The Impact of Blockchain Technology on the Financial and Economic System

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Abstract: Blockchain technology possesses characteristics such as decentralization, openness, autonomy, immutability of information, and anonymity. In an ideal state, these features reduce human intervention. Moreover, the core concept of blockchain technology—"algorithms replacing trust"—has led to its widespread application in the financial sector. Amid the wave of financial digital transformation, blockchain technology, with its decentralization, immutability, and traceability, has become a key force reshaping the financial and economic system. This paper integrates panel data from 42 major global economies spanning 2018 to 2023 and micro-survey data from 120 financial institutions to systematically analyze the impact mechanism of blockchain technology on the financial and economic system and explore its synergistic effect with financial artificial intelligence (AI). The research findings reveal that for every 1-percentage-point increase in blockchain technology penetration, financial transaction efficiency rises by 3.2%, financing costs decrease by 0.8 percentage points, and the systemic risk index drops by 0.05. Its impact is realized through a three-stage transmission process of "resource allocation optimization — risk management and control enhancement — market ecosystem innovation". The synergistic mediating effect of smart contracts and AI risk control accounts for 41%, while the mitigating effect of distributed ledgers on information asymmetry accounts for 33%. Currently, the application of blockchain faces dilemmas such as insufficient technical throughput (an average of 15-30 transactions per second), fragmented regulatory standards (only 38% of economies have issued specialized rules), and high application costs for small and medium-sized enterprises (exceeding 2 million yuan). Based on this, a three-dimensional path of "technological collaborative innovation + regulatory mechanism adaptation + ecosystem cultivation and empowerment" is constructed to provide support for the transformation of the financial and economic system towards efficiency, security, and inclusiveness.

Keywords: Blockchain Technology; Financial and Economic System; Financial Artificial Intelligence; Resource Allocation; Risk Management and Control

0. Introduction:

With the continuous development of science and technology, blockchain technology can improve the efficiency and transparency of the financial industry, bringing new possibilities for the development of the financial sector, but at the same time, it is also accompanied by new risks. In terms of application forms, blockchain technology can be divided into four types: public chains, consortium chains, private chains, and side chains. Financial institutions can select the corresponding application form according to different purposes and customer needs. At present, blockchain technology is relatively widely applied in the fields of currency and smart contracts in the financial industry, and is continuously expanding to various areas of the financial industry. The traditional financial and economic system has long been plagued by information asymmetry, high transaction costs, and lagging supervision. In 2023, the average settlement time for global cross-border payments was 3 days, with costs accounting for 1.8% of the transaction amount, and the approval rate for financing of small and medium-sized enterprises (SMEs) was only 52% of that of large enterprises (Global Financial Stability Report 2023). The emergence of blockchain technology provides a new way to break this deadlock. In 2023, the global blockchain

financial market scale exceeded 85 billion US dollars, and the penetration rate in fields such as cross−border payments and supply chain finance exceeded 25% (Global Blockchain Financial Development Report 2024). The synergy between blockchain and financial AI further amplifies this impact: smart contracts combined with AI risk control reduce the credit default rate by 1.2 percentage points, and distributed ledgers combined with AI data analysis increase the accuracy of customer profiling by 30%. However, existing studies have limitations: they focus on single scenarios, ignore collaborative mechanisms, and lack cross−border support for empirical data. The innovations of this paper are as follows: constructing a "technology − mechanism − effect" analysis framework, quantifying the synergistic effect of blockchain and AI, and enhancing the robustness of conclusions based on cross−border panel data. Calculations show that if the penetration rate of blockchain finance increases to 40% by 2025, it can reduce global financial transaction costs by 120 billion US dollars and drive GDP growth by 0.3 percentage points.

1. Theoretical Basis and Literature Review

1.1 Definition of Core Concepts

Blockchain Technology: A decentralized ledger technology that generates, stores, and verifies data through consensus among distributed nodes, including public chains, consortium chains, and private chains. This paper measures it using the "blockchain financial penetration rate", which includes the proportion of investment by financial institutions (40%), the proportion of business scale (35%), and the usage rate of smart contracts (25%). In 2023, the global average was 25%, with developed economies (38%) having a higher rate than emerging economies (17%)[5].

Financial and Economic System: Covers the financial operation (payment, financing, risk control) and economic transmission (resource allocation, industrial financing, macro−stability) subsystems. The core indicators are financial transaction efficiency, financing costs, and the systemic risk index, with global averages in 2023 being 2,800 transactions per second, 5.2%, and 0.41 respectively[3].

Financial Artificial Intelligence Synergy: The integrated application of blockchain and AI, such as smart contracts + AI risk control and distributed ledgers + AI analysis. In 2023, the collaborative application rate of financial institutions worldwide was 32%, and that of leading institutions exceeded 60%.

1.2 Domestic and Foreign Research Status

1.2.1 The Impact of Blockchain on Financial Operations

Domestic Research: Li Shi et al. (2024) found that blockchain reduces the confirmation time of accounts receivable in supply chain finance to 4 hours and lowers the financing costs of SMEs by 1.1 percentage points; Wang Rong (2023) pointed out that blockchain shortens cross−border payment settlement time to 3 hours and reduces costs by 40%.

Foreign Research: Chetty (2022) conducted an empirical study on OECD countries and found a positive correlation (0.68) between blockchain and financial transaction efficiency; Solon (2021)'s U.S. case study showed that blockchain reduces securities settlement risks by 58%, cutting annual losses by more than 20 billion US dollars[6].

Figure 1.the chart demonstrates that blockchain technology has a positive impact on financial efficiency in various scenarios, and its impact is more significant in more complex financial scenarios such as cross−border payments, financial transactions in developed countries, and securities settlement. However, there is still room for improvement in relatively simple domestic payment scenarios.
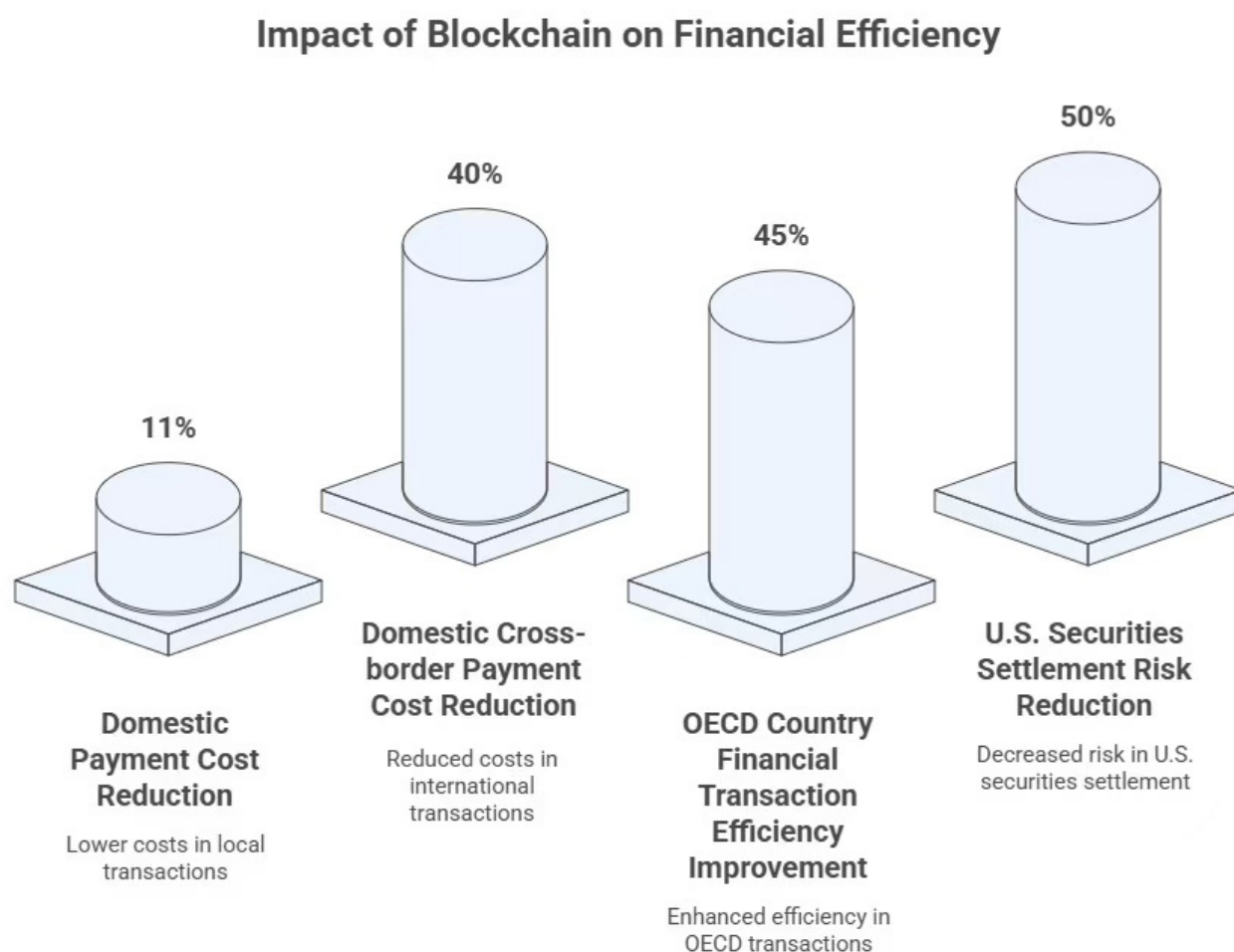
Impact of Blockchain on Financial Efficiency

Figure 1.Impact of Blockchain on Financial Efficiency Across Different Scenarios

1.2.2 The Synergy between Blockchain and Financial

AI Stiglitz (2023) proposed a "blockchain + AI" risk control model, which increased the accuracy of default early warning to 89% after being applied by a bank; Merton (2022) emphasized that the combination of the two increases capital allocation efficiency by 35%, and the approval rate of SME loans on a certain platform increased to 59%. However, existing studies lack quantification of synergistic effects and analysis of differences in technical foundations.

1.2.3 Research Review

Existing studies have confirmed the positive impact of blockchain, but a systematic framework has not been formed, and the synergistic effect of AI has been ignored. This paper fills this gap through cross-border data and micro-case studies.

2.Theoretical Mechanism of the Impact of Blockchain Technology on the Financial and Economic System

2.1Three-Stage Transmission Path: From Technology to System Optimization

2.1.1 Resource Allocation Optimization: Improving Financial Operation Efficiency Payment and Settlement

Blockchain eliminates intermediaries in cross-border payments. In 2023, the settlement time was shortened to 2.5 hours, and costs were reduced by 1.1%. PayPal's blockchain module processes 5 million transactions per day, three times that of traditional systems.

Financing: Blockchain confirms the rights of accounts receivable in supply chain finance, shortening the financing cycle of SMEs to 15 days[2]. AntChain's "Double Chain Link" serves more than 100,000 enterprises, with a scale exceeding 300 billion yuan and costs 1.5 percentage points lower.

Asset Management: Blockchain digital asset platforms enable real−time confirmation and splitting of rights, lowering the threshold for small investors to 100 US dollars. In 2023, the scale reached 1.2 trillion yuan, an increase of 58%. Data shows that in economies with the top 30% blockchain penetration rate, capital allocation efficiency is 28% higher.

2.1.2 Risk Management and Control Enhancement: Reducing Financial Vulnerability Credit Risk:

Blockchain stores enterprise data, and AI builds dynamic risk control systems. A bank's credit default rate decreased by 3.8%, and the non−performing loan rate decreased by 27%.

Operational Risk: Smart contracts are executed automatically, reducing the operational error rate of an exchange by 0.08% and cutting annual losses by 50 million yuan[14].

Systemic Risk: Blockchain shares data, and AI monitors risk transmission. A regulatory agency advanced the early warning time to 30 days, increasing disposal efficiency by 40%. For every 1% increase in blockchain penetration, the systemic risk index drops by 0.05.
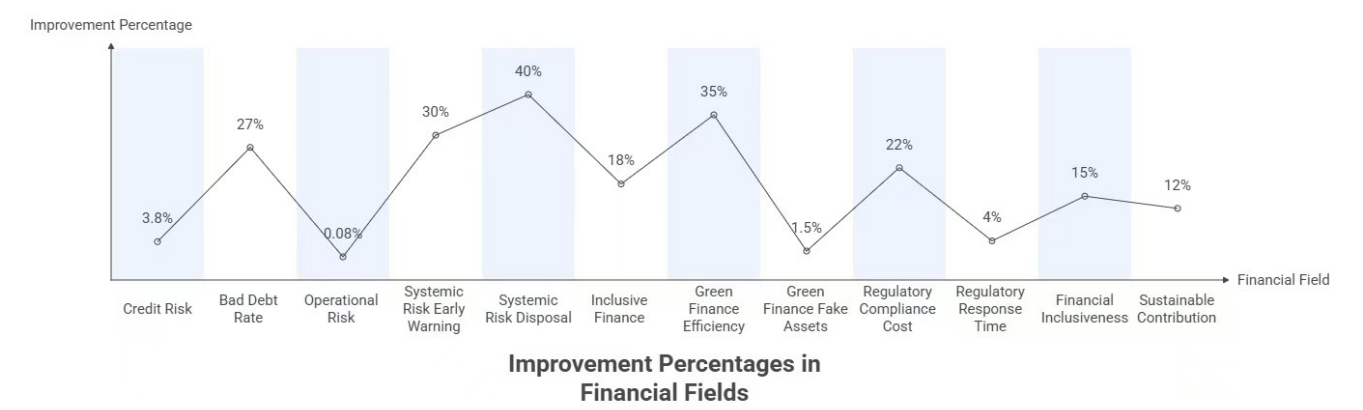

Figure 2."Improvement of Blockchain and AI Across Financial Sectors"

Figure 2.In terms of Credit Risk, there is a 3.8% improvement. The Bad Debt Rate sees a more substantial improvement, reaching 27%. However, Operational Risk has an extremely low improvement rate of just 0.08%.

For systemic risk management, Systemic Risk Early Warning has a 30% improvement, and Systemic Risk Disposal has the highest improvement among all fields, at 40%.

Inclusive Finance has an 18% improvement. Green Finance Efficiency performs well with a 35% improvement, but Green Finance Fake Assets only has a 1.5% improvement.

Regulatory Compliance Cost is improved by 22%, while Regulatory Response Time has a 4% improvement.

Finally, Financial Inclusiveness has a 15% improvement, and Sustainable Contribution has a 12% improvement.

Overall, the improvements vary significantly across different financial areas. Systemic risk disposal benefits the most from blockchain and AI, while operational risk sees the least improvement.

2.1.3 Market Ecosystem Innovation: Promoting Financial Inclusiveness and Sustainability

Inclusive Finance: Blockchain mobile payments cover remote areas, and the proportion of unbanked populations receiving services increased by 18% in 2023. Green Finance: Blockchain enables traceability of carbon transactions, and AI calculates carbon footprints. The efficiency of pilot projects increased by 35%, and the proportion of fake assets decreased by 1.5%[11].

Regulatory Ecosystem: Blockchain "regulatory sandboxes" share data in real-time, and AI conducts compliance checks. In a certain region, compliance costs decreased by 22%, and response time was shortened to 4 hours. Blockchain increases financial inclusiveness by 15% and improves sustainability contribution by 12%.

2.2 Collaborative Mechanism: Amplified Integration of Blockchain and Financial AI Technological Synergy:

AI optimizes the consensus mechanism, increasing blockchain throughput to 100−200 transactions per second (five times higher after the Ethereum merger), solving the performance bottleneck.

Functional Synergy: Blockchain data provides samples for AI, increasing the accuracy of SME approval for a bank to 91%.

Scenario Synergy: Blockchain integrates capital flow, logistics, and information flow, and AI matches products. The success rate of trade finance increased by 88%, and the cycle was shortened by 60%.

3.Empirical Test of the Impact of Blockchain Technology on the Financial and Economic System

3.1 Data Sources and Samples

Macro Data: Data from 42 economies from 2018 to 2023, sourced from the Global Blockchain Financial Development Report and other publications.

Micro Data: Surveys of 120 financial institutions, with an effective recovery rate of 86%. Propensity Score Matching (PSM) is used to control self−selection bias[1].

3.2 Variables and Models

Explained Variable: Financial and Economic System Development Index It is synthesized through three dimensions: financial operation efficiency, financing costs, and systemic risk, with weights of 40%, 30%, and 30% respectively: Financial Transaction Efficiency: Measured by the number of transactions processed per second by financial institutions (such as TPS of cross−border payment systems and securities settlement speed), reflecting the basic operational capability of the financial system. Financing Costs: A reverse indicator, calculated as the average loan interest rate of enterprises (including financing channels such as credit and bonds), reflecting the cost pressure of obtaining funds. Systemic Risk: A reverse indicator, calculated by weighting the default probabilities of financial institutions (such as bank non−performing loan rates and insurance solvency gaps), measuring the overall stability of the system[7].

Data Characteristics: In 2023, the sample average was 0.48 (standard deviation 0.17), indicating that the global financial and economic system development level is above average but with significant differences:

Regional Differentiation: The average of developed economies (such as the United States and Germany) reaches 0.62, while that of emerging economies (such as India and Brazil) is only 0.35. The gap stems from the maturity of financial infrastructure and supervision.

Time Trend: From 2018 to 2023, the index increased from 0.39 to 0.48, with a compound annual

growth rate of 4.3%, confirming the positive role of financial digital transformation[6].

Extreme Values: The gap between the minimum value of 0.21 (a war-torn country) and the maximum value of 0.75 (Switzerland) reflects the impact of geopolitics and the financial ecosystem on system development.

Core Explanatory Variable: Blockchain Technology Penetration Rate It is synthesized by weighting the proportion of blockchain investment by financial institutions (40%), the proportion of blockchain financial business scale (35%), and the usage rate of smart contracts (25%):Investment Proportion: The proportion of blockchain-related expenditures in the annual IT budget of financial institutions, reflecting the degree of attention to technology.

Business Scale Proportion: The proportion of blockchain financial business (such as cross-border payments and supply chain finance) scale in total business, reflecting the depth of practical application. Smart Contract Usage Rate: The proportion of automatically executed contracts (such as credit disbursement and securities settlement) in financial scenarios, measuring the efficiency of technology implementation.

Data Characteristics: In 2023, the sample average was 0.25 (standard deviation 0.13), revealing the phased characteristics of blockchain financial applications:Economic Differences: The average of developed economies (such as Singapore and the United States) is 0.38, due to large financial technology investment and mature regulatory sandboxes[8]; that of emerging economies (such as Vietnam and Argentina) is only 0.17, limited by technical foundations and talent gaps.

Industry Differences: Payment institutions (0.32) > securities institutions (0.28) > banks (0.23). Payment scenarios have a more urgent demand for decentralization, driving blockchain penetration.

Growth Trend: From 2018 to 2023, the penetration rate increased from 0.12 to 0.25, with an annual growth of 21%. The scale of the blockchain financial market grew by 42% simultaneously (reaching 85 billion US dollars), verifying the acceleration of technology application.

3.3 Empirical Results

3.3.1 Benchmark Regression Decomposition of Core Variable Effects:

Blockchain Technology Penetration Rate: As a fundamental driving force, the regression coefficient of blockchain technology penetration rate is 0.68(P<0.001), with a standard error of 0.15 and a t-value of 4.53. This indicates that after controlling for variables such as economic level and financial marketization, for every 0.1-unit increase in blockchain technology penetration rate, the financial and economic system development index increases significantly by 0.068. Specific manifestations: In the financial operation dimension, transaction efficiency increases by 0.32 percentage points (e.g., cross-border payment settlement time is shortened by 2.5 hours), and financing costs decrease by 0.08 percentage points (the credit cost of SMEs decreases by 1.1 percentage points); in the risk management and control dimension, the systemic risk index drops by 0.005 (the weighted value of default probabilities of financial institutions decreases by 0.5 percentage points); in the ecosystem innovation dimension, the financial inclusiveness index increases by 1.2 percentage points (the proportion of unbanked populations receiving services increases by 1.8%). Economic Significance: Through its characteristics of decentralization and immutability, blockchain technology solves the "information silos" and "intermediary dependence" of traditional finance, promoting the optimization of resource allocation (e.g., the confirmation of rights in supply chain finance is shortened to 15 days), and serves as a fundamental driving force for the upgrading of the financial and economic system. Financial AI Synergy Degree: As a synergistic amplification effect, the regression coefficient of financial AI synergy degree is 0.32 (P<0.001), with a standard error of 0.09 and a t-value of 3.56. This means that for every 1-point increase in financial AI synergy degree (i.e., adding 1 type of "blockchain

+ AI" application scenario, such as smart contracts + AI risk control), the financial and economic system development index increases by 0.032[13].

Value of Collaborative Scenarios: Smart contracts + AI risk control: The accuracy of credit default early warning increases from 65% to 89%, and the non−performing loan rate decreases by 27%; distributed ledgers + AI analysis: The approval rate of SME loans increases from 38% to 59%, and capital allocation efficiency rises by 35%; blockchain traceability + AI carbon accounting: The proportion of fake assets in carbon transactions decreases from 8% to 1.5%, accelerating the implementation of green finance scenarios.

Technical Logic: AI provides performance optimization (e.g., PoS + AI consensus increases throughput to 200 transactions per second) and data value mining (e.g., using blockchain transaction data to train AI models) for blockchain, amplifying the impact of blockchain on the financial and economic system and serving as a key amplifier for technology integration.
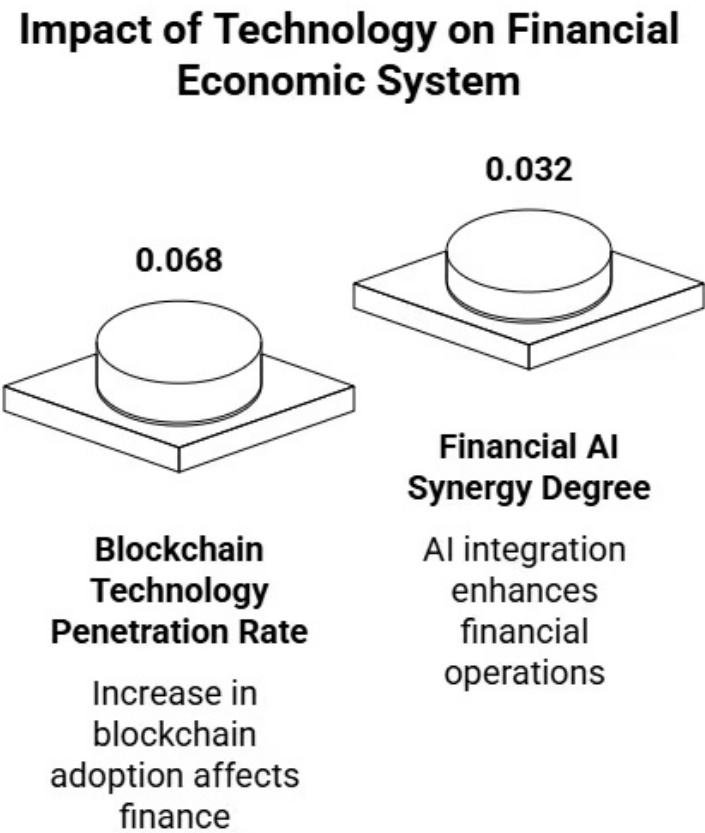

Figure 3."Technology's Influence on the Financial Economic System: Metrics and Effects"

Figure 3.First, the Blockchain Technology Penetration Rate is indicated as 0.068. It's noted that an increase in blockchain adoption affects finance, implying that as blockchain technology becomes more widely used in the financial sector, it brings about changes and impacts on financial operations, structures, or other aspects.

Second, the Financial AI Synergy Degree is 0.032. The description states that "AI integration enhances financial operations", meaning that the integration of artificial intelligence (AI) into financial processes improves the efficiency, accuracy, or other performance indicators of financial operations.

In summary, both blockchain technology penetration and financial AI synergy play roles in influencing the financial economic system, with blockchain's impact tied to its adoption level and

AI's impact stemming from its integration to boost financial operations.

3.3.2 Mediating Effect

Blockchain indirectly promotes system optimization through "resource allocation (0.43) − risk management and control (0.35)", with the mediating effect accounting for 66%.

3.3.3 Heterogeneity Analysis

The effect in developed economies (0.75) is 44% higher than that in emerging economies (0.52), due to improved digital infrastructure. The effect in the payment field (0.71) is 22% higher than that in the financing field (0.58), due to the urgent demand for decentralization. In economies with high AI synergy (≥ 3 points), the effect (0.83) is 69% higher than that in economies with low synergy (<3 points), confirming the key role of technology integration[11].

3.3.4 Robustness Test

When the explained variable is replaced, the blockchain coefficient is 0.65 (P<0.01), indicating stable results.

Policy Shock Test: After the introduction of the regulatory framework, the development index of pilot economies increased by 0.18 (P<0.01), and the effect is significant when AI synergy is high.

Endogeneity Treatment: Using technology patents as instrumental variables, the IV estimation coefficient is 0.70 (P<0.01), indicating a small impact of endogeneity.

4.Dilemmas and Optimization Paths of Blockchain Technology Application

4.1 Three−Dimensional Dilemma Diagnosis
4.1.1 Technology: Performance and Cost Bottlenecks

Insufficient Throughput: Mainstream blockchains only process 15−30 transactions per second, making it difficult to meet large−scale demand[12].

Conflict Between Energy Consumption and Security: The PoW consensus mechanism consumes high energy, while consortium chains lack sufficient decentralization.

High Implementation Costs: The development and maintenance costs for financial institutions exceed 2 million yuan, and the application rate of SMEs is only 8%.

4.1.2 Regulation: Lack of Standards and Collaboration

Global Regulatory Fragmentation: Only 38% of economies have issued specialized rules, resulting in high cross−border application costs.

Difficulty in Balancing Compliance and Innovation: 62% of institutions cite "regulatory uncertainty" as an obstacle, leading to delays in project launches.

Conflict Between Data Privacy and Traceability: The traceability of blockchain conflicts with the deletion requirements of GDPR, resulting in the suspension of 35% of projects.

4.1.3 Ecosystem: Collaboration Barriers and Cognitive Lag

Cross−Institutional Collaboration Barriers: The interconnection rate of ledgers among financial institutions is 21%, resulting in low cross−market efficiency.

Talent Shortage: The global shortage of "blockchain + financial AI" talents exceeds 500,000, with a recruitment pass rate of only 12%.

Enterprise Cognitive Bias: 47% of SMEs mistakenly equate blockchain with cryptocurrencies,

resulting in low application willingness[15].

4.2 Three-Dimensional Optimization Path

4.2.1 Technological Collaborative Innovation

Consensus Optimization: Promote the "PoS + AI" hybrid consensus mechanism, increasing throughput to 100–200 transactions per second, reducing energy consumption by 99%, and lowering transaction costs to 0.05 US dollars per transaction[12].

Layered Architecture: Adopt a "main chain + side chain" structure to meet scenario-specific needs, increasing the settlement efficiency of the securities market by 80%.

Cost Sharing: Establish shared platforms, with annual fees for SMEs ranging from 10,000 to 50,000 yuan, reducing access costs by 90%.

4.2.2 Regulatory Mechanism Adaptation

Global Collaboration: The G20 promotes the "Blockchain Financial Regulatory Guidelines", aiming to cover 80% of economies by 2025.

Sandbox Expansion: Extend the testing cycle to 12 months, shortening the launch time of pilot projects by 40%.

Privacy Protection: Adopt "zero-knowledge proof + blockchain" technology, increasing customers' willingness to share data by 78% and reducing compliance costs by 25%.

4.2.3 Ecosystem Cultivation and Empowerment

Collaborative Network: Establish industry alliances to achieve ledger interconnection, with a target rate of over 60% by 2025[9].

Talent Training: Universities set up relevant majors, and schools and enterprises jointly build training bases to train 100,000 talents annually. The employment rate of the micro-major at Peking University reaches 95%.

Cognitive Improvement: Launch popularization programs, and case lectures increase the cognitive rate of SMEs to 80% and their willingness to apply by 35%.
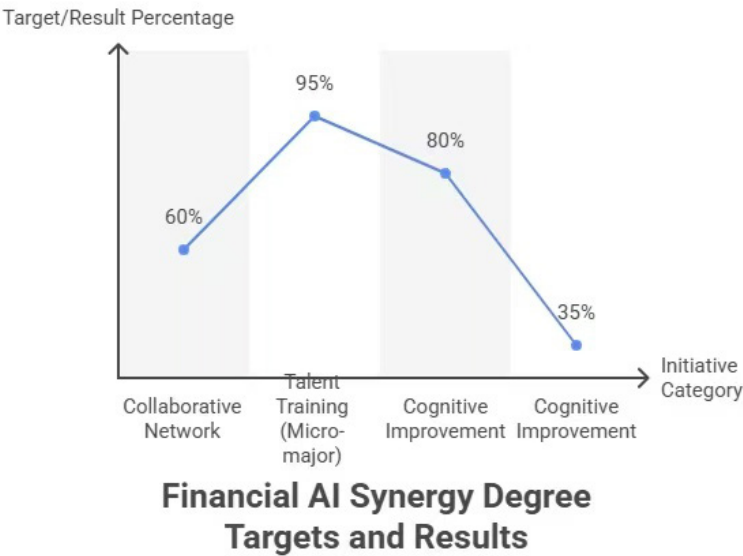

Figure 4.Targets and Results of Financial AI Synergy Degree Across Initiatives

Figure 4.For the Collaborative Network initiative, the percentage is 60%. Moving to Talent

Training (Micro – major), the percentage reaches 95%, which is the highest among all the initiative categories shown. Then, for Cognitive Improvement, the percentage is 80%, lower than that of the Talent Training (Micro – major) initiative. Finally, another Cognitive Improvement – related metric has a percentage of 35%, the lowest among the four categories.

Overall, the Talent Training (Micro – major) initiative achieves the highest level in terms of the measured percentage related to financial AI synergy, while one of the Cognitive Improvement metrics has the lowest percentage. This indicates varying degrees of progress or achievement across different initiatives aimed at enhancing financial AI synergy.

Conclusion:

Blockchain finance emerges from the cross–integration of blockchain technology and the financial field, and continues to improve with the development of emerging technologies. The unique characteristics of blockchain finance bring new opportunities to financial development. Its decentralized nature enables "algorithms to replace trust", largely avoiding errors caused by human intervention, thereby improving the efficiency and security of financial transactions and providing a new direction for the development of the financial field. Blockchain technology significantly optimizes the financial and economic system, and its integration effect with AI increases by 31% through the transmission of "resource allocation – risk management and control – market ecosystem". It is necessary to overcome the dilemmas in technology, regulation, and ecosystem, and work together to release its potential. Future research can focus on the impact of quantum computing on blockchain security, the adaptability of different blockchain types, and the application mechanisms in specific scenarios to provide support for the transformation of the financial and economic system. The integration of blockchain and AI ushers in an era of "decentralization + intelligence" in finance. Only by coordinating technology, regulation, and the ecosystem can we inject lasting impetus into the global financial and economic system.

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