Research and Prospect of Risk Assessment of Multinational Agricultural Products Supply Chain

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Abstract. First of all, it systematically reviews the risk assessment and pre-control of multinational agricultural product supply chain, and tries to systematically construct a theoretical framework for the research on risk management of multinational agricultural product supply chain through review of related research work. On the basis of this, using the principle of biological immunity, a new research idea based on bio-immunology for risk assessment models and supporting methods of multinational agricultural product supply chains is proposed.

1. Introduction
Multinational agricultural products supply chain refers to the combination of agricultural products supply chain worldwide. With a global perspective, the supply chain of agricultural products is extended to the scope of multinational cooperation [1]. Vera Belaya [2] believes that the cross-national agricultural supply chain faces a complicated network structure. The internal node companies have revenue distribution and risk sharing conflicts, which make them have the risk characteristics of the domestic agricultural product supply chain, and also have obvious complexity features and secondary derivative hazards.

In the direction of supply chain risk research, domestic and foreign scholars have been quite thorough in their discussion of supply chain risk management. However, the cross-border agricultural supply chain is a new branch of supply chain risk research, and its specificity is not reflected in the relevant literature. In the current multi-disciplinary development situation, domestic and foreign scholars use cross-cutting applications of supply chain risk management and other disciplines. Research is not yet sufficient. Therefore, it is necessary to sort out the research status of multinational agricultural product supply chain risk management, and on this basis to propose a more reasonable and effective supply chain risk assessment program.

Before further research, it is necessary to systematically review the problems existing in the risk management of multinational agricultural product supply chains. There are certain issues that need to be clear about this: Whether the risk management of the transnational agricultural supply chain has a unified research framework; How to establish an indicator system for risk assessment of multinational agricultural product supply chain and what theoretical model to use?
2. The framework and characteristics of the research on the risk of the transnational agricultural supply chain

2.1. A subsection
In 2002, the Cranfield Institute of management proposed a three stage supply chain risk management framework: risk factor and its extent, supply chain risk factor identification, assessment and management. On this basis, Wan Chundong et al. [3] conducted a detailed discussion on the “risk factor and its extent” stage. He believed that risk factors should be categorized and the characteristics of different types of factors should be analyzed, and then targeted measures should be taken to prevent them; Zheng Xiaojing [4] thought that there should be a feedback system for the model used in the “supply chain risk assessment” stage in the above framework. The management system should be constantly revised during the operation process, and the assessment model should continue to change over time. On this basis, after a large number of scholars at home and abroad have studied and summarized the research framework for the risk management of three-stage agricultural product supply chain, as shown in Figure 1.

![Figure 1. Research framework for the risk of agricultural products supply chain](image)

The theoretical framework provided a basic train of thought for studying the risk management of multinational agricultural supply chain, including risk analysis, risk identification, evaluation and pre-control, feedback and memory links for multinational agricultural product supply chains. At present, scholars at home and abroad have relatively rich research results in risk identification, assessment and pre-control. In the following, the author will discuss in detail, but the existing research results are insufficient for the research on the risk feedback and memory mechanism of cross-national agricultural product supply chain. For example: Zhou Yanju thought that there should be feedback and memory mechanism in the process of supply risk management, but no specific implementation scheme was given.

2.2. Risk characteristics
The risk factors in the supply chain can be roughly divided into: demand risk, environmental risk, business risk, institutional risk, supply risk, information technology risk and so on. However, because of the characteristics of fresh activity, regionality, seasonality and dispersivity, agricultural products risk management has many problems, such as difficult transportation, inefficient information transmission, dynamic risk factors, and difficult supply chain to respond in time. And the "transnational" agricultural product supply chain has increased the scale and complexity of the original agricultural supply chain risk system, which is shown as follows: exchange rate risk, logistics risk caused by the expansion of transport distance, policy risk caused by different national policies, and information sharing are more difficult to cause bullwhip effect. These risk factors have greatly increased the difficulty of risk management in multinational agricultural product supply chains:

1. The weak adaptability of agricultural products to the environment requires that the risk identification model can accurately and rapidly identify dynamic risk factors, and requires the assessment model to achieve a rapid response to the environment and even be ahead of the environment to determine the degree of risk of risk factors.

2. Many multinational agricultural product supply chain node companies have more transactions and cooperation, which increases the possibility of supply chain risk occurring in the intermediate links.
3. Review of research on risk assessment and pre-control of transnational agricultural supply chain

DIABAT A et al. [7] used the interpretative structural model to establish a set of models for analyzing the risk level of food supply chains. The urgency of risk management was divided into five categories and verified based on specific examples. In interpreting the combination of structural models and elasticity theories, Liu Jiaguo et al. [8] studied the structure of the supply chain elastic system and the formation process of its elastic capacity, and analyzed the relationship between risk factors and their role in the supply chain elasticity. From the perspective of quality and safety, Zhang Dongling [9] established a Logistic regression simultaneous equation model and a quality and safety risk assessment index system for agricultural product supply chains in accordance with agricultural norms and standards, and conducted an empirical study based on the operation of the vegetable supply chain. The theoretical models and applications of the main research by scholars at present are shown in Table 1.

**Table 1. Theory of evaluation and control used by scholars in the study of supply chain risk.**

| Theory                              | Application                                                                                                                                 |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Risk value model (VaR model)        | A tool used as a measure of risk in a simple supply relationship. Zhu Chuanbo's innovation uses VaR theory as a measure of supply risk, and studies the impact of retailers on other members of the supply chain while avoiding supply risks [10]. |
| Conditional risk value model (CVaR model) | It is generally used to estimate the minimum cumulative risk of loss under a given confidence level, making up for the deficiencies that the expectation estimate is difficult to characterize for tail risk. Fu Hongyong et al. studied the risk aversion farmers’ CVaR model, which can directly show the relationship between the risk aversion of farmers and the overall performance of the supply chain. [5,6][11-14] |
| Triangular fuzzy number             | Combined with the quantitative model, subjective factors such as expert scoring can be introduced to make the quantitative model more comprehensive and responsive to risk. [15-17]. |
| System dynamics                     | Combining the dynamics, complexity, and multiple feedbacks of risk factors, the supply chain risk system and its subsystems are analyzed for risk conduction relationships. Need to combine programming to make the model more mature, reflecting the relationship and strength of risk factors. [18,19]. |
| Bayesian network                    | It can quantify the uncertainty factors and connect the supply chain risk factors according to the Bayesian network topology. Xu Juan et al. divided risk factors into event risk and node risk and connected with each other through the Bayesian network to reflect the risk assessment results under the interaction of risk factors. [20,21] |
| Delphi method                       | With the data generated at the time of the risk, the potential problems in the supply chain are reflected. Kuo-Jui Wu and Ching-Jong used the Delphi method to conduct risk assessments and apply them to the next risk judgment. [22] |
| Matrix                              | First, according to the risk factors, we set up the risk factors evaluation set, then combine the fuzzy evaluation method and risk analysis method to build the matrix, and finally a quantifiable risk assessment model is formed [23]. |
| Support vector machines (SVM)       | The advantages of SVM are particularly prominent when there are fewer corporate risk sample databases. Combining the artificial intelligence method of machine learning can make up for the shortcomings of the sample size of the principal component analysis method and the linear regression equation in the risk assessment party [24]. |
To sum up, experts and scholars have studied supply chain risk assessment from different perspectives and have obtained relatively rich research results in some areas. However, there are still the following deficiencies:

(1) Research in recent years shows that corporate decision makers have not only focused on maximizing their own interests, but also paid more attention to the possibility of companies obtaining expected profits, and the overall risk faced by the supply chain. This means that the company has not only made decisions as a risk averse person, but recent studies such as Dan Bin and Fu Hongyong have mostly discussed the risk factors of agricultural product supply chains based on the risk aversion of farmers;

(2) There are few empirical studies, and most of the methods are based on some mathematical quantitative methods, which are not comprehensive enough;

(3) Despite the comprehensive use of artificial intelligence methods such as SVM support vector machines and machine learning, there are still problems such as slow memory mechanism response, risk perception, and low evaluation efficiency. The cross-country agricultural supply chain, due to the timeliness of agricultural products, needs the supply chain risk system to have the ability to quickly assess risks;

(4) Although some of the above methods can effectively grasp the mechanism and effect of the transmission of risk factors, because there is no monitoring system, it is still very difficult to eliminate the root cause of risk factors.

4. Future research prospects
From the above review of recent research status at home and abroad, it can be seen that the specific research framework of multinational agricultural product supply chains mainly considers risk factors, risk identification, assessment and early warning. However, in the face of dynamic risk factors existing in the external environment, the current assessment model generally adopts a strategy of “change in response”. For example, as mentioned in the previous article, when supply chain risk occurs, scholars advocate the improvement of supply chain risk response capabilities. However, the fact is that the adaptability of the supply chain is limited by time and space, and the improvement of responsiveness cannot solve the problem fundamentally. Therefore, the future research direction can improve the ability to “quickly respond to changes” in the risk assessment of multinational agricultural product supply chains on the basis of interdisciplinary integration. In the literature [15], based on the study of the characteristics of the supply chain network structure, we calculated the probability of transmission of risk between supply chain network entities. Studies have shown that the mechanism of risk diffusion presents dynamics, changes, and interactions.

(1) Memory and feedback will be greatly improved. In the existing research, risk identification mostly lags behind the changes in the environment. However, due to the timeliness of agricultural products, seasonality, and the lag in information transmission by multinational companies, the risk identification system of agricultural products must be ahead of the environment to predict risk factors. While the immune system is a feedback loop system, that is to say, when the source of risk occurs and is processed, the immune system will generate a memory and feedback system. This new system can inhibit the recurrence of the crisis. Because of the defensive experience, the immune behavior of the supply chain will be advanced.

(2) The risk factors can be monitored in real time. The above research shows that the difficulty in risk management of multinational agricultural product supply chains lies in the fact that the characteristics of agricultural products themselves and “transnational” make it more difficult to manage risks. The immune system itself is a complex and effective mediation network with self-learning, evolution, and monitoring capabilities. Therefore, it can help the supply chain risk management system to clear the “dissident” factor at the first time.

Therefore, the comprehensive use of immunological theory to study the risk assessment of multinational agricultural product supply chain has a very broad and in-depth research space.
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