottleneck of model application and promotion. Wang's research also clearly points out that data quality is one of the main challenges faced by AI model in the application of financial risk control, which is intertwined with financial data fragmentation and limited access, and further highlights the key restrictive role of data quality in the application of artificial intelligence in financial risk prediction [9].

There is a natural contradiction between data sharing and privacy protection among financial institutions, so how to balance the two is the focus of current research. Although federal learning, differential privacy and other technologies have made some progress in application, there are still limitations such as performance loss. Compliance requirements such as the personal information protection act further reduce the scope of data use, which limits the space for model optimization.

3.2 Model Interpretability

The decision-making process of „black box“ models such as deep learning and complex integrated learning is difficult to trace, which brings great difficulties to the decision-making demonstration and regulatory review of financial institutions. Practitioners lack trust in the output results of the model, which directly hinders the landing application of related technologies. Relevant studies show that the lack of causality is the core sticking point leading to the lack of interpretability of the model, and even the gen AI model based on the large language model, its reasoning process is difficult to be fully transparent.

The application of interpretability enhancement technology is particularly prominent. Although shap value and lime algorithm have been applied in model interpretation, they are facing the problem of balancing accuracy and efficiency in complex deep learning models. Most technologies can only provide local interpretation, can not achieve global logical reduction, and improving interpretability often needs to be at the expense of prediction performance. For the gen AI model, the adaptability of the current interpretability enhancement technology still needs to be further explored.

3.3 Technology Adaptation and Robustness

At the level of technology adaptation, deep learning and other algorithms have higher requirements for computing power and storage, which makes it difficult for small and medium-sized financial institutions to bear the corresponding costs. In discussing the impact of artificial intelligence on the financial industry, Naim emphasizes the value of promoting change, but also implies the comprehensive cost problem to be considered in the application of technology [10]. The adaptability of the model in traditional banking, Internet Finance and other different formats is significantly different, and in the face of changes in business innovation, policy adjustment and other scenarios, parameter optimization and algorithm iteration are extremely difficult. The deployment of Gen AI model also needs strong computing support, which further increases the difficulty of technology adaptation.

The challenge of insufficient model robustness is also prominent. Artificial intelligence models are vulnerable to adversarial attacks, and malicious data tampering can avoid risk warning. In extreme market environments such as liquidity crisis, the performance of the model will decline significantly, and there is a general problem of overfitting, and the generalization ability in new scenarios is relatively weak. Gen AI model may also have prediction bias in the face of sudden anomalies in the financial market.

4. Future Development Trend and Research Direction of Artificial Intelligence in Financial Risk Forecasting

4.1 Innovation Direction of Technology Integration

Multimodal artificial intelligence has become a research focus because it can integrate text, image and timing data to achieve comprehensive risk assessment, and the optimization of cross modal fusion technology is the key to

improve the accuracy of assessment. However, although Gen AI has the inherent advantages of multimodal fusion, its efficiency in information filtering and feature extraction still needs to be improved. The AT-FinGPT model proposed by Xie et al. integrates financial audio and text summary data for financial risk prediction, and empirical results show that its performance is better than most advanced methods, which not only provides a specific technical practice example for the application of multimodal artificial intelligence in financial risk prediction, but also provides a reference for the integration and innovation of multimodal artificial intelligence technology [11].

In addition to multimodal technology, the potential for collaborative application of artificial intelligence, block chain and big data is also very significant: block chain technology can directly enhance data reliability, and big data technology can improve predictive timeliness, but in the process of integration, the two are facing problems such as excessive computing power consumption and fuzzy privacy compliance boundaries. In addition, the compound architecture of „Ai+blockchain+big data“ has broad prospects in systemic risk monitoring, but its dynamic adaptation ability in complex financial networks still needs to be improved through long-term practical testing.

4.2 Model Optimization and Performance Improvement Direction

In view of the core bottleneck of scarce risk data, small sample and zero sample learning have become important breakthroughs. Migration learning can effectively alleviate the problem of insufficient data in emerging markets, but it needs market feature adaptation algorithm to optimize the accuracy; Although meta learning technology can quickly adapt to scenarios such as risk prediction of new financial products, it should balance generalization and complexity. At the same time, Nan's research mentions the advantages of data processing brought by the application of artificial intelligence technology to financial risk management, but also points out the challenges of program errors and information security, which enlightens us that when support small sample scenarios with the help of Gen AI knowledge migration ability, need to focus on its possible risks such as deviation transmission [3]. In addition to data adaptation, the study of model interpretability is also crucial: on the one hand, need to build a global interpretable model and develop causal algorithms to meet the needs of supervision and trust; On the other hand, the combination of financial knowledge map can also improve interpretability, but the contradiction between map updating and reasoning speed should be solved. Especial-

ly for Gen AI model, its interpretability research is still in its infancy, and how to achieve compliance interpretation without sacrificing prediction performance is still a key topic to break through.

4.3 Direction of Application Scenario Expansion

With the increasing complexity of financial markets, on the one hand, the demand for systemic financial risk forecasting is becoming more and more urgent. Such forecasts need to integrate multi-dimensional data modeling such as macro-economy, cross market and institutional correlation, but there are some problems, such as difficult variable screening, weak cross economic cycle adaptability of the model and so on, and the response accuracy of Gen AI to macro policy changes still needs more empirical verification. Wang and others use big data and artificial intelligence to build an enterprise risk assessment system, which provides a reference for the technical application of systemic financial risk prediction, and also reflects the data integration potential of artificial intelligence in complex scenarios [8].

On the other hand, the rise of new financial formats has led to the demand for special risk forecasting. Emerging risks such as digital RMB money laundering and green project „floating green“ need exclusive AI models, but they are facing the problems of difficult risk feature extraction and insufficient sample accumulation. At the same time, technological innovation also needs to take into account the adaptability of formats and the flexibility of models to avoid excessive rigidity of models due to excessive adaptation to specific formats. Fu, X. The research provides a practical reference for the research and development of special models under the new financial format, and further highlights the importance of applying artificial intelligence in combination with industry practice [4].

4.4 Direction of Improvement of Risk Prevention and Control System

On the basis of technology and model innovation, building an AI-driven dynamic risk prevention and control mechanism has become a key measure: specifically, this requires adding core technical components like a real-time stream computing module (e.g., Apache Flink) to process transaction data within 1 second, as well as integrating a configurable rule engine to adjust disposal strategies automatically based on AI model alerts. Such mechanisms need to be based on real-time data updating and model iteration to achieve real-time risk monitoring, automatic early warning and rapid response, while building a „forecast early warning and rapid response“ closed-loop system

can further enhance the systematization of prevention and control. However, the effective operation of this mechanism depends on the stability of real time data transmission and the automation of disposal scheme, so it is necessary to solve the problem of transmission delay through technical architecture optimization and avoid disposal rigidity through dynamic rule adjustment.

At the same time, the integration of regtech and AI is also an important support to improve the prevention and control system. In the fields of „regulatory sandbox“ monitoring, innovation and compliance balance, AI can significantly improve regulatory accuracy and efficiency, but the integration of the two still faces challenges: on the one hand, the digital transformation of financial regulatory rules is difficult, on the other hand, the regulatory adaptability of AI model is insufficient. Although Gen AI can assist in the application of regulatory rules, its ability to accurately grasp policy intentions still needs to be further improved through multi scenario training.

5. Conclusion

This study systematically combs the application, difficulties and future trends of artificial intelligence in the field of financial risk prediction, which not only demonstrates the innovative vitality of this field, but also reveals many critical problems to be solved. At the application level, various algorithms have their own advantages in different risk prediction scenarios, but there are also shortcomings such as scenario limitations; In terms of application difficulties, the problems of data, model, technology adaptation and robustness have exposed the practical obstacles to the deep integration of artificial intelligence and financial scenarios, and the degree of technology matching needs to be examined from a critical perspective. Looking forward to the future, technology integration and innovation, model optimization, scene expansion and prevention and control system improvement are the core directions. Technology integration paths such as multimodal artificial intelligence and „Ai+blockchain+big data“ architecture provide the possibility to break through bottlenecks; Small sample learning, interpretable technology deepening and other model optimization methods help to enhance the practicality and credibility of technology; Systemic risk, the forecast expansion of new financial formats and the construction of dynamic prevention and control mechanism can enhance the foresight and comprehensiveness of financial risk governance.

Generally speaking, the development of artificial intelli-

gence in the field of financial risk prediction is a process of constantly solving the contradiction between technology and scenario in innovation. Future research needs to continue to think critically and promote the precise docking of technological breakthroughs with the actual needs of Finance in order to fully release its enabling potential.

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