Research on Global Financial Governance Innovation in the Digital and Low Carbon Era Based on Multilevel Game Model

Lu Qin

The University of Sydney, Camperdown NSW, 2050, Australia

lqin0454@uni.sydney.edu.au

Keywords: Digital Finance; Low-Carbon Economy; Global Financial Governance; Multi-Level Game Model; Financial Innovation Strategy

Abstract: As digitalization and low-carbon economy enter a new era, the global financial system has entered a stage of high-quality development. It is necessary to propose effective strategies to meet the new financial governance requirements in the era of globalization and informatization to adhere to the sustainable development concept led by innovation. Based on the dynamic evolution of digital transformation and low-carbon goal development, a theoretical analysis framework for global financial governance innovation is constructed according to the inherent logic of a multi-level game model. This can explain the evolution path of the financial governance system jointly generated by complex game mechanisms and market regulation cycle mechanisms involving various countries' governments, financial institutions, technology enterprises, and environmental organizations. From the perspective of comprehensive changes and practical deduction of financial stability, resource allocation efficiency, and environmental impact, we will continue to explore possible paths towards more efficient and green global high-quality financial development goals. Financial governance innovation aims to provide financial services that meet sustainable development standards for the global economy, as well as continuously improve the financial system stability, and enhance the satisfaction of all parties involved. For this purpose, measures such as strengthening financial risk control based on the internal circulation of financial technology quality, constructing an interactive feedback mechanism between financial products and market behavior quality perception, and establishing an evaluation system for financial performance and environmental impact should be taken to achieve high-quality development of global finance, promote economic green transformation, and truly meet the needs of the digital and low-carbon era.

1. Introduction

With the gradual development of digital technology, it has been widely applied in global financial governance, promoting the speed of information processing and decision-making efficiency. However, in the practical application process, facing the increasingly complex international financial environment and the low-carbon economic transformation requirements, the existing financial governance system shows problems of insufficient adaptability and lack of coordination mechanisms, especially in dealing with cross-border data flow, carbon footprint assessment, and green financial product innovation. Therefore, there is an urgent need for a new theoretical and practical framework to guide the transformation and upgrading of financial governance.

Based on the widespread existence of the above-mentioned issues in the field of global financial governance, this article mainly innovatively designs the global financial governance system based on a multi-level game model. In response to the characteristics of the digital and low-carbon era, this model is used to deeply analyze the strategic interaction between various stakeholders, especially in terms of financial resource allocation, risk management, and environmental policy consistency. Meanwhile, in response to the balance between financial efficiency and environmental sustainability, this article introduces the latest advances in digital technology and designs a set of strategic tools that can promote financial governance efficiency and support low-carbon transformation, to effectively improve the limitations of traditional financial governance models in addressing new challenges.

  DOI: 10.25236/icamfss.2024.017

This article applies a methodology combining multi-level game models and digital technology and solves problems such as information asymmetry, incentive compatibility, and internalization of environmental externalities in financial governance by constructing dynamic game scenarios and algorithm optimization. It provides important support for promoting a more efficient, collaborative, and sustainable development path of the global financial governance system, and also opens up a new perspective for future research on the integration of financial innovation and low-carbon economy.

2. The Research Background of Global Financial Governance in the Digital and Low-Carbon Era Based on a Multi-Level Game Model

2.1. The Impact of Digitalization and the Low-Carbon Era on Global Financial Governance

Digital finance is a concept that has developed in parallel with the information technology revolution. It is imbued with efficient and transparent information processing concepts, highlighting the innovation-driven direction of the financial system in the 21st century and reflecting the profound transformation strategy of global economic integration since entering the 21st century. However, when we attempt to construct the definition and essence of global financial governance in the digital finance era using traditional financial regulatory and governance standards, it is still difficult to obtain a comprehensive and accurate definition. Meanwhile, a low-carbon economy, as an inevitable choice to address global climate change, is profoundly changing the flow and allocation logic of financial capital, requiring the financial system to internalize environmental costs and demonstrate new trends in green and sustainable financial development. This transformation challenges the flexibility and foresight of the existing financial governance framework and highlights the urgency and complexity of reconstructing the global financial governance system under the dual drive of digitization and low carbon [1].

2.2. Application of Multi-Level Game Model in Financial Governance Research

The multi-level game model is an important criterion for analyzing financial governance strategies and precisely expressing the interaction mechanism between stakeholders in complex financial environments. Economists and financiers have discussed the various definitions of cooperation and competition in financial governance from the perspectives of behavioral economics, institutional economics, and others. Some scholars argue that game theory models are tools for quantifying the rationality of decision-makers strategic choices or evaluating the effectiveness of financial policies. Because game theory has higher explanatory power in simulating real-life conflicts and cooperative scenarios, it belongs to the applied mathematical science aimed at prediction and optimization decision-making. The theoretical history of game theory can even be traced back to ancient Greece, at that time, its main activities revolved around strategy interaction, payment matrix, and equilibrium state analysis. The concepts and methodologies of game theory are closely related to resource allocation, risk management, and policy formulation in modern financial markets. Understanding and coordinating conflicts of interest among multiple stakeholders through the introduction of game models has become an important responsibility of financial governance. The Nash equilibrium theory of the mid-20th century mainly contributed to revealing the concept of stable solutions in non-cooperative games. Therefore, multi-level game models initially focused on measuring strategic interaction based on the standard attribute of the rational man hypothesis [2].

2.3. The Necessity and Urgency of Global Financial Governance Innovation

Compared with traditional financial governance models, global financial governance innovation emphasizes the mutual relationship between international cooperation and digital technology application with stronger openness and dynamic adaptability. Although some scholars question whether there may be a direct positive correlation between financial technology innovation and financial stability, most scholars advocate that quantitative analysis can provide a rational evaluation of the socioeconomic effects of financial innovation. The classic game model of financial globalization was proposed by Stiglitz et al., which includes elements such as information asymmetry

and regulatory arbitrage. Since then, it has become a typical tool for studying the transmission of global financial risks, thus developing the concept of strengthening macroprudential supervision in global financial governance. These scholars believe that the global financial system is highly interconnected and an important component of the global village [3]. Only when strengthening global cooperation can financial risks be effectively prevented and controlled. Therefore, financial governance innovation is seen as a result of addressing the increasing complexity of the global financial system. Some scholars have summarized the financial governance framework as a two-layer game model, which includes a multilateral coordination model based on the national level and a self-discipline and incentive compatibility model based on the market level. The former focuses on international cooperation and rulemaking, while the latter focuses on market efficiency and risk management, which means ensuring financial stability while encouraging innovation. Although global financial governance has encountered some crises and challenges in practice, from a long-term development perspective, it can promote the resilience and sustainable development of the financial system. As a result, the concept of collaborative governance and technological innovation integration from a global perspective has gradually become a common consensus in financial research and practice.

3. The Research Foundation and Key Technologies of Global Financial Governance in the Digital and Low-Carbon Era Based on a Multi-Level Game Model

Figure 1 illustrates the research foundation and key technologies of global financial governance in the digital and low-carbon era based on a multi-level game model.

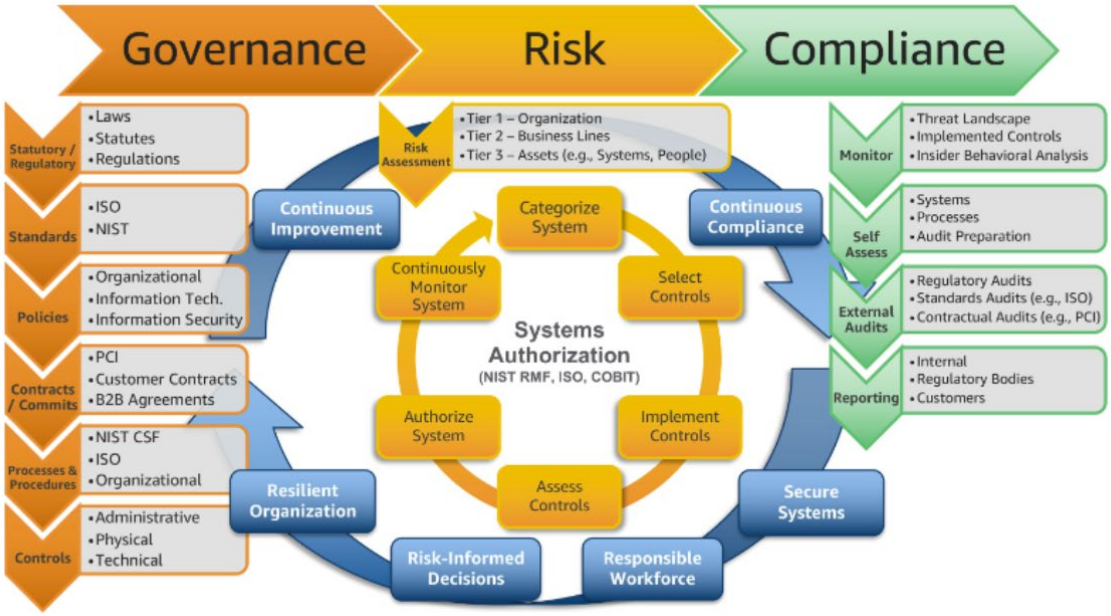

Figure 1: Research foundation and key technologies of global financial governance in the digital and low-carbon era based on a multi-level game model

3.1. The Principle and Characteristics of the Multi-Level Game Model

The concept of multi-level game models essentially focuses on the optimization problem of interaction strategies among stakeholders in complex systems. This model is a deepening application of game theory thinking in financial governance. As a new analytical framework, it has entered the core of research to overcome the shortcomings of single-level analysis in comprehensively grasping the dynamics of the financial system. The basic idea of this framework is that global financial governance should ensure an effective balance of interests among all parties involved; Set clear rules and standards for financial stability and sustainable development; Capture market information asymmetry and risk dynamics through technologies such as big data and artificial intelligence [4];

Use mathematical modeling and computer simulation methods to measure the decision-making impact accurately. The multi-level game model reconstructs the analytical dimensions of financial governance, emphasizing the need to enhance the depth, breadth, flexibility, and foresight of system analysis, and build a global financial governance mechanism that can respond to short-term fluctuations and guide long-term transformation, which requires that in model design, not only the direct game between macro and micro entities such as countries, financial institutions, and enterprises should be considered, but also broader exogenous factors such as international rules, technological progress, and environmental changes should be incorporated to form a three-dimensional, multi-dimensional, and dynamically adaptable analysis system [5].

3.2. Application of Digital Technology in Financial Governance

Digital technology is the main driving force for the modernization of financial governance, emphasizing the improvement of governance efficiency and transparency in the information age. and directly reflects the real-time status of financial market operations and risk warnings through tools such as blockchain, big data analysis, and artificial intelligence. Multiple constituent elements of the fintech ecosystem, such as digital currency, smart contracts, and automated compliance platforms, are gradually becoming important components of financial infrastructure. Data security and privacy protection, digital identity authentication, and various performance evaluation systems are also receiving increasing attention from the industry and regulatory authorities. However, from a global practical perspective, the process of financial digitization in some regions is still in partial experimentation or initial application, and there is still a certain gap between the ideal comprehensive and collaborative logical framework and efficient operation mechanism of digital financial governance. This has led to a series of challenges such as regulatory lag, inconsistent technical standards, data silos, and cross-border coordination difficulties [6].

3.3. Correlation Analysis of the Low-Carbon Economy and Financial Market

From the perspective of sustainable development, a low-carbon economy is a fundamental link in global economic transformation and a core manifestation of addressing climate change. Therefore, the financial market is initially driven by green finance, aiming to promote the development of environmentally friendly projects and enterprises. Green finance is the main financing channel for a low-carbon economy and a key entity in promoting the achievement of carbon reduction goals. At present, the financial market is divided into three main forms to strengthen carbon emission control from the perspective of policy and market dual drivers: first, the construction of a carbon trading market. Clarify the effective allocation and trading of carbon emission rights among governments, enterprises, and individuals; The second is the environmental information disclosure system. By establishing carbon footprint calculation standards, environmental performance evaluation standards, and publicly disclosing the environmental performance standards of relevant enterprises to investors, green and standardized control of investment and financing activities can be achieved; The third is the internal process reengineering of financial institutions, strengthening environmental and social risk management. In recent years, banks, securities companies, and others have increased the green content of fund allocation by issuing green bonds, green loans, and other means, and increased the support of financial services for sustainable development goals. However, compared to international best practices, the domestic financial market needs further improvement regarding innovation and market maturity of green financial products.

4. Modeling and Application of Global Financial Governance Innovation in the Digital and Low-Carbon Era Based on a Multi-Level Game Model

4.1. Construction of Global Financial Governance Innovation Model

The fundamental difference between traditional finance and digital finance lies in their information technology attributes. The transparency standards and efficiency guidelines of digital finance aim to promote resource allocation optimization, and their development is mainly reflected in the significant

improvement of data processing speed and risk management capabilities. In the multi-level game framework of global financial governance, accurate identification of risks, quantitative assessment, immediate response, and collaborative supervision are the core values and highest standards for developing digital finance. The diversity of financial product types and differences in market participants have led to a complex and distorted trend in global financial governance [7]. Despite significant technological progress, the global financial regulatory system is incomplete, and each financial center lacks effective cross-border coordination mechanisms. Therefore, the shortcomings in global financial governance, affect the stability and efficiency of the financial system, especially in supporting and regulating green finance in the process of promoting low-carbon economic transformation.

4.2. Empirical Analysis of the Multi-level Game Model in Financial Governance Innovation

From the perspective of market efficiency, traditional governance models are unable to provide the flexible supervision and services required for financial innovation. Market participants mainly evaluate financial products and services through satisfaction, but regulatory agencies lack sufficient market dynamic information and rapid response mechanisms. The core of this problem may be information asymmetry and inefficient communication mechanisms. In financial transactions, information is often described as the "lifeblood of the market", and its decisive role in price formation directly reflects the level of market efficiency. However, most of the existing data is based on surface information such as historical trading volume and price changes, lacking in-depth risk preferences, expected adjustments, and other information. Usually, these implicit factors are difficult to directly obtain or accurately measure. Asymmetric information and imperfect communication feedback mechanisms directly lead to obstacles between financial innovation and effective regulation. Therefore, the application of a multi-level game model in empirical analysis and simulating the strategic interactions of different participants can evaluate policy effectiveness, identify blind spots in governance structures, and provide the scientific basis for optimizing financial governance decisions.

4.3. Application of Digital Technology in Improving the Efficiency of Financial Governance

From the perspective of resource allocation efficiency, long-term information asymmetry and slow response have seriously constrained financial governance capabilities. Since the 21st century, digital technologies that integrate cloud computing, big data, and artificial intelligence have reshaped the financial industry through intelligent means. However, the fragmentation and lag of traditional governance models still constrain market efficiency and stability. Not only is the updating speed of regulatory policies unable to keep up with technological innovation, but also the cross-border coordination difficulties brought about by the increase in cross-border financial activities, and the global financial governance system still needs to be improved. Under the premise of digital transformation, using technological means to improve regulatory efficiency is seen as a direct way to solve the problem. However, the actual effectiveness of technology-driven regulatory technology (RegTech) in identifying and responding to financial risks still needs to be tested in practice. Meanwhile, regulatory agencies lack comprehensive and real-time market insights due to legal and technical difficulties in data sharing and privacy protection. Therefore, relying on technological upgrades does not always seem to achieve the expected governance optimization goals. The digital transformation of financial governance is not only a technical challenge, but also faces multidimensional challenges such as legal, ethical, and international cooperation [8].

4.4. The Innovation and Practice of Financial Governance Strategy in the Low-Carbon Era

Undoubtedly, the financial industry cannot avoid playing a double-edged sword role as a source of high carbon emissions in promoting economic development. In the low-carbon transformation mechanism, green finance policies are standard and effective incentive and constraint tools, playing an important role in guiding capital flow to green industries, which also makes green finance not only an environmental concept but also a developmental concept. Therefore, financial products mainly based on "green credit and green bonds" have become market incentive mechanisms to promote a

low-carbon economy. The practical interpretation of green finance is generally a gradual transformation path formed based on combining policy guidance with market mechanisms, although this path involves trial and error and adjustment attempts. From concept advocacy to specific implementation, green finance has always been closely focused on the dual goals of economic benefits and environmental protection. Financial innovation should strive to improve resource allocation efficiency to meet the requirements of the digital and low-carbon era. However, the amplification of financial risks also brings a dilemma: the green financial foam phenomenon. Overall, market access, risk assessment, and other aspects of green finance need to improve, and its regulatory framework and standard system need to be further perfected, which are important tasks for global financial governance innovation.

5. Conclusion

This article proposes a novel multi-level game analysis method based on the challenges faced by global financial governance in the digital and low-carbon era. Firstly, the traditional financial governance model is reconstructed with digital and low-carbon factors, and then the strategy interaction information in the game model is utilized; After further adjusting the interests and environmental impacts of the participating parties, combined with machine learning algorithms, this study optimizes and predicts financial risks and resource allocation. Based on empirical analysis results, it constructs a model for financial innovation and regulatory adaptability and evaluates the effectiveness of financial policies through big data analysis. Theoretical analysis, case studies, and empirical results show that this method can effectively improve the efficiency and adaptability of financial governance, promote the development of the financial system towards a more green and sustainable direction, and provide a theoretical basis and practical path for global financial governance innovation.

References

[1] Wainstein M E, Bumpus A G. Business models as drivers of the low carbon power system transition: a multi-level perspective[J]. Journal of Cleaner Production, 2016, 126: 572-585.

[2] Hafezalkotob A, Alavi A, Makui A. Government financial intervention in green and regular supply chains: Multi-level game theory approach[J]. International Journal of Management Science and Engineering Management, 2016, 11(3): 167-177.

[3] Kwon E. Financial power in the global village: financial globalization and the United States[D]. , 2005.

[4] Mullins M, Holland C P, Cunneen M. Creating ethics guidelines for artificial intelligence and big data analytics customers: The case of the consumer European insurance market[J]. Patterns, 2021, 2(10).

[5] Bumpus, Adam G. Firm responses to a carbon price: corporate decision making under British Columbia's carbon tax[J]. Climate Policy, 2015, 15(4):475-493. DOI: 10.1080/14693062. 2014.937389.

[6] Talab H R, Flayyih H H. An Empirical Study to Measure the Impact of Information Technology Governance Under the Control Objectives for Information and Related Technologies on Financial Performance[J]. International Journal of Professional Business Review: Int. J. Prof. Bus. Rev., 2023, 8(4): 25.

[7] Alexander K, Dhumale R, Eatwell J. Global governance of financial systems: the international regulation of systemic risk[M]. Oxford University Press, 2005.

[8] Wu J. Nexus analysis of financial management, digital finance and new technologies[J]. Global Finance Journal, 2023, 57: 100869.