

Research on Risk Management of Agricultural Products Supply Chain Based on Blockchain Technology

Keyao Wang, Xiuxia Yan, Kaiying Fu

School of Management, Shandong University of Technology, Zibo, China
Email: mnrnobody_2020@qq.com

How to cite this paper: Wang, K. Y., Yan, X. X., & Fu, K. Y. (2020). Research on Risk Management of Agricultural Products Supply Chain Based on Blockchain Technology. *Open Journal of Business and Management*, 8, 2493-2503.
<https://doi.org/10.4236/ojbm.2020.86155>

Received: October 21, 2020

Accepted: November 14, 2020

Published: November 17, 2020

Copyright © 2020 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

As the basic necessity of national life, agricultural products have become the basic elements of economic and social development. Because of the complexity and uncertainty of the internal and external environment, the supply chain of agricultural products has various risks, such as vulnerability and instability in the system structure. This paper analyzes the common structural model and risk factors of agricultural product supply chain, discusses the main factors of agricultural product supply chain risk factors, and combines the characteristics of decentralization and information encryption of block chain technology with the governance of each node of agricultural product supply chain. This paper puts forward the optimal analysis of agricultural product supply chain model construction and related node risk management under block chain technology.

Keywords

Block Chain Technology, Agricultural Supply Chain, Risk Management, Information Sharing

1. Introduction

In October 2019, General Secretary Xi Jinping emphasized that the integrated application of blockchain technology plays an important role in new technological innovation and industrial transformation when presiding over the collective study of the current status and trends of blockchain technology by the **Political Bureau of the CPC Central Committee**. It is necessary to take the blockchain as an important breakthrough in independent innovation of core technologies, clarify the main direction, increase investment, focus on capturing

a number of key core technologies, and accelerate the development of blockchain technology and industrial innovation, January 2, 2020, the State Council's opinion on focusing on key tasks in the area of "agriculture, rural areas and farmers" and ensuring that a comprehensive well-off society is achieved on schedule stated that 2020 will be the year when the goal of building a well-off society in all respects will be achieved, and will be the final year of winning the battle against poverty in all respects and ensuring food security. It has always been the top priority of state governance. In strengthening agricultural modernization, we should rely on existing resources to build agricultural and rural big data centers, and accelerate the application of modern information technologies such as the Internet of Things, big data, blockchain, artificial intelligence, fifth-generation mobile communication networks, and smart weather in the agricultural field, and carry out the national digital village pilot.

Due to the complexity of the system network and the complicated relationships among various nodes, the agricultural product supply chain is easily affected by internal and external environmental policies. Although with the joint efforts of national policies and experts and scholars, the management of the agricultural product supply chain has been significantly improved and optimized, but the node enterprises of the existing agricultural product supply chain still cannot fully and effectively share agricultural product information, which is very easy to cause risks in the supply chain formation and risk spread; in addition, agricultural products themselves have the characteristics of storage, freshness and quality, short shelf life, short logistics cycle and high storage requirements. Therefore, how to effectively control the risks of the agricultural product supply chain is the key to improving the efficient, green and healthy operation of the agricultural product supply chain; as blockchain technology gradually appears in the public's sight, blockchain technology itself has its own decentralization, information sharing and multi-point transparency technology, which can better solve the agricultural product supply chain. Because of the risk impact caused by information sharing, it has a good technical fit with the risk management of the agricultural product supply chain. This article explores the current agricultural product supply chain structure model and node operation characteristics, analyzes the risk factors that may occur during the operation of each node and the main reasons for the risk factors; tries to build the agricultural product supply chain structure model under blockchain technology; analyzes its risk control management and optimization of agricultural product supply chain under blockchain technology.

2. Research Status of Agricultural Products Supply Chain Risk Management

The research on agricultural product supply chain management in China started late compared with foreign research. Especially in recent years, food safety issues have gradually attracted public attention. Among them, the problem of unba-

lanced supply of rigidly needed agricultural products and the contradiction of safety issues are particularly prominent, such as:

- In 2012, the price of green onions in my country rose sharply due to the price plunge of the previous two years, the freezing of southern green onions, and the speculative hoarding of dealers; the supply of agricultural products was caused by the external environment of the agricultural product supply chain and the non-sharing of information from speculative dealers Chain risk.
- Affected by the African swine fever in 2019, the supply of live pigs was greatly reduced. In addition, the livestock and poultry breeding industry regulations that took effect in 2014 reduced part of the production capacity of live pigs in the short term, which caused the problem of soaring pork prices; it is precisely due to the external environment risks The factors are transmitted to the domestic pork supply chain, and the imbalance of domestic pork supply and demand has led to the continuous expansion of risk factors in my country's pork supply chain, causing prices to skyrocket.

Agricultural product supply chain risks gradually aroused domestic scholars' attention and research on the risks of agricultural product supply chains. With the deepening of economic globalization, the complexity of the continuous development of agricultural product supply chains has brought more risks, vulnerabilities and uncertain factors have seriously affected the sustainable and healthy development of China's agricultural production and supply.

The "bullwhip effect" in the existing agricultural product supply chain and the main risks of each node enterprise are mainly reflected in the failure of the upstream and downstream nodes of the supply chain to effectively realize the information sharing between the upstream and downstream nodes of the supply chain, The so-called "bullwhip effect" refers to an abnormal supply relationship in which demand information is abnormally amplified step by step during the transmission process due to the inability to fully share information in the supply chain; How to improve the information transparency of the upstream and downstream, so that the enterprises at each node of the supply chain are willing to contribute their own information advantages in order to jointly maintain the efficiency and transparency of the agricultural product supply chain, and reduce the risk of the agricultural product supply chain. In this regard, domestic Foreign scholars have conducted various studies, such as: Ning Zhong (2004) believes that one of the major obstacles hindering the application of effective risk management in the supply chain is the lack of an integrated action process and the lack of a set of appropriate management tools, and proposed "3P" management principles; Zhang Cheng et al. (2019) analyzed the internal and external risks of the agricultural product supply chain and the second-level detailed indicators, using the analytic hierarchy process and fuzzy comprehensive evaluation method to analyze the information risk level in the supply chain risk., Followed by logistics risks and production risks, indicating that there are still major problems in the construction and production of logistics infrastructure in the current

agricultural product supply chain; Yan & Zhang (2018) used the conditional value-at-risk method to characterize the retailer's risk, and used Stackelberg game Studying the expected profits of participants in the three-level supply chain under decentralized decision-making and centralized decision-making, it is concluded that the use of blockchain technology can reduce the transaction costs between supply chain members, realize information sharing, and thereby increase the overall profit of the supply chain. Cheng Zitao (2016) started from the characteristics and operation mode of the supply chain, and analyzed the current situation of risk management in China's agricultural product supply chain, summarized seven major types of risks, and established an agricultural product supply chain risk assessment index system, Zheng & Jin (2018). Through the risk analysis of different agricultural product supply chain models, information risk control measures are proposed, such as establishing long-term partnerships between various node enterprises, signing option contracts between farmers and enterprises, and making full use of the Internet of Things to complete information processing and sharing, Fu Yonggui (2018) proposed that supply chain information sharing helps promote the improvement of supply chain management efficiency, and proposed a blockchain-based supply chain information sharing mechanism and management model.

Through the above research on the risk factors of the agricultural product supply chain, it can be found that the main key is the information sharing problem in the supply chain and the coordination mechanism control management of the node enterprises that use technical means to carry out agricultural product information. Because the risks of the agricultural product supply chain present a distributed characteristic, risk factors may exist in the various nodes or logistics links that make up the agricultural product supply chain. Therefore, its risk factors can easily spread in the agricultural product supply chain, thereby reducing the local Small risks have gradually expanded into risks in the entire agricultural product supply chain; in addition, due to the characteristics of agricultural products, agricultural products have a certain regionality, which is likely to cause the problem of "information islands" for agricultural product manufacturers and cause imbalance in supply and demand in the agricultural product supply chain. Therefore, applying the technical characteristics of the blockchain to the risk management of the agricultural product supply chain has good utility value; based on this, the research methods and structure of this article are mainly:

- Explain and analyze the common research methods and conclusions of Chinese scholars on the risk management and avoidance of agricultural product supply chain through the research methods of literature review;
- Analyzed the common structural model of my country's agricultural product supply chain and its current situation of information flow, order, warehousing and supervision of agricultural product supply chain, as well as the risk effects that easily occur at various supply chain nodes, and analyzed the main reasons for the risk;

- Introduced and explained the technical characteristics of the blockchain, analyzed the technical advantages of the blockchain technology in information sharing and traceability, and carried out an analysis of the fit of the blockchain technology in the risk management of the agricultural product supply chain;
- Proposed the structure model of agricultural product supply chain under blockchain technology, and analyzed the optimization method of blockchain technology in the risk management of agricultural product supply chain through the perspective of each node of the supply chain according to the structure model.

3. Analysis on the Risk Structure of My Country's Agricultural Products Supply Chain

The agricultural product supply chain is a supply chain network system composed of agricultural product producers, agricultural product purchasers, retailers, agricultural product processors, agricultural product logistics distribution node enterprises and agricultural product consumers. It is affected by the environment, policies, and the behavior of the main actors in the supply chain. At present, China's agricultural product supply chain mainly has three models, namely the supply chain model with processors as the core, logistics center as the core, and "agricultural super docking". The specific structure is shown in **Figures 1-3**. The agricultural product supply chain model, the agricultural product supply chain has problems such as complex structure, diverse models, large demand fluctuations, and prominent quality and safety risk factors. Different agricultural product supply chain models have different risk factors.

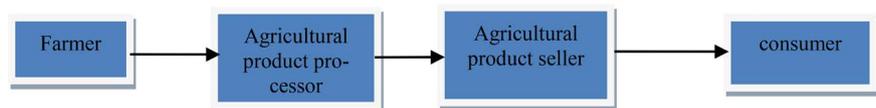


Figure 1. Agricultural product supply chain centered on processors.

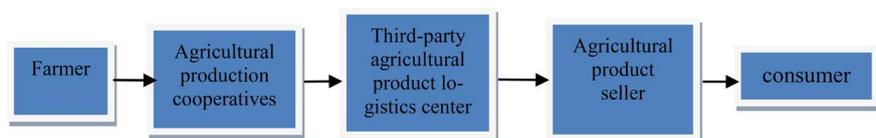


Figure 2. Agricultural product supply chain centered on third-party logistics centers.

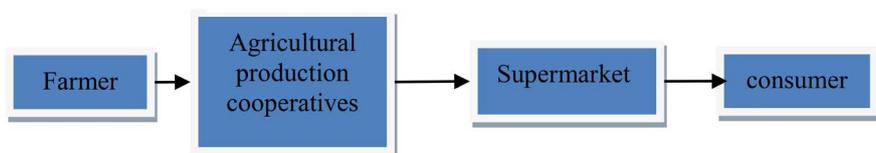


Figure 3. The agricultural product supply chain of the "agricultural supermarket docking" model.

First of all, the risk from agricultural product producers: A considerable proportion of agricultural product producers are farmers at the grass-roots level, who are less organized, accept modern agricultural technology and have limited levels of acceptance of modern agricultural technology, and are blocked by information that is affected by geographic location. Choosing agricultural products that are more suitable for the market environment to maximize the benefits is a vulnerable group that bears risks in the agricultural product supply chain.

Second, the risk from the purchasers of the agricultural product supply chain: due to the asymmetry of information between the nodes of the agricultural product supply chain, the information between the agricultural product producer and the agricultural product processor or agricultural product seller cannot be effectively shared, and the buyer node enterprise is in its own interests., Concealing the true cost, causing the deterioration of the benefits at the front end of the supply chain, and the phenomenon of inflated prices of agricultural products by agricultural product processors and agricultural product sellers, that is, the so-called “low vegetables hurts farmers, expensive vegetables hurts the people”. This results in an imbalance in the supply of agricultural products in the next supply cycle.

Third, the processing and supervision risks from the processors of the agricultural product supply chain: the secondary processing of agricultural products by the manufacturers of agricultural products will cause hidden dangers to the quality and food safety of agricultural products due to factors such as time period and self-manufacturing, and pass this potential risk to Downstream, it causes safety supervision risks in the supply chain of agricultural products and harm to end consumers.

Finally, the risk from agricultural product sellers: the business integrity of agricultural product sellers and the differentiation of agricultural product prices influencing factors, such as price differences caused by regional characteristics, agricultural product sellers use the information asymmetry characteristics of agricultural product price influence factors to form The balance of sales links in the agricultural product supply chain, coupled with vicious competition between industries, has exacerbated the vulnerability of the agricultural product supply chain structure. In addition, although the safety of agricultural products has attracted certain attention from the public, there is still a lack of more effective technical means to supervise them.

Through the risk analysis of the agricultural product supply chain nodes, it can be seen that on the one hand, the use of information asymmetry at all levels of agricultural product supply nodes causes the imbalance of supply and demand information in the agricultural product supply chain, causing “low vegetables to hurt farmers and expensive vegetables to hurt the people” in the process of social development. On the other hand, the supervision system and supervision information of agricultural products in all transport links of the supply chain are not sound, and there is a lack of true grasp of the “full chain” information of the

production and logistics links of agricultural products. Consumers and regulatory authorities cannot The tracing of information in each link of agricultural products can easily lead to the dissemination of false information in all links of the agricultural product supply chain; in addition, the demand relationship between agricultural node enterprises is prone to “bullwhip effect”, and demand information is supplied from the original demand node of the supply chain to the terminal. In the process of commercial delivery, the demand information is gradually amplified due to the inability to effectively share information, which leads to greater and greater fluctuations in demand information; finally, for consumers, the food safety of agricultural products is the first issue. How to “buy with confidence and eat with confidence” is the primary concern of consumers. Therefore, information sharing in the agricultural product supply chain is the key to ensuring risk aversion in the agricultural product supply chain.

4. Risk Factor Management of Agricultural Products Supply Chain Based on Blockchain Technology

According to the analysis of agricultural product supply chain structure model and risk factors, combined with the technical characteristics of blockchain technology, such as decentralization, information sharing, asymmetric encryption processing and transmission of block information, and smart contracts; apply blockchain technology to the structure of agricultural product supply chain Mode, try to construct a structural model of agricultural product supply chain risk management architecture based on blockchain technology to integrate blockchain technology into the structure of agricultural product supply chain. The specific structure is shown in **Figure 4**. Supervise, trace and share agricultural product information in various links, and improve the overall income of the agricultural product supply chain and the income of node enterprises, so as to effectively control the occurrence of risk factors and improve the environment and safety of the entire agricultural product supply chain.

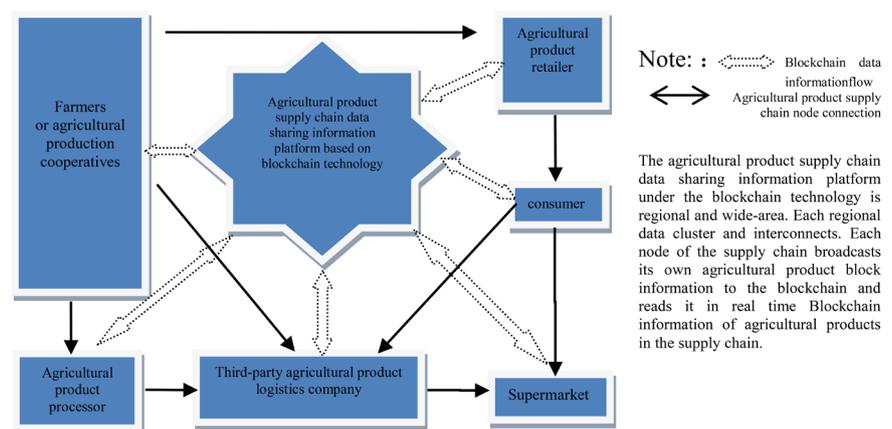


Figure 4. Blockchain-based risk management architecture of agricultural product supply chain.

4.1. Analysis of the Risk Management Process of Agricultural Product Supply Chain under Blockchain Technology

In the agricultural product supply chain risk management architecture based on blockchain technology, the node companies in the agricultural product supply chain actively share the attributes, logistics, and inventory information of agricultural products to the blockchain, and the node companies can read and feedback the agricultural product supply chain in real time. With the help of the Internet of Things and 5G communication technology, the data and information of agricultural products are integrated into the exclusive physical address. (Such as exclusive QR code library) and released into the blockchain of the agricultural product supply chain.

The specific definitions of variables are shown in **Table 1**.

For the agricultural product supply chain as a whole, the gradual sharing of information and data will better reflect the true situation of the supply chain, will reduce the adverse effects caused by information islands (Information islands refer to the inability to effectively spread and share information caused by the informatization or synergy of many participating companies in the supply chain of agricultural products, resulting in low credibility of information in the supply chain and high timeliness requirements), and will help the state and regulatory authorities to make more accurate policy feedback and reflect better. The most real hidden risk factors are revealed. Although some scholars have analyzed that, driven by interests, agricultural product supply chain nodes can consciously avoid sharing real information, but for the overall agricultural product supply chain environment, in an environment where the overall agricultural product supply chain risk is effectively controlled. From a long-term perspective, the income of each node enterprise is actually better than the status quo; the information sharing and coordination mechanism between supply chain nodes under the blockchain technology will be more perfect, the risk impact will be reduced as a whole, and the performance level of the agricultural product supply chain will be improved as a whole.

Table 1. Agricultural product supply chain block information.

Agricultural product block information	Block information composition	
	1 st block information	nth block information
	Physical address of block information	Physical address of block information
	Territory	Territory
	Production Date	Production Date
	Node enterprise inventory information	Node enterprise inventory information
	Store information in logistics	Store information in logistics
	Supply and demand price information	Supply and demand price information

4.2. Analysis of Risk Management Elements of Agricultural Product Supply Chain Based on Blockchain Technology

1) In terms of node enterprises in the agricultural product supply chain; through participation in the regional or broader agricultural product supply chain, through fully transparent information sharing, not only can the integrity risk of transactions between enterprises be reduced, but also blockchain technology The real-time information provided below can help adjust production and business strategies, reduce business costs, and reduce potential risks caused by product backlog, slow sales, and devaluation, and can be formulated quarterly in the next production cycle based on the feedback information in the blockchain Better production and operation plans to reduce enterprise development risks.

2) In terms of inventory; the current inventory risk in the supply chain of agricultural products is due to the quality and freshness requirements determined by the characteristics of the agricultural products on the one hand, and on the other hand the abnormal amplification of supply and demand information in the supply chain, resulting in “distortion” of demand information in the supply chain, That is, the “bullwhip effect”; through the introduction of blockchain technology, under the Internet of Things and 5G communication technology, the “full chain” transparent management and storage information sharing of each node’s inventory information can be realized, and each node enterprise can rely on The agricultural product inventory information on the blockchain adopts better inventory control strategies to reduce inventory management cost risks. For agricultural product supply chains, it can effectively control the “bullwhip effect” caused by the imbalance of supply and demand information between supply chain nodes.

3) In terms of logistics; through the support of blockchain technology and the supporting technologies of the Internet of Things, 5G and other technologies, the seamless connection of logistics information in the entire agricultural product supply chain can be realized. Through the agricultural product supply chain information platform of blockchain technology, not only It is conducive that the receiving enterprise can truly and effectively realize the whole-process “monitoring” of the logistics and transportation links of agricultural products in real time, anytime, anywhere. Under the premise of high information sharing, the enterprise can plan a more valuable logistics transportation system, and reduce the efficiency effectively. Improve logistics efficiency and value under the premise of the risk of loss of logistics cost and value of agricultural products on the way, and achieve a win-win situation; for consumers, it can also help end consumers to read and master various links of agricultural products through the blockchain information of agricultural products in real time The real situation, to ensure that “buy rest assured, eat rest assured”.

4) In terms of end consumers; through the entire record information of the exclusive address of the purchased agricultural products in the real-time block-

chain, you can truly feedback and truly grasp all the information and conditions of the production, processing, transportation, and sales links of the agricultural products. There is a transparent channel for the entire process of agricultural products from producer to consumer. Consumers no longer passively accept “falsely high” agricultural products, reducing the risk of consumers’ terminal consumption risks.

In general, blockchain technology is a decentralized, multi-point transparent distributed ledger technology. The digital signature technology of processing information and information through a hash algorithm makes data transmission safe and reliable. Its unique technical characteristics enable data query And data traceability is safer and more reliable; therefore, the traceability and query of agricultural product information in the entire supply chain is more accurate, and it is easier to trace and control risk sources in the agricultural product supply chain, which can help the industry establish a risk early warning mechanism and promote supply chain nodes. Establish coordination and sharing mechanisms to eliminate the disadvantages of “information islands” in the supply chain and improve the overall performance of the supply chain.

5. Conclusion, Limitation and Prospect

Based on the narration of the characteristics of blockchain technology, this article analyzes the common agricultural product supply chain models in China, analyzes and summarizes the risk factors that are likely to exist in different models, and obtains the main causes of various risk factors. The cause is the exploration caused by the overall coordination and information sharing between various nodes in the agricultural product supply chain. The main cause of various risk factors is caused by the imperfect coordination and lack of information sharing between the nodes in the agricultural product supply chain; taking this as a starting point, combined with the technical characteristics of decentralization, information security and transparency in blockchain technology, analyzed the fit and technical application of blockchain technology in the risk management of agricultural product supply chain, this article attempts to establish a risk management structure of agricultural product supply chain under blockchain technology, and analyzes the process and elements of risk management of agricultural product supply chain under blockchain technology. The shortcomings of this article are that it fails to conduct detailed technical analysis of blockchain technology in the circulation of agricultural products in the supply chain, and lacks certain data and model verification to support the positive effect of blockchain technology on the overall performance of the agricultural product supply chain. In addition, the application of the agricultural product supply chain structure model under the blockchain technology also requires the general mobilization of the regional agricultural product industry and government agencies to implement it. The next step will be to further study and illustrate the advantages of blockchain technology in the risk management of agricultural product

supply chain through algorithm design example data.

Acknowledgements

The paper was supported by Ministry of Education Humanities and Social Sciences Planning Project (NO: 18YJA630125) and Shandong Province Social Sciences Planning Project (NO: 18CJJJ17).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- Cheng, Z. T. (2016). *Research on Risk Management of Agricultural Products Supply Chain in my Country*. Harbin: Harbin University of Science and Technology.
- Fu, Y. G. (2018). *Research on Supply Chain Information Sharing Mechanism and Management Model Based on Blockchain*. Beijing: Central University of Finance and Economics.
- Ning, Z. (2004). The Influencing Factors and Management Principles of Supply Chain Vulnerability. *China Circulation Economy*, No. 4, 15-18.
- Yan, Y., & Zhang, J. (2018). Study on Risk Avoidance of Supply Chain Entities Based on Blockchain Technology. *Industrial Engineering and Management*, 23, 33-42. <https://doi.org/10.1016/j.aei.2019.100976>
- Zhang, C., & Liao, J. L. (2019). Empirical Research on Risk Identification and Control of Agricultural Products Supply Chain. *Logistics Technology*, 42, 145-150.
- Zheng, Y. Q., & Jin, C. (2018). Research on Risk Control of Agricultural Products Supply Chain Based on Multi-Dimensions. *Journal of Chongqing University of Science and Technology: Social Science Edition*, No. 1, 52-55.