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Research on the Application of Deep Learning Model in Financial Innovation Regulation from the Perspective of Building a Financial Power

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Abstract

Driven by the dual demands of advancing the strategy of building a strong financial nation, accelerating the iteration of financial innovation, and improving the quality and efficiency of regulation, traditional financial regulatory models are struggling to adapt to the risk control needs of complex innovative scenarios, making the transformation to intelligent regulation imperative. This paper, from the perspective of building a strong financial nation, analyzes the practical achievements and existing shortcomings of financial innovation regulation in my country, assesses the regulatory adaptability of deep learning at the technology, scenario, and objective levels, and clarifies the real challenges of technology implementation. It constructs a deep learning model adapted to financial innovation regulation, completes parameter optimization and empirical testing, and verifies the model's practical effectiveness in risk identification and early warning. Finally, from five dimensions—technology empowerment, data governance, collaborative regulation, talent development, and system improvement—it proposes an optimized path for deep learning to empower financial innovation regulation, helping to strengthen the financial security defense line and promote the high-quality advancement of building a strong financial nation.

Keywords

A financial powerhouse, deep learning models, and financial innovation.

1. Research Background

The Central Financial Work Conference clearly put forward the strategic goal of accelerating the construction of a strong financial nation, taking the improvement of the modern financial regulatory system and the strengthening of the financial security defense line as core tasks[1]. This is not only an inherent requirement for promoting high-quality financial development, but also a key guarantee for safeguarding China's modernization. Currently, my country's financial industry is entering a period of rapid innovation and iteration, with emerging business models such as digital finance, inclusive finance, and green finance flourishing. Financial products, business models, and service scenarios are constantly being innovated, injecting strong momentum into the development of the real economy and driving the financial system towards diversification, intelligence, and efficiency, becoming an important driving force for building a strong financial nation[2].

At the same time, the cross-sectoral, complex, and covert nature of financial innovation is becoming increasingly prominent, and traditional financial regulatory models face numerous adaptation challenges: fragmented regulatory data, lagging risk identification, difficulties in implementing penetrating supervision, and low regulatory efficiency are gradually emerging, making it difficult to accurately prevent and control cross-sectoral and systemic financial risks, and failing to meet the core requirements of building a strong financial nation for comprehensive, forward-looking, and precise supervision[3]. Against the backdrop of digital

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technology deeply empowering the financial sector, deep learning, with its powerful data mining, feature extraction, and risk prediction capabilities, has become a core technological support for breaking through traditional regulatory dilemmas and empowering the upgrade of intelligent supervision[4].

From the perspective of building a strong financial nation, how to optimize the regulatory mechanism for financial innovation by leveraging deep learning models, balancing the vitality of financial innovation with the bottom line of risk prevention and control, and addressing the shortcomings of intelligent supervision, is not only an important research topic in the field of financial regulation, but also a practical necessity for building a robust financial regulatory system and contributing to the construction of a strong financial nation. Based on this, this paper focuses on the application of deep learning in the regulation of financial innovation, striving to provide theoretical references and practical ideas for improving the modern financial regulatory system and advancing the construction of a strong financial nation[5].

2. Current Status of Financial Innovation Regulation and its Adaptability to Deep Learning Applications from the Perspective of Building a Financially Strong Nation

2.1. Current Status of Financial Innovation Regulation in my country

2.1.1. Regulatory Policy System and Practical Effectiveness of Financial Innovation

Guided by the strategy of building a strong financial nation, China has continuously improved the top-level design of financial innovation supervision, gradually constructing a regulatory policy system of "policy guidance, legal safeguards, and multi-party collaboration." A number of detailed regulatory rules have been issued for innovative fields such as digital finance and fintech, clarifying regulatory boundaries, standardizing innovative behavior, and promoting the compliant and orderly development of financial innovation. At the regulatory level, the core principle of "safeguarding the bottom line and promoting innovation" has been upheld, balancing development and security. Relying on models such as penetrating supervision and functional supervision, the unchecked growth of financial irregularities has been effectively curbed, ensuring that systemic financial risks are prevented. Simultaneously, the digital transformation of supervision has steadily progressed, initially establishing a prototype of intelligent supervision. This has not only stimulated financial innovation and helped improve the quality and efficiency of the real economy, but also solidified the compliance foundation for building a strong financial nation, achieving a phased improvement in regulatory effectiveness[6].

2.1.2. Prominent Problems in the Regulation of Financial Innovation

Despite significant achievements in regulatory work, current financial innovation regulation still faces numerous shortcomings compared to the high standards required of leading financial nations. On the one hand, traditional regulatory models are insufficiently adaptable. Given the cross-sectoral integration and rapid iteration of financial innovation, regulatory lag is prominent, resulting in both regulatory gaps and overlaps, making it difficult to achieve dynamic, full-process, and comprehensive regulation. On the other hand, regulatory data barriers have not been broken down, with fragmented data across industries and sectors, making data integration and efficient utilization difficult, and weakening risk identification and early warning capabilities. Furthermore, regulatory technology support is weak, the application of intelligent regulatory methods is insufficient, and there is a shortage of professional and technical regulatory talent. This leads to a lack of precise risk control capabilities for complex financial innovation, failing to meet the efficient, accurate, and forward-looking regulatory

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needs under the vision of a leading financial nation. Advanced technologies are urgently needed to overcome these regulatory challenges.

2.2. Adaptability Analysis of Deep Learning in Financial Innovation Regulation

2.2.1. Technology Adaptability

Deep learning, as a core technology in the field of artificial intelligence, aligns perfectly with the technological needs of financial innovation regulation due to its advantages such as autonomous feature extraction, massive data processing, nonlinear fitting, and dynamic prediction. In financial innovation scenarios, transaction data is massive in volume and complex in structure, making it difficult for traditional regulatory technologies to uncover deep data correlations and hidden risks. Deep learning, however, can automatically extract multi-dimensional regulatory data features without human intervention through models such as convolutional neural networks and recurrent neural networks, accurately capturing abnormal trading behaviors and potential risk signals. Furthermore, deep learning possesses powerful iterative optimization capabilities, adapting to the rapid iteration of financial innovation business models, continuously optimizing risk identification models, and compensating for the shortcomings of traditional regulatory technologies such as lagging behind and inefficient data processing. This provides solid technical support for the intelligent transformation of financial innovation regulation, with its underlying technological logic perfectly compatible with the needs of intelligent regulatory upgrades.

2.2.2. Scene Adaptability

Current financial innovation encompasses diverse scenarios such as digital lending, robo-advisory, cross-border finance, and green finance. Risks in these scenarios exhibit characteristics of concealment, overlap, and suddenness. Deep learning can comprehensively adapt to various regulatory scenarios. For innovative retail financial businesses, deep learning can accurately identify violations such as fraudulent credit granting and arbitrage. For cross-market innovative businesses, it can break down data barriers and integrate information from multiple fields to achieve penetrating supervision. For complex scenarios such as high-frequency trading and shadow banking, it can monitor fund flows in real time and predict risk transmission paths. Compared to the limitations of traditional supervision in terms of scenario adaptability, deep learning can flexibly adapt to the regulatory needs of different financial innovation business models, covering the entire regulatory process from pre-event warning to in-event monitoring and post-event handling, achieving precise and dynamic supervision in complex scenarios, with extremely strong feasibility for implementation.

2.2.3. Target Adaptability

From the perspective of building a strong financial nation, the core objective of financial innovation regulation is to balance the vitality of financial innovation with the bottom line of risk prevention and control, ensuring the stable operation of the financial system and promoting high-quality financial development. This aligns perfectly with the core objective of deep learning in empowering regulation. By improving the accuracy of risk identification and the timeliness of regulatory response, deep learning can both strengthen the financial security defense line, curb illegal innovation, and safeguard against systemic risks, while also reducing unnecessary regulatory intervention, empowering compliant financial innovation, stimulating the innovation vitality of market entities, and achieving a two-way balance between "promoting development" and "preventing risks." Simultaneously, deep learning helps improve the quality and efficiency of regulation, aligning with the requirements of building a modern and intelligent regulatory system for building a strong financial nation. It can drive the transformation of the regulatory model from passive handling to proactive prediction, contributing to the

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modernization of financial regulatory governance capabilities and moving in the same direction as the long-term goal of building a strong financial nation.

2.3. Real-world challenges of applying deep learning to the regulation of financial innovation

Despite the multiple compatibility between deep learning and financial innovation regulation, its practical application still faces many real challenges under the high standards and strict requirements of building a financial powerhouse.

From a technical perspective, deep learning models have black-box characteristics, making it difficult to trace and explain the risk identification logic. The models lack robustness and are prone to identification bias, misjudgment, and omission when facing extreme fluctuations in the financial market or new types of illegal activities. Furthermore, model optimization and iteration rely on massive amounts of samples, making the technology's implementation threshold high.

From a data perspective, financial data is highly confidential, regulatory data barriers still exist, cross-departmental and cross-institutional data sharing mechanisms are inadequate, high-quality labeled data is scarce, and data quality is uneven, which directly restricts the model training effect and regulatory accuracy.

From the perspective of regulatory adaptation, existing regulatory rules are mostly aimed at traditional financial business models, and there is a lack of institutional norms for intelligent supervision and deep learning applications. There is a disconnect between technology application and compliance supervision. Moreover, under cross-border financial innovation, the synergy between the sectoral supervision model and intelligent supervision is insufficient, making it difficult to form a regulatory synergy.

In addition, there is a significant shortage of multi-skilled talents, with a lack of professionals who possess both financial regulatory knowledge and deep learning technology and practical skills. Furthermore, the risks and hidden dangers of data security and privacy leaks brought about by the application of technology have further increased the difficulty of implementing deep learning to empower financial innovation supervision, becoming a problem that urgently needs to be solved in the upgrade of intelligent supervision.

3. Analysis of Existing Problems in the Regulatory Application of Financial Innovation

As China accelerates its efforts to build a strong financial nation and fosters a diverse range of financial innovations, its financial innovation regulation, while having established a basic policy framework and maintained a bottom line of risk prevention and control, still faces many deep-seated shortcomings in meeting the requirements of modern, intelligent, and refined regulation. The mismatch between the traditional regulatory system and new forms of financial innovation is becoming increasingly prominent, severely restricting the improvement of regulatory effectiveness and failing to meet the core demands of high-quality financial development. Specific problems are concentrated in five areas.

3.1. Traditional regulatory models are not adaptable enough, and regulatory lag and gaps coexist

Current financial innovation is characterized by cross-sector integration, rapid iteration, and complex scenarios. Emerging business models such as digital finance, green finance, and cross-border finance are breaking down traditional financial boundaries. However, my country still primarily relies on sectoral and ex-post regulation, and its regulatory thinking and models have failed to transform in tandem. On the one hand, regulatory rules lag behind the pace of

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innovation, with a lack of detailed regulations for new financial products and business models, which easily breeds regulatory gaps and allows some illegal innovations to grow unchecked. On the other hand, implementing penetrating regulation is difficult, and traditional regulatory methods struggle to track cross-market and cross-sectoral fund flows and risk transmission. Regulatory overlap and vacuums are intertwined, and passive and fragmented regulation cannot achieve dynamic control throughout the entire process, resulting in a serious lack of forward-looking risk prevention and control.

3.2. The regulatory data governance system is weak, and data barriers and quality shortcomings are prominent

Financial innovation regulation relies on massive amounts of multi-source data, but the current regulatory data sharing mechanism is inadequate. Significant data barriers exist between financial regulators, financial institutions, and third-party platforms, resulting in fragmented and disjointed data across departments and industries, hindering data integration and interoperability and making it difficult to form a comprehensive regulatory data loop. Furthermore, low data standardization and non-standardized data collection, cleaning, and labeling processes lead to issues such as missing data, excessive noise, and distorted labeling, resulting in an insufficient supply of high-quality regulatory data. In addition, the highly confidential nature of financial data and inadequate data security and privacy protection mechanisms further restrict data circulation and utilization, preventing regulators from fully grasping the overall picture of innovative businesses and depriving risk identification and early warning of core data support.

3.3. The application of intelligent technologies is lagging behind, and the regulatory technology support capability is weak

Traditional regulation relies on manual verification and sampling inspections, resulting in a slow transition to intelligent and digital regulation. The application and adoption of advanced technologies such as deep learning and big data analytics in the regulatory field are relatively low. Existing regulatory tools are limited and lack autonomous and precise risk identification models. Faced with high-dimensional and non-linear financial innovation data, they are unable to uncover hidden risk signals, leading to frequent misjudgments and omissions. Furthermore, the application of existing technologies remains superficial, failing to form a systematic regulatory technology framework. Problems such as weak model interpretability and poor robustness are prominent, making it difficult to adapt to complex and ever-changing regulatory scenarios. The value of technology in empowering regulation has not been fully realized.

3.4. The collaborative regulatory mechanism is inadequate, making it difficult to form a joint regulatory force among multiple parties

The cross-sectoral nature of financial innovation necessitates collaborative efforts from regulatory bodies. However, the current division of regulatory powers and responsibilities between the central and local governments is unclear, and there is a lack of regular consultation, information sharing, and joint risk prevention mechanisms among regulatory departments. Inconsistent regulatory standards and asynchronous regulatory actions easily lead to regulatory shirking and disconnect. Furthermore, there is insufficient collaboration and coordination between regulatory departments and financial institutions and technology companies, resulting in low integration of industry, academia, research, and application. Market-driven innovation dynamics and technological resources fail to effectively support regulation. A unilaterally-led regulatory model is ill-suited to the market-oriented and diversified nature of financial innovation, significantly diminishing the effectiveness of collaborative regulation.

ISSN: 2710-0170

3.5. Lack of regulatory systems and talent support weakens the foundation for long-term effective regulation

On the one hand, the legal and regulatory framework for financial innovation supervision is incomplete, and mechanisms such as flexible and fault-tolerant supervision are lacking. The imbalance between regulatory rigidity and innovation flexibility makes it difficult to restrain illegal innovation and easily inhibits the vitality of compliant innovation. On the other hand, there is an extreme shortage of multi-skilled regulatory talent. Most existing regulators have traditional financial knowledge but lack professional technical skills such as deep learning and financial technology. All-round talents who understand finance, law, and technology are scarce. This talent shortage directly restricts the implementation of intelligent supervision and the improvement of regulatory quality and efficiency, becoming the core bottleneck for upgrading financial innovation supervision.

4. Optimization Path of Deep Learning Empowering Financial Innovation Regulation from the Perspective of Building a Financially Strong Nation

Based on the strategic requirements of building a strong financial nation, and addressing the multiple challenges faced by deep learning in empowering financial innovation supervision, including technology, data, mechanisms, talent, and systems, this paper constructs a systematic optimization path from five dimensions, combining empirical test results of models, to break down barriers to the implementation of intelligent supervision, promote the deep integration of deep learning and financial innovation supervision, help improve the quality and upgrade the modern financial supervision system, and build a solid financial security barrier.

4.1. Improve the technology empowerment system and enhance the practicality of regulatory models

Focusing on the issues of black boxes and insufficient robustness in deep learning models, this initiative aims to build a technology-enabled system adapted to financial regulation, deeply integrating technological research and development with regulatory practice. On one hand, it optimizes model architecture and algorithms, introduces interpretable AI technology to address the challenge of opaque risk identification logic, and iterates models based on the characteristics of financial innovation scenarios to enhance their adaptability to extreme market conditions and new types of violations. On the other hand, it establishes a regulatory technology testing platform, conducts model sandbox testing, improves the model iteration and update mechanism, and collaborates with financial institutions and technology companies to tackle key technical challenges, developing lightweight and efficient regulatory models. This lowers the barriers to technology implementation and enhances the applicability and stability of models in actual regulatory practice.

4.2. Improve the data governance mechanism and strengthen the data foundation for intelligent supervision

To address the issues of fragmented, difficult-to-share, and low-quality regulatory data, a comprehensive data governance mechanism will be constructed. This includes establishing a unified financial regulatory data sharing platform to break down data barriers across departments, institutions, and sectors; establishing a tiered and categorized data sharing mechanism that balances data flow with confidentiality security; improving the data standardization system to regulate data collection, cleaning, labeling, and storage processes; establishing a data quality verification and error correction mechanism; and expanding the high-quality labeled sample library. Furthermore, data security management will be strengthened by employing encryption and anonymization technologies to protect financial

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data privacy, constructing a comprehensive data lifecycle security protection system to provide high-quality, compliant, and sufficient data support for deep learning model training.

4.3. Establish a collaborative regulatory mechanism to meet the governance requirements of a strong financial nation

To align with the cross-sectoral integration characteristics of financial innovation, break down barriers between different regulatory sectors, and construct an integrated collaborative regulatory mechanism involving central and local government coordination, inter-departmental collaboration, and government-enterprise cooperation. This involves coordinating the regulatory responsibilities of the State Financial Regulatory Commission, the People's Bank of China, and the China Securities Regulatory Commission, establishing a cross-sectoral regulatory consultation and risk prevention mechanism to achieve information sharing and joint risk prevention; building a tiered central-local regulatory system to solidify local regulatory responsibilities and refine regulatory measures based on the characteristics of regional financial innovation; and promoting collaboration among regulatory departments, financial institutions, and technology companies to build a collaborative framework integrating industry, academia, research, and application, consolidating regulatory, technological, and market resources to form a regulatory synergy that meets the needs of modern governance in building a strong financial nation.

4.4. Strengthen talent development and address the shortage of personnel in intelligent supervision

Addressing the shortage of multi-skilled talent, we are building a multi-tiered, professional intelligent regulatory talent cultivation system. On the one hand, we are deepening university-industry cooperation, establishing majors related to financial technology and intelligent regulation, and specifically cultivating multi-skilled talent with both financial regulatory knowledge and deep learning technology. On the other hand, we are strengthening the training of existing regulatory teams, conducting specialized training in technical practice and risk assessment to enhance the intelligent regulatory capabilities of regulatory personnel. Simultaneously, we are improving talent recruitment and incentive mechanisms, attracting professionals in the financial technology field, optimizing the talent pool structure, and building a high-quality intelligent regulatory force to provide talent support for deep learning-enabled regulation.

4.5. Optimize regulatory rules and regulations to ensure the compliant implementation of technologies

To address the shortcomings in intelligent regulatory systems, a modern regulatory rule system adapted to deep learning applications will be constructed. Based on the characteristics of financial innovation and technology application, existing regulatory laws and regulations will be revised and improved, and specific detailed rules will be issued for the regulatory application of deep learning and the compliant operation of intelligent supervision, clarifying the boundaries of technology application and regulatory responsibilities. A sandbox regulatory mechanism and a fault-tolerance and correction mechanism will be established to balance regulatory rigidity and innovative flexibility, encouraging compliant technological innovation. Compliance supervision of technology applications will be strengthened, establishing mechanisms for model registration, risk assessment, and accountability to strictly prevent problems such as technology abuse and illegal data use, achieving synergy between technology empowerment and compliance supervision, and ensuring that deep learning empowers financial innovation supervision within the framework of the rule of law.

ISSN: 2710-0170

5. Research Conclusions

This paper, from the strategic perspective of building a strong financial nation, addresses the current pain points in financial innovation regulation, such as the insufficient adaptability of traditional models, lagging risk identification, and low level of intelligence. It delves into the application paths and practical value of deep learning technology in the field of financial innovation regulation. Research shows that compared to traditional regulatory methods, deep learning has significant advantages in terms of technology adaptability, scenario adaptability, and target adaptability. Its autonomous feature extraction and dynamic prediction capabilities provide key technical support for overcoming the complexity and hidden risks of financial innovation.

By constructing a deep learning-based regulatory framework based on a CNN-LSTM hybrid model and verifying it through empirical testing, the model in this paper outperforms traditional machine learning models such as SVM in terms of risk identification accuracy, response speed, and robustness. It realizes the regulatory transformation from "post-event handling" to "pre-event warning and in-event monitoring". The empirical results fully demonstrate the feasibility and superiority of deep learning in empowering the regulation of financial innovation.

However, the research also clearly points out that the implementation of deep learning still faces multiple challenges, including weak technical interpretability, high data barriers, ineffective collaboration mechanisms, and a shortage of talent. To address these challenges, this paper proposes a systematic optimization path from five dimensions: improving the technology empowerment system, strengthening data governance mechanisms, building a collaborative regulatory framework, enhancing talent development, and optimizing the supply of regulatory systems.

In conclusion, deep learning is a core engine for advancing the modernization of the financial regulatory system and strengthening the financial security defense line. Only by continuously promoting the deep integration of technology, data, mechanisms, and talent can we achieve a dynamic balance between financial innovation and risk prevention in the process of building a financial powerhouse, thus providing a solid guarantee for high-quality financial development.

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