Research on Financial System Risk Control Based on Complex Network Theory

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Abstract: As financial technology enters a new era and the financial system enters a stage of high-quality development, new propositions need to be proposed better to meet the risk control needs of the financial market, focusing on adhering to the financial management concept of risk control as the core. Based on the dynamic evolution of complex network theory, a theoretical analysis framework for risk control is constructed according to the internal logic of the financial system. This framework can explain the risk development mechanism of the financial system, which is jointly generated by the risk propagation mechanism and risk feedback cycle mechanism involving financial institutions and market participants. From the perspective of development changes and practical deduction of risk control, the possibility of moving towards the goal of high-quality financial development is further explored. The purpose of financial system risk control is to provide services that meet expected standards for the financial market and to continuously improve the quality of risk management and enhance market satisfaction. To this end, measures such as strengthening financial control based on the internal circulation of risk quality, constructing mechanisms for interaction and communication between financial institutions and market quality perception, and establishing an evaluation system for risk and benefits should be taken to achieve high-quality development of the financial system, promote financial market stability, and truly meet the needs of financial participants.

1. Introduction

Risk control in the financial system is one of the main responsibilities of financial management and is a general term for financial market stability. It can be divided into basic risk control and advanced risk control, respectively composed of traditional financial theory and complex network theory. To better meet market demand, financial regulatory agencies also entrust professional institutions to provide technical support for risk control. Since the global financial crisis, risk control has become a key aspect of financial management, while financial stability has become a critical indicator for evaluation. Unlike traditional financial theories, complex network theory emphasizes more on systematicity, dynamism, and complexity. Therefore, the financial system risk control issue based on complex network theory has been proposed, and complex network theory provides a new perspective for financial risk management [1].

The theory of complex networks originates from the complexity science centered on the financial system, which contains systematic thinking and is also a tool for analyzing financial risks. From the perspective of financial system structure, complex network theory pursues the precision of risk control and achieves modernization of financial risk management through the combination of theory and empirical evidence. However, this conclusion is only at the theoretical level. To this day, complex network theory has embarked on a unique application path. The comprehensive promotion of theory has changed the implementation of financial risk management, reflecting new ideas for risk control and changing the operation mode of financial markets, which profoundly affects financial stability. Therefore, discussing risk control in the financial system must have a global perspective and strategic framework. Therefore, a risk control proposition based on complex network theory has been proposed in the field of financial management [2].

In short, complex network theory is the key condition and guarantee for achieving financial system stability. From a practical perspective, the theory of complex networks has made progress in financial

risk management, but there are also shortcomings in its application. The research has not yet fully identified an effective path for risk control, and efforts are still being made to move forward. Therefore, the theory of complex networks still needs to be continuously improved, which is not only crucial for theoretical development but also a practical requirement for the stability of financial systems.

Based on the above background analysis, this article proposes a financial system risk control method based on complex network theory, aiming to solve the risk control problem through complex network theory and analysis methods. The main content is to construct a risk control model to effectively respond to financial system risks, which has theoretical and practical significance.

2. Study on the Background of Financial System Risk Control Based on Complex Network Theory

2.1. Significance of Financial System Risk Control

Financial system risk control is an important standard of financial management and the core reflection of financial market stability. Financial economists and risk-management experts discuss different definitions of risk control from the perspective of financial market volatility and linkages between financial institutions. Some scholars argue that financial system risk control is the degree of market uncertainty or the measurement of the robustness of financial institutions. Because of the importance of financial system risk control to the stability of the financial market, it belongs to the financial science for risk management. The history of financial system risk control can be traced back to the 19th century, whose main activities include risk assessment and supervision of financial institutions.

2.2. The Application of Complex Network Theory in the Financial System Risk Control

Compared with traditional financial risk control, complex network theory pays more attention to the correlation between financial institutions, with the systematic characteristics. Although some scholars argue that the complex network theory may not be directly related to financial market stability, most scholars advocate that complex network theory can make a rational evaluation of financial risk. Barabási et al. proposed a complex network model that includes correlations between multiple financial institutions. Since then, this model has become a typical tool for financial risk control, thus developing the concept of financial risk control based on complex networks. These scholars argue that a complex network, as the minor of risk conduction, is dynamic because only when the model reflects the interaction of financial institutions precisely, risk control will be more effective. Thus, complex networks are the result of financial risk control. The former focuses on the correlation between financial institutions, while the latter focuses on market volatility, which is the dynamic evolution of risk. Although complex network theory has experienced some practical failures, from a long-term perspective, it can provide valuable insights, and the concept of complex network theory has gradually become a consensus in financial risk control research and practice [3][4].

3. Research Foundation and Key Technologies of Financial System Risk Control Based on Complex Network Theory

3.1. The Basic Concepts and Characteristics of Complex Network Theory

The concept of complex network theory essentially focuses on the issue of interconnectivity between financial systems. Complex networks are the application of systems thinking in the financial field. To overcome the shortcomings of traditional financial analysis methods, complex network analysis frameworks have entered the research scope as a new alternative model. The basic idea of this framework is that the model should ensure the effective implementation of correlation between financial institutions; Set statistical standards for financial market output; Capture the correlation between financial institutions through network topology and other technologies; And Use network analysis methods to measure finance.
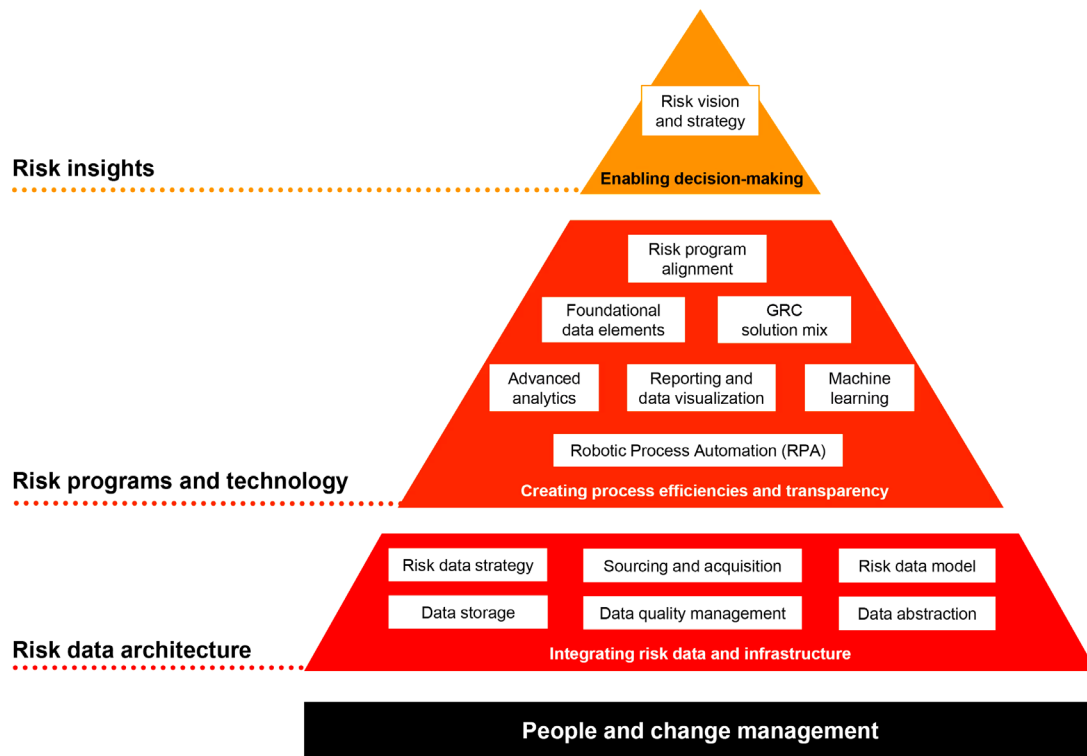
Figure 1: Research foundation and key technologies of financial system risk control based on complex network theory

Interactions between institutions. The complex network analysis framework reconstructs financial risk control, emphasizing the need to enhance the explanatory power of the model and construct the predictive, robust, flexible, and applicable relationships between financial institutions, as shown in Figure 1 [5].

3.2. Common Methods and Techniques of Financial System Risk Control

The commonly used methods and techniques for risk control in the financial system are the main means of financial risk management, emphasizing the systematic and forward-looking nature of risk management. It directly reflects the correlation between financial institutions and market dynamics, Through risk assessment and control. Certain essential components of financial risk management are gradually emerging, and risk management methods and various evaluation systems are also gaining traction. However, from a practical application perspective, some risk management practices are still in their nascent stages and are at odds with the logical framework and generation mechanisms of financial markets, giving rise to risk management issues [6].

3.3. Advantages of Complex Network Theory in Risk Control of the Financial System

From the perspective of risk control, complex network theory is the fundamental link between financial system risk control and the core reflection of model application. Therefore, complex network analysis is primarily data-driven in generating logic. Model construction is the main technical link in complex network analysis and the core of risk control. Nowadays, from the methodological perspective, the way complex network analysis enhances risk control is divided into three forms: The first is model selection. Clarify that the model achieves optimal fit between within and outside the sample; The second is parameter estimation. By establishing statistical and measurement standards, and publicly disclosing estimation standards to the academic community, standardized risk control can be achieved; The third is the internal process reengineering of the model structure. In recent years, scholars and professionals have used complex network analysis methods to enhance risk management capabilities and enhance financial system stability. However, compared with ideal models, the applicability and predictive accuracy of current complex network analysis in risk control still need to be further improved.

4. Modeling and application of financial system risk control based on complex network theory

4.1. Construction of Financial System Risk Control Model

The fundamental difference between financial system risk control models and traditional risk control models lies in their systematic attributes. The standards and guidelines for financial system risk control models are aimed at risk management, and the development of the financial system mainly reflects the correlation between financial institutions and market dynamics. In the risk control framework of complex financial systems, accurate modeling, parameter estimation, predictive analysis, and policy recommendations are the core values and highest criteria for financial system risk control. The diversity and differences in risk control models of the current financial system have led to a diversified trend in risk control. Although the financial system risk control model has advantages in predicting global economic and financial trends, because of the imperfection of the model selection, the financial system risk control model itself lacks a self-correction mechanism. Therefore, a "weakness" in the risk control model emerges, which affects the accuracy of risk control in the financial system [7].

4.2. Empirical Analysis of Complex Network Theory in Financial System Risk Control

From an empirical analysis perspective, complex network theory cannot provide all the information required for financial system risk control precisely. The satisfaction evaluation of financial risk control by market participants is the main form, but complex network theory lacks sufficient reflection of market sentiment and other related information and nonlinear mechanisms. The core of this problem may be the linear assumption of the model. In empirical research, complex network theory is often described as "data-driven", and the interrelationships between financial variables and complex networks directly reflect market dynamics. However, complex network theory is mostly about historical data and other information, and the capture of market expectations is relatively scarce. Usually, market expectations are difficult to obtain or measure. Asymmetric information and difficulties in model selection leads to obstacles in risk control of complex network theory.

4.3. The Formulation and Implementation of Financial System Risk Control Strategy

From the perspective of risk control, traditional financial risk control methods have long constrained the stability of financial markets. Since the 21st century, the complex network theory that integrates big data and computing power has reshaped financial risk management through multivariate time series analysis. However, the drawbacks of traditional risk control methods still constrain the effectiveness of financial system risk control. Not only due to the linear assumption of the model but also due to the influence of market nonlinearity, the risk control strategy of the financial system still needs to be improved. Under data-driven conditions, complex network theory serves as a direct approach to financial risk control strategies. However, the actual impact of model-based strategies on financial risk control strategies remains to be debated. Meanwhile, due to information asymmetry and difficulties in model selection, financial system risk control strategies lack sufficient empirical support. Therefore, risk control strategies in the financial system do not always seem to achieve the goal of financial market stability. It is evident that risk control in the financial system is not only a technical challenge but also faces challenges from methodology and empirical support [8].

4.4. Evaluation and Optimization of Financial System Risk Control Effect

Undoubtedly, the evaluation and optimization of risk control effectiveness in the financial system cannot avoid "data dependence" as an evaluation tool in risk control. In risk assessment mechanisms, complex network theory is a standard and effective risk management tool that plays an important role in financial markets. This situation also makes complex network theory not only a theoretical concept but also a practical concept. Therefore, data-driven complex network analysis has become a mechanism for evaluating the effectiveness of financial risk control. The practical deduction of complex network theory is generally an evaluation path gradually formed based on data analysis, although this path involves attempts at model selection and parameter estimation. From risk

identification to risk warning, complex network theory has closely revolved around the stability of financial markets from beginning to end. Although complex network theory should strive to improve risk control effectiveness to adapt to market changes. However, under the amplified market volatility context, complex networks also bring a dilemma of uncertainty in risk assessment. Overall, risk assessment and other aspects of complex network theory also need to be improved, and the evaluation of its risk control effectiveness needs further improvement, which is also an important task for future research.

5. Conclusion

This article proposes a novel application method of complex network theory based on financial system risk control problems. Firstly, the financial system risk control model is reconstructed, and then the correlation information between financial institutions in the complex network model is utilized; Further revise the model and combine it with risk management algorithms to evaluate financial risks; Based on empirical analysis results, construct a risk control model for the financial system, and combine risk control algorithms to develop and implement risk management strategies. Theoretical analysis, simulation, and experimental results indicate that the financial system risk control method based on complex network theory has significant advantages in improving the accuracy and effectiveness of risk management.

References

[1] Alexander C. The present and future of financial risk management[J]. Journal of Financial Econometrics, 2005, 3(1): 3-25.

[2] Estrada E. The structure of complex networks: theory and applications[M]. American Chemical Society, 2012.

[3] Petrone D, Latora V. A dynamic approach merging network theory and credit risk techniques to assess systemic risk in financial networks[J]. Scientific Reports, 2018, 8(1): 5561.

[4] Markose S. Multi-Agent Financial Network Analyses For Systemic Risk Management Post 2007 Financial Crisis: A New Complexity Perspective for G-10 and BRICs[J]. Talk given at the Reserve Bank of India Financial Stability Division, 2010: 22-23.

[5] Hu D, Schwabe G, Li X. Systemic risk management and investment analysis with financial network analytics: research opportunities and challenges[J]. Financial Innovation, 2015, 1: 1-9.

[6] Chatterjee R. Practical methods of financial engineering and risk management: tools for modern financial professionals[M]. Apress, 2014.

[7] Burtonshaw-Gunn S A. Risk and financial management in construction[M]. Routledge, 2017.

[8] Melecky M, Podpiera A M. Financial sector strategies and financial sector outcomes: Do the strategies perform?[J]. Economic Systems, 2020, 44(2): 100757.