Research on the Application Path and Supervision Mechanism Optimization of Blockchain Technology Embedded in Elderly Care Finance

Ruier Li

Affiliation: School of Economics and Finance, Xi'an International Studies University, Chang'an District, Shaanxi Province, 710128, China
Email: LiruierAAA@outlook.com

Abstract

Against the backdrop of accelerating population aging and issues concerning the security of elderly care finance, the innovation of elderly care finance is urgently needed. This study takes Chongqing, a typical region in China, as an example, adopting literature research and case analysis methods to explore the specific application paths of blockchain technology and the optimization of supervision mechanisms. The research results show that blockchain technology has significant advantages in pension management, service collaboration, and financial supervision, but there are still problems at the technical, application, and supervision levels. Therefore, based on the practice in Chongqing, this study innovatively constructs a "technology + application + supervision" trinity systematic optimization framework(including regulatory sandbox and tech tools), aiming to improve the quality and efficiency of elderly care financial services, ensure the foundation for the healthy development of the industry, and provide a reference for the innovation of elderly care financial models and the upgrading of efficiency.

Keywords: Blockchain Technology; Elderly Care Financial Supervision; Financial Technology; Regional Practice

1. Introduction

With the continuous acceleration of the population aging process, the demand for elderly care finance has expanded rapidly. However, frequent loopholes in pension security management and incidents of illegal misappropriation have posed severe challenges to the stable operation of the elderly care financial system. As a representative city in China with a high degree of aging, an early layout of blockchain technology, and a relatively mature financial technology ecosystem, Chongqing provides a typical sample for exploring the in-depth integration of blockchain technology and elderly care finance. Through in-depth analysis of the Chongqing case, this study not only helps to expand the theoretical perspective of rights protection mechanisms but also provides a basis for the optimization of supervision systems and the practical protection of the rights and interests of the elderly.

1.1 Research Background

The intensification of population aging has driven up the demand for elderly care finance. Data released by the Ministry of Civil Affairs and the National Working Committee on Aging on January 17, 2025, shows that the population aged 60 and above accounts for 22% of the total population in China. Notably, according to the Chongqing Statistical Yearbook data on May 31, 2025, this proportion reached nearly 25.11% in Chongqing in 2024, ranking second in China and first in western China. Meanwhile, the "Audit Report on the Implementation of the Central Budget and Other Fiscal Revenues and Expenditures in 2024" issued by the National Audit Office on June 24, 2025, revealed that 40.626 billion yuan of residents' pensions had been misappropriated or fraudulently obtained. Some elderly people in Chongqing and other places have encountered difficulties in living security, reflecting the defects of traditional financial supervision. In addition, Chongqing has significant advantages in financial technology and blockchain infrastructure. As early as 2021, Chongqing built China's first blockchain-themed digital economy industrial park. An industry report released by the China Research and Intelligence Network on July 3, 2025, shows that the scale of Chongqing's financial technology market will exceed 120 billion yuan by 2030, becoming a new engine for the high-quality economic development of western China.

1.2 Research Significance

1.2.1 Theoretical Significance

Based on the specific case of Chongqing, this study describes the application scenarios and operational details of blockchain technology in Chongqing's elderly care finance, analyzes the problems exposed in practice, and provides a new perspective for the research on rights protection mechanisms.

1.2.2 Practical Significance

The case is typical. In-depth analysis of the application details and supervision practices of a single case helps to explore the application of blockchain technology in elderly care finance and protect the rights and interests of the elderly from the institutional level.

2. Literature Review

Regarding blockchain and elderly care finance, existing studies can be summarized into two main strands: foreign studies focus on regulatory compliance and privacy risks, while domestic studies emphasize service reconstruction and application paths.

Junaid Rahman et al. (2025) revealed the constraints of regulatory fragmentation on cross-border pension operations by comparing global blockchain asset supervision frameworks, providing a macro perspective on regulatory dilemmas[1]. Sunday Abayomi Joseph (2024) compared cases in Europe and the United States and found that the transparency of public blockchains increases the risk of identity information leakage for the elderly by 23%, providing a compliance benchmark for privacy protection solutions[2]. Päivi Hutukka (2024) compared the financial technology legal systems of Europe, the United States, and China, clarifying the differences in the application of blockchain finance in different jurisdictions and providing references for compliant operations[3]. Zhang Lin and Liao Feimei (2025) analyzed the reconstructive effect of blockchain underlying architecture innovation on the service logic and processes of elderly care finance[4]. Jin Tian (2022) put forward a systematic plan for blockchain to facilitate the innovation of elderly care finance, focusing more on technology integration and business innovation[5]. Dang Xue and Zhou Zhenguo (2021) constructed a "demand-supply-ecology" framework and proposed four technical optimization paths[6]. Dang Xue (2021) analyzed practical problems from four dimensions and clarified the empowerment logic of blockchain[7]. Liu Xiangfang (2020) verified that blockchain can solve the financing dilemma of the health and elderly care industry by optimizing financial tools and processes[8].

Existing studies have laid a foundation, but there are shortcomings: there are few systematic plans for the in-depth integration of technology and elderly care finance; research on cross-regional supervision coordination mechanisms is weak; and there is a lack of in-depth analysis of single-case technology applications and supervision practices. This study aims to address the above research gaps, focusing on the integration of application path innovation and supervision coordination mechanisms, and strengthening the construction of rights protection mechanisms under technology empowerment.

3. Case Practice of Blockchain Technology Embedded in Elderly Care Finance in Chongqing

3.1 Basis for Selecting the Chongqing Case

Chongqing has a prominent aging problem, with the population aged 60 and above accounting for nearly 25.11% of the total population, ranking second in China and first in western China. According to the "Chongqing Elderly Care Finance Research Report (2024)" released by People's Network on November 11, 2024, Chongqing has taken the lead in launching a number of innovative pilots in the field of elderly care finance, such as the personal pension system. At the same time, Chongqing has a solid foundation in blockchain technology. In April 2021, it built China's first blockchain-themed digital economy industrial park, with a cross-chain service platform supporting service sectors including elderly subsidies. The Chongqing Municipal People's Government Report on December 29, 2024, showed that it pioneered the "one-chain" service model to realize city-district linkage and municipal-level traceability. The "Western Financial Center (Chongqing) Development White Paper" on May 23, 2025, mentioned that Chongqing's blockchain cross-border financial innovation was rated as an excellent national case. Data from the China Research and Intelligence Network on April 21, 2025, shows that the application of blockchain in local financial technology accounts for 18%, providing a foundation for technology empowerment in elderly care finance.

3.2 Current Application Situation in Chongqing

3.2.1 Pension Management

In the pilot project in Yuzhong District of Chongqing, the FISCO BCOS consortium chain and Zero-Knowledge Proof (ZKP) technology are used for identity verification. According to a report by 16 ministries and commissions including the Cyberspace Administration of China in June 2024, this pilot has increased the efficiency of identity verification by 85% and achieved zero data leakage, and its experience has been included in the "China Blockchain Innovation Application Development Report (2023)".

3.2.2 Elderly Care Service Collaboration

As reported by Chongqing Daily on April 14, 2025, through the "blockchain + health records" model, Chongqing has initially realized cross-regional sharing of key data such as electronic medical records. Taking the well-known medical and elderly care enterprise "Taikang Home · Yuyuan" as an example, it was included in the "Chongqing Grand Health Industry Development White Paper 2025" by virtue of this model. Data shows that by the end of 2024, its occupancy rate reached 87% and customer satisfaction was 91.6%, indicating that technology application has improved service quality.

3.2.3 Supervision Collaboration

As disclosed by the "China Market Supervision News" on October 17, 2024, Chongqing has built the "Yukuailian" supervision platform and the "Shancheng Youxin" mini-program, which have pushed more than 100 million compliance reminders and other messages, designated 40 "regional sandbox" pilots, and included 137,000 elderly care financial entities in the "regulatory sandbox". However, the "Chongqing Morning Post" on December 7, 2024, pointed out that Chongqing Cangzhou Network Technology Co., Ltd. developed an illegal APP under the name of blockchain, which was not supervised in a timely manner.

3.3 Core Problems in the Application in Chongqing

3.3.1 Technical Performance and Data Risks

There are three major challenges in technical performance and data. Firstly, blockchain has insufficient international competitiveness, and its participation in the formulation of global standards is weak. Secondly, the FISCO BCOS consortium chain is prone to node delays and transaction failures during the centralized pension distribution period, requiring configuration optimization. Thirdly, there are privacy vulnerabilities in the interaction between public chains and consortium chains, and inconsistent data standards among multiple institutions affect collaboration. Fourthly, Oracle, a key component, has defects of low data reliability and high volatility, which may affect the fair execution of smart contracts and the overall stability of the financial system.

3.3.2 Challenges in Application Implementation and the "Digital Divide"

Traditional elderly care institutions and the new blockchain system are difficult to integrate due to inconsistent data formats and interfaces, resulting in delayed subsidy distribution in some community service stations during peak periods. The congestion in pension distribution during peak periods may trigger a trust crisis. Some applications "prioritize technology over scenarios" and have a low matching degree with actual needs. Although Zero-Knowledge Proof technology has alleviated privacy concerns to a certain extent, the "digital divide" problem remains prominent. According to the 2024 corporate report of Taikang Home · Yuyuan, only 19% of the elderly over 80 can independently query blockchain health records, 65% need assistance, and the operation error rate reaches 23%. The low acceptance of technology by elderly users deeply reflects the structural contradiction between the lack of age-appropriate design and the imperfection of the technical training system.

3.3.3 Risks in Supervision Collaboration and Policy Adaptation

Platforms such as "Yukuailian" face problems such as difficult node interconnection and blocked cross-regional data flow in practice. More importantly, the incident of Chongqing Cangzhou Company reveals that there are major loopholes in the information sharing and collaborative response mechanisms among multiple departments, making it difficult to effectively identify cross-scenario illegal risks. The current supervision system lags significantly behind technological innovation, and relevant laws and policies lack sufficient adaptability, posing risks to the safe operation of elderly care finance.

4. Suggestions for Optimizing the Supervision Mechanism

In response to the above problems, this study proposes a multi-level and systematic supervision mechanism optimization plan to address the challenges in technology, application, and supervision collaboration.

4.1 Implementation Path of the Regulatory Sandbox

A closed-loop mechanism of "early warning → smooth transition → post-event support" is adopted to reduce the short-term impact of withdrawal on the financial order. This mechanism is promoted in three phases: the prediction phase focuses on risk prediction, the evaluation phase conducts regional effect monitoring, and the promotion phase realizes national adaptation.

4.2 List of Regulatory Technology Tools

Data Verification Tools: Introduce Chainlink nodes to the Central Bank's Financial Technology Certification Center, and adopt a "double signature + multi-node voting" mechanism to improve the tamper-proofing and reliability of Oracle data. Use the MythX tool for formal verification and static analysis of smart contracts. The operation process includes: first uploading the pension contract code pre-reviewed by "Yukuailian", identifying high-risk functions, generating and archiving compliance reports. Once data anomalies occur, a circuit breaker mechanism is triggered to freeze transactions and transfer them to manual review.

Responsibility Division Tools: Losses caused by parameter misconfiguration shall be borne by the government and enterprises in accordance with the pre-agreed proportion. Enterprises shall refer to the contract model of Taikang Home · Yuyuan and clarify the requirements for purchasing technology liability insurance in smart contracts. If Oracle transmits wrong data leading to losses, the data provider shall bear 80% of the compensation.

4.3 Collaborative Governance

Strengthening cross-departmental collaboration is the key to solving regulatory fragmentation. It is suggested to establish a joint supervision mechanism for blockchain elderly care finance, integrate the forces of the market supervision department, the financial bureau, and the public security bureau, establish a real-time sharing list covering 32 indicators such as credit scores and violation records of 137,000 enterprises, and conduct weekly joint risk assessment. For the 40 existing pilot areas, a 3-month "observation period" for sandbox withdrawal should be set up, requiring institutions to complete compliance rectification, stress testing, and user notification procedures before withdrawal. Drawing on the experience of Yuzhong District, the market impact should be controlled within 5%.

5. Conclusions and Acknowledgments

5.1 Research Conclusions

Taking Chongqing as a sample, this study conducts an in-depth analysis of the application paths of blockchain technology in elderly care finance, filling the gap in cross-chain collaborative supervision in single-case research. The research confirms that blockchain has significant potential in improving the efficiency of pension management and optimizing elderly care service collaboration. The "technology + application + supervision" trinity optimization framework proposed in this paper is both systematic and applicable,potentially replicable with adaptations for similar cities.

5.2 Research Limitations and Acknowledgments

This study has limitations. On the one hand, the case only focuses on Chongqing, and its "city-district linkage+municipal-level traceability" model relies on authority, so cross-provincial application may face hierarchical coordination problems. On the other hand, there is still room for improvement in covering financial supervision risks and constructing countermeasures. In addition, blockchain technology is updating rapidly, and its long-term application effects and risk evolution still require continuous tracking research. Future research can focus on cross-regional comparisons, the design of technical interface standardization, and the development of more refined policy tools to continuously improve the research system of blockchain empowering elderly care finance.

References

[1] Zhang, L., Liao, F.M. (2025) Risk challenges and innovative paths of blockchain technology-driven fintech regulation. Western Finance and Accounting, 2025(02): 48-51.
[2] Jin, T. (2022) Pension finance "ignited" by blockchain applications. Modern Commercial Banking, 2022(14): 22-25.

[3] Dang, X., Zhou, Z.G. (2021) Path selection for blockchain technology assisting the smart upgrade of China's pension service finance. Southwestern Finance, 2021(12): 69-79.
[4] Dang, X. (2021) The enabling role and path of fintech in the development of pension finance. Southwestern Finance, 2021(02): 49-60.
[5] Liu, X.F. (2020) Research on the application of blockchain technology in the investment and financing of the health and wellness industry. DOI:10.27714/d.cnki.gjljjs.2021.000024.
[6] Rahman, J., Rahman, H., Islam, N., Tanchangya, T., Ridwan, M., & Ali, M. (2025). Regulatory Landscape of Blockchain Assets: Analyzing the Drivers of NFT and Cryptocurrency Regulation. BenchCouncil Transactions on Benchmarks, Standards and Evaluations, 5, 100214.
[7] Joseph, S. A. (2024). Balancing Data Privacy and Compliance in Blockchain-Based Financial Systems. Journal of Engineering Research and Reports, 26, 169-189.
[8] Hutukka, P. (2024). Fintech Law in the European Union, the United States and China: Regulation of Financial Technology in Comparative Context. Maastricht Journal of European and Comparative Law, 31, 559-594.