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Research article[1]

Quantum Financial System — Development Process and Impact on the Real Sector

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Abstract

This article is devoted to the study of the Quantum Financial System (QFS), its development, and its potential impact on the real sector of the economy. Theoretical foundations of QFS, including principles of quantum computing and blockchain technologies, are discussed, emphasizing secure transactions and transparent financial operations. The advantages of implementing QFS—such as reducing fraud risks, improving capital management efficiency, and enhancing investment decision-making—are outlined. Integration challenges with existing financial structures, as well as legal, technical, and human capital requirements, are considered. Governments and central banks are increasingly recognizing QFS as a tool to modernize financial systems, with central bank digital currencies (CBDCs) serving as ideal testbeds. Potential risks, including regulatory adaptation, skills development, and technical limitations, are also discussed. Recommendations for advancing QFS focus on accelerating the transition to a new financial model and ensuring sustainable economic growth.

Keywords: quantum financial system, quantum technologies, financial projects, Monte Carlo method

Introduction

The Quantum Financial System (QFS) is a theoretical concept considered a potential alternative to the SWIFT system. It is believed that QFS uses artificial intelligence (AI), quantum computing, and blockchain technology to process financial transactions, potentially replacing existing systems such as SWIFT.

The relevance of this study is driven by the rapid development of quantum computing and its applications across multiple sectors. Experts currently identify finance as one of the most promising areas for the deployment of quantum computing. Corporations and governments are investing heavily in quantum technology development.

The main challenge is that QFS currently exists only as a theoretical concept; no practical implementations have been confirmed. The authors hypothesize that QFS will see

widespread adoption across various sectors by 2040, significantly impacting the real economy.

The approach includes:

1. Theoretical evaluation of QFS's impact on the real sector;
2. Examination of quantum computing applications in finance;
3. Analysis of the theoretical development stages of QFS.

Quantum Analysis of Financial Projects

Traditional financial project analysis provides a single forecast, which is unstable and often unreliable. In contrast, quantum financial analysis is based on the following principles:

1. The future cannot be described with a single forecast.
2. Reliable predictions require computing billions of possible scenarios.
3. Only by visualizing all potential scenarios can analysts make informed decisions today.

Quantum analysis models billions of future scenarios for financial projects, providing stability and reliability. Traditional financial analysis can be seen as a special case of quantum analysis. While conventional analysis may take years, quantum analysis, utilizing high-performance parallel computing, reduces this to days or even hours.

Monte Carlo Method in Quantum Finance

The Monte Carlo method is widely applied in financial modeling, risk assessment, and option pricing. Quantum computing enhances Monte Carlo simulations by processing multiple solutions simultaneously through superposition, offering faster and more accurate results.

Advantages:

- High computational speed due to simultaneous processing of alternatives;
- Increased accuracy with fewer repetitions;
- Efficiency in handling large datasets.

Challenges:

- Limited access to quantum computers;
- Susceptibility to errors and noise;
- High implementation complexity requiring expertise in quantum mechanics and programming.

Quantum Cryptography and Financial Security

Financial institutions are vulnerable to quantum attacks because they rely heavily on cryptography. Quantum algorithms can analyze large volumes of data in real time, detecting fraud and ensuring transaction security. Quantum cryptography improves encryption and

authentication, enhancing overall system robustness. QRate systems, for example, provide high-security financial operations.

Historical and Current Applications

The first proposal for quantum-secured currency verification was by Stephen Wiesner (1969), formalized in 1983. In the late 1980s, Bennett and Brassard developed the BB84 protocol for quantum communication. Recent examples include:

- 2017: QxBranch began developing quantum computing applications for Commonwealth Bank of Australia;
- 2020: JPMorgan Chase partnered with Honeywell to use quantum devices for client verification, risk calculations, and scenario planning;
- 2022: HSBC collaborated with IBM for quantum-powered portfolio optimization and risk management.

Key Players in QFS Development

Quantum computing companies: IBM, Google, Microsoft (Azure Quantum). **Blockchain pioneers:** Ethereum Foundation, Ripple, Stellar Development Foundation.

Governments and central banks are exploring QFS applications. For example, China's central bank integrates quantum technology with its digital yuan, and the European Central Bank studies quantum-resistant algorithms for future CBDCs.

Potential Impact of QFS on the Real Economy

Although unproven, QFS could significantly affect the real sector by:

1. Improving transaction speed and security;
2. Optimizing financial modeling and risk assessment;
3. Reducing operational costs through automation;
4. Enhancing scenario prediction accuracy in large economic systems;
5. Enabling real-time fraud detection.

Quantum computing allows simultaneous evaluation of numerous economic scenarios, providing better-informed decision-making and faster, more secure transactions across industries.

Conclusion

The study identifies potential applications of quantum computing in finance, outlines theoretical stages of QFS development, and assesses its possible influence on the real sector. Quantum technologies promise higher accuracy, optimization, and security in financial operations. While currently theoretical, QFS may become widely implemented in the next 20–30 years, significantly impacting economic activity.

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