Article

Data Ecology and Accurate Portrait: Optimization of Credit Risk System for SMEs in Supply Chain Finance Based on Big Data Technology

Chenyang Wu [1,2], Jinyue Liu [1,2] and Hongmei Zhang [1,2,*]

[1] School of Big Data Application and Economics, Guizhou University of Finance and Economics, Guiyang (550025), Guizhou, China

[2] Guizhou Institution for Technology Innovation & Entrepreneurship Investment, Guizhou University of Finance and Economics, Guiyang (550025), Guizhou, China

* Correspondence: zhm1035@qq.com; Tel.: +86-0851-88510575

Abstract: Big data technology can collect data, store it, mine it, and create an accurate portrait. It can assist financial institutions in resolving information asymmetry between banks and enterprises, as well as lowering the likelihood of default of small and medium-sized financing enterprises (SMEs). The credit risk system for SMEs in supply chain finance can realize "visualization" management of credit risk with the help of open public data in government affairs, collaborative development of various technologies, and the establishment of an ecological platform with transparent and accurate data portraits. The platform with accurate risk warning capability can reduce the risk monitoring cost and improve the risk management efficiency of financial institutions. The core enterprises are more willing to grant credit to SMEs through the big data technology supervision platform, which significantly improves the financing efficiency of SMEs. Moreover, a better financing credit circumstance also could improve transaction efficiency of enterprises and deeply connect the business relationship between enterprises. The main conclusion of this research: big data technology has a significant impact on supply chain in the digital economy era. Firstly, big data technology can identify credit risks accurately, which narrows the "information gap" between financial institutions and supply chain financing enterprises, and lower the likelihood of credit default. Secondly, financial institutions can allocate funds accurately based on the "visualization" information provided by the big data platform, and strengthen supervision of the use of funds. Lastly, the supply chain finance credit risk supervision system based on big data technology promotes the deep integration of big data and real economy. Therefore, in order to ensure the sustainable development of supply chain finance and financing risk management, it is necessary to create a digital ecosystem of supply chain finance with supply chain finance control tower as its core, as well as a supply chain finance credit risk control system based on big data in the context of the continuous development of big data technology.

Keywords: Supply Chain Finance; Big Data Technology; Data Ecology; Accurate Portrait; Risk Management Visualization

1. Introduction

Science and technology promote the economic changes of the times, and every technological innovation would create a new mode of economic operation. In the context of the third wave of information technology marked by big data, cloud computing and the Internet of Things, the

economy mode of China is gradually upgrading from resource-led to data-led, and data has become an important factor of production. The State Council issued the Opinions on Building a Better Institutional Mechanism for Factor Market Allocation on March 20, 2020, which explicitly included data as a new factor of production. On October 10, 2021, the "National Standardization Development Outline" clearly put forward the implementation of the new industry standardization pilot project. This policy document also emphasizes that standards should be used to enhance the stability of the industrial chain supply chain, and enhance the comprehensive competitiveness of the industry in the era of digital economy is significant.

SMEs play an important role in economy but they still face many financing problems. The proportion of loans from financial institutions to SMEs has been increasing year by year, and the total amount of loans has been expanding, while it is still difficult and high-cost for SMEs to finance. According to the SME loan demand index in the Wind database, this index showed an overall upward trend from 2016 to 2020. In recent years, it has become an important topic to improve the regulatory environment of credit risk of supply chain finance through big data, thus improving the dilemma of financing difficulty and high financing cost of SMEs. As a new financing method based on the upstream and downstream of the industry, supply chain finance can meet the short-term financing needs of enterprises due to real trade, and provide financing services for SMEs in a flexible manner. In the Guiding Opinions on Actively Promoting Supply Chain Innovation and Application issued by The General Office of the State Council in 2017, it is clearly pointed out that supply chain finance should be actively and properly developed, and commercial banks and other financial institutions should be encouraged to assist core enterprises in establishing supply chain finance platforms to provide convenient financing channels for SMEs.

However, it must be acknowledged that all kinds of financial innovation methods, including supply chain finance, cannot avoid the theoretical logic among financial innovation, financial risk, and financial supervision. Meanwhile financial supervision usually lags behind, so it is imperative to regulate supply chain finance based on big data technology. While in reality, only a few leading enterprises, such as MYbank and WeBank, have realized supervision of credit risks by utilizing their own mature digital technologies. Even if financial institutions have part of data element resources, they cannot give full play to the value of data elements because they have not mastered a series of big data technologies such as collection and acquisition, storage and management, data mining and analysis.

According to Luo Hao [1], big data thinking is gradually becoming an integrated innovation tool applied to the technology supply chain, brand ecological chain, and user experience chain. By building a supply chain finance ecology, big data technology can narrow the "information gap" among the stakeholders in the supply chain, promote credit risk management in supply chain finance, and help SMEs to manage risk. Song Hua [2] believed that the relationship between supply chain finance and Internet finance, the elements of industrial ecology on which supply chain finance operations rely and the next development trend are important to promote supply chain finance. Wang Jun [3] implicated that digital technology or digital technology can propel supply chain finance to bridge the data gap, and multiple parties should collaborate to build a supply chain finance ecology that meets the needs of China's industrial development. Ding Qianlan [4] confirmed that data plays an important role in the development of smart supply chain and proposed the creation of a general framework of digital-driven smart supply chain ecosystem. Wen Lu [5] pointed out that big data has

promoted the development process of supply chain integration, and the acquisition, screening, analysis, and integration of business data by enterprises have promoted cross-border integration of member enterprises. Gou Yanjie [6] confirmed that to innovate agricultural supply chain finance needs to build an agricultural industry ecology of "cross-border, empowerment, integration, symbiosis and synergy", and to aggregate various elements, so that agricultural supply chain finance can complete the evolution from "point" to "ecological chain". Further, the supply chain finance could strengthen credit risk management tools. Based on the cooperative and symbiotic ecological relationship among supply chain subjects, Zhao Chengguo [7] establishes a cooperative and symbiotic mechanism of internal and external supply chain finance ecological risk management from the perspective of resource, organization, and knowledge analysis. Jing Jun [8], based on a case study of the supply chain finance ecosystem mode built by "car payment", showed that the industrial ecology and platform based on financial technology can greatly reduce the transaction costs and risks of supply chain finance.

To construct a "control tower" based on big data technology could boost credit risk management of supply chain finance. The supply chain control tower serves as a central hub, serving as a "dashboard" of data flows, key business metrics and events connected across the supply chain. The supply chain control tower allows the supervision platform to gain more comprehensive understanding of the information and solve key supply chain problems in real time.   Several famous consulting companies, such as Gartner, Accenture, and Capgemini, regard the control tower as seamless, end-to-end, holistic visibility that provides real-time data analysis, prediction, and decision-making to solve problems quickly and build collaborative, consistent, agile, and demand-driven supply chains. Wang Chuanlei [9] believed that supply chain control tower is an integrated control center of supply chain data, and an effective tool to realize digital transformation. Supply chain control tower can realize end-to-end visualization of supply chain through coordinated development of various financial technologies. Song Hua [10] believed that the intelligent control tower can not only effectively master the operation status of business and assets, but also detect abnormal situations in time, and implement risk early warning, monitor the compliance of supply chain and its financial activities meanwhile to ensure the safety and effectiveness of supply chain finance. Tang Longji [11] found out that the core framework of applying digital control tower to supply chain was first reported in the white paper Industry 4.0 published by PwC in 2016.

Scholars have much less explored the use of digital technology to embed digital control tower into the core framework of supply chain ecosystem. Therefore, the supply chain financial ecosystem coined in this paper is innovative. Supply chain finance is still in its early stages in China, and the depth and breadth of credit risk management of supply chain finance need to be improved. The supply chain finance mode has the characteristics of diversified transaction subjects and complicated transaction scenarios. Asymmetry information makes it difficult to identify and measure credit risks. This study aims to apply big data technology to the credit risk management of SMEs in supply chain finance. First to analyze the feasibility of applying big data technology to supply chain finance credit risk management. Then take big data technology as the core factor, to design a supply chain financial ecosystem which regards supply chain finance control tower as the core. Last to realize intelligent management of credit risks in supply chain finance.

2. Analysis of Credit Risk Sources of Traditional Supply Chain Finance Mode

2.1. Analysis of Credit Risk Sources of Accounts Receivable Financing Mode

The accounts receivable financing mode is a financing method in which the upstream enterprises pledge to financial institutions the outstanding receivable accounts guaranteed by the core enterprises of the supply chain, in order to obtain liquidity in time. Enterprises can adopt this mode to solve capital shortage after selling goods but before receiving payment. Credit risk supervision of accounts receivable financing mainly includes the following two aspects: (1) The authenticity of trade is difficult to supervise. The fabrication process of accounts receivable contract is so easy that counterfeit trade contracts directly increase the difficulty of supervision. For example, core enterprises would collude with some of SMEs to sign false trade contracts to attain credit loan. Thus, banks and other financial institutions shall determine the authenticity of transaction contracts firstly when SMEs submit accounts receivable contracts to prevent such problem. (2) The use of funds is difficult to supervise. The phenomenon of "borrowing to support lending" is serious in SMEs. In the case of insufficient funds, enterprises often "rob Peter to pay Paul". If SMEs use accounts receivable financing to repay other loans, it will be difficult for financial institutions to supervise, which will have a negative impact on the financing availability of supply chain enterprises. Therefore, credit risk supervision of accounts receivable financing should attach great importance to trade authenticity and use of financing.

2.2. Analysis of Credit Risk Sources of Prepayment Financing Mode

The prepayment financing mode emerged to relieve liquidity pressure of downstream SMEs. Enterprises in the downstream of the supply chain often need to pay the core enterprises in advance in order to obtain the raw materials and some other required products. The core enterprises use the right of delivery or materials in transit as the credit basis to grant prepayment financing credit to SMEs. The credit risk of prepayment financing mainly comes from the sales of goods of SMEs and the repurchase ability of the core enterprises. Under the prepayment financing mode, SMEs sell goods to obtain payment for the goods, and then pay the bank deposit to obtain the right to take delivery of the goods in the next step, and then obtain more quantities of goods. Therefore, in this financing environment, the sales of SMEs become the key to influence the credit risk of prepayment. For SMEs, having an efficient sales and marketing mode will not only assist them in increasing their market share, but will also lead to higher financing capacity with high sales volume. If the SMEs' sales are poor or the goods are not selling due to certain market factors, SMEs are unable to sell the products and thus cannot obtain stable repayment. At this point, the ability of the core company to execute the repurchase commitment becomes the key to the stable development of the SMEs under the prepayment financing mode.

2.3. Analysis of Credit Risk Sources of Inventory Pledge Financing Mode

The inventory financing mode can improve the operating conditions of SMEs. However, banks are generally reluctant to use inventory as pledges because of the characteristics of inventory such as market price variability and difficulty in valuation. Through the guarantee of core enterprises and the supervision of storage and logistics, small and medium-sized financing enterprises can realize inventory financing through supply chain finance. In view of the credit problems of traditional inventory pledge financing, it is concluded that the credit risk of inventory pledge financing mode mainly comes from the review of transportation qualification of third-party logistics enterprises and

the pledge qualification of storage institutions. (1) The qualification of third-party logistics companies in transporting pledged goods. The main problems are whether the logistics company can properly store the pledged goods, the destination of the pledged goods and the ability to assess the value of the pledged goods. After receiving the goods, there are cases of third-party logistics companies running away with the goods. Therefore, in order to ensure the effective supervision of credit risk in the inventory pledge financing mode, the transportation qualification of the third-party logistics enterprises should be examined in focus. (2) The pledge qualification of the storage institution. It is mainly manifested in three aspects: the problem of storage institution's ability to keep the pledged goods, the problem of repeated pledges of pledged goods and the ability to assess the value of pledged goods. The loss of value in the process of storage of pledged goods by the storage institution happens from time to time. For the problem of duplicate pledges of pledges, banks and other financial institutions do not have their own warehouses, so banks need to sign supervision agreements with third-party pledge supervisors. Since banks and other financial institutions are not able to supervise pledges in real time, they can only rely on the credit of the pledging institution. When the third-party warehousing department colludes with the financing SMEs, it can cooperate with multiple banks and other financial institutions, and a real pledge can be financed several times, which is a credit default situation of "repeated warehouse receipt financing".

3. Feasibility Analysis of Combining Credit Risk of Supply Chain Finance with Big Data Technology

3.1. Big Data Technology Can Solve the Difficulties of Credit Risk Management in Supply Chain Finance

The difficulty of credit risk management in supply chain finance lies in the limited access to data by risk managers. In recent years, there have been a lot of collapses in supply chain finance, the root cause of which is the serious information asymmetry among the stakeholders in the chain. Banks and other financial institutions have limited ability to identify and manage risks, and are unable to understand the actual operating conditions of SMEs in the supply chain in real time. Supply chain finance has gone through three stages. Under the supply chain finance 1.0, financial institutions as risk managers have limited access to data and can only assess credit risk through financial data of historical transactions between upstream and downstream enterprises. Under the supply chain finance 2.0, the core enterprises can grasp the transaction flow, logistics and information flow, but the core enterprises are unwilling to share these information. And under the supply chain finance 3.0, the third-party professional service platform is trying to build its own data platform. Since there is no unified implementation standard, diverse and heterogeneous platforms and data types further exacerbate the barriers to information.

3.2. Big Data Technology Drives "Visualization" of Credit Risk Management in Supply Chain Finance

Chinese President Xi Jinping has proposed, "The in-depth development of digitization, networking and intelligence is enhancing the level of wisdom of social operation and empowering the modernization of national governance capacity." As a productive force, big data technology boosts the evolution of modern economy to intelligence and wisdom. With the continuous improvement and development of information infrastructure, 5G, as a strategic resource in the current global concentrated competition, will widely empower banks and other financial institutions.

Big data technology with the help of new infrastructure such as 5G, block chain, cloud computing and artificial intelligence technology can break through the limitations of time and space and boost the intelligent development of economy.

Data transaction process visualization has become a basic requirement for supply chain finance credit risk management, and the emergence of big data technology has proposed a new solution for supply chain finance credit risk management. The key technologies of big data include the following aspects: (1) Real-time data collection. Through the data interface or with the help of web crawler technology, the credit data related to the credit assessment subject can be obtained, ensuring the traceability of the data; (2) Transaction process traceability. All transaction processes are stored in the database in real time, and the transaction status of the transaction subject can be traced to ensure the traceability of the data; (3) Accurate risk early warning. Using data mining technology, the credit evaluation subject's historical data is repeatedly trained, which means that the machine is allowed to simulate various user behaviors.

Transaction subjects of supply chain finance can be interconnected through data interface interchange or sharing. Nowadays, various algorithms are being gradually improved, and big data technology has been able to accurately fit the behavior of users within a certain range, which can make accurate portraits of credit evaluation subjects. Combining with historical data of financial operation activities, big data technology can carry out effective risk early warning, meeting the "visualization" demand of supply chain finance risk management. Banks and other financial institutions also can obtain valuable credit risk information with the help of big data supervision platform and provide various financial services for supply chain enterprises.

3.3. Analysis of the Driving Effect of Big Data Technology on Supply Chain Finance

3.3.1. Strengthen the Risk Supervisory Capacity of Financial Institutions

Financial institutions can use big data technology to know about the activity data and comprehensive information data of the financial operation, and effectively reduce the opportunism and moral risk caused by information asymmetry, the difficulty of project evaluation and supervision, and high financing cost in supply chain finance. Various financial activities happen in real time, big data technology crawls massive data for data collection, then each stakeholder can obtain information in a zero-delay context. Banks and other financial institutions can promote the real-time monitoring and early warning capability to credit subjects in supply chain finance, by retrieving historical credit data, then attaining accurate credit status of customers through machine learning models and set credit risk early warning level respectively.

3.3.2. Accelerate the Development of Cost-effectiveness Intensification of Supply Chain Supervision

Big data technology speeds up breaking down the information barriers of each subject in supply chain finance gradually, and alleviates the asymmetric effect of information among various subjects in supply chain finance gradually. Diversified big data technology reduces the acquisition cost and storage cost of each transaction subject. Accurate data mining technology strengthens the risk monitoring ability of financial subjects and reduces various credit risk supervision costs, including human resource and audit costs. Therefore, in the whole supply chain finance management, using of big data technology has realized the cost reduction and efficiency of risk management for each

transaction enterprise, and driven the cost-effectiveness intensive development of supply chain financial risk supervision.

3.3.3. Promote the In-depth Integration of Industry and Finance

Supply chain finance is a financing business established between the upstream and downstream of the industrial chain in order to meet the transaction. Financial institutions in the traditional mode do not participate in the supply chain transaction business, which leads to the inability to effectively integrate and supervise the transaction flow, logistics and information flow of supply chain finance business. Supply chain finance business does not develop completely between the upstream and downstream of the industry.

Use of big data technology can effectively solve the problem of information asymmetry between financial institutions and SMEs. Its risk warning ability can effectively reduce the cost of risk monitoring of financial institutions, improve the efficiency of risk management of financial institutions, and reduce the probability of default of SMEs. Core enterprises are more willing to grant credit to SMEs on the big data technology supervision platform, which results in the financing efficiency of SMEs has been significantly improved. Better financing and credit status will reversely increase the transaction efficiency between the upstream and downstream of the industry and deepen the business relationship between enterprises. Song Hua (2020) confirmed that the real combination of industry and finance is to apply financial thinking to the actual scenes of the industrial chain, so that finance becomes the blood flowing in the industry. With the enhancement of credit risk supervision capability promoted by big data technology, the tight integration of industrial subject and supply chain finance is improved.

4. Optimization Design of Supply Chain Finance Credit Risk Ecosystem Based on Big Data Technology

4.1. Overall Layout of Supply Chain Finance Ecosystem

Supply chain finance has evolved through three development stages, with the 1.0 mode dominated by financial institutions, the 2.0 mode dominated by core enterprises and the 3.0 mode dominated by third-party professional service institutions. The advancement of big data technology has the potential to accelerate the transition of supply chain finance from financial institutions to an industrial Internet technology platform. The credit risk ecosystem of supply chain finance is designed with the concept of "Embracing Openness and Cooperation for Mutual Benefit" of data elements. This paper expands on the traditional supply chain finance model by introducing the role of a big data platform. The supply chain finance control tower with big data platform can monitor big data of multiple agents and achieve accurate portrait of credit risk of supply chain finance, as shown in Figure 1.

4.2. Functions of Each Subject Constitution in Supply Chain Finance Ecosystem

Subject constitutions are the fundamental building blocks of supply chain finance credit risk system. The main subject constitutions of the ecosystem designed by this study include core enterprises, upstream small and medium-sized suppliers, downstream small and medium-sized

distributors, financing institutions, big data platforms, third-party logistics companies and warehousing departments. Figure 2 depicts the fundamental logical structure.
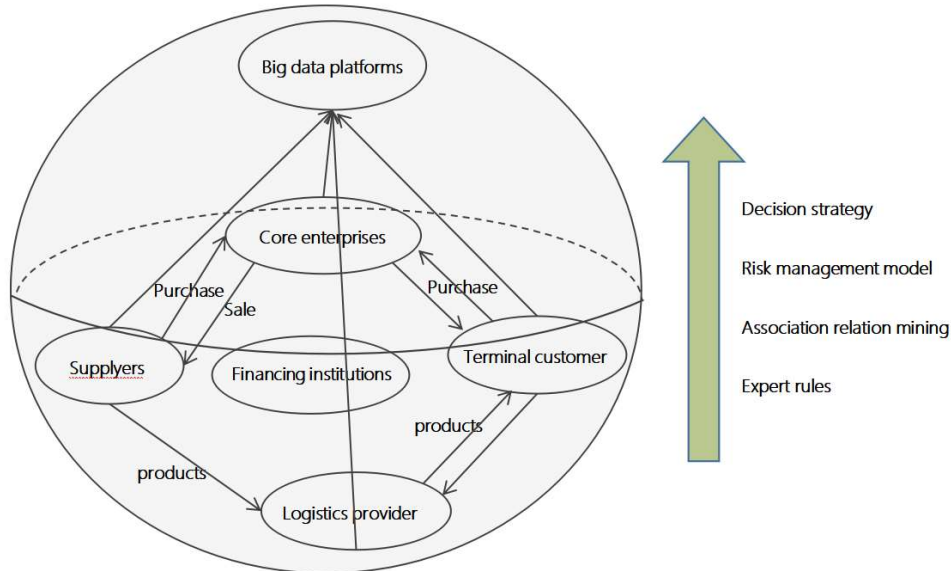

Figure 1. Supply chain finance ecosystem including big data platforms.
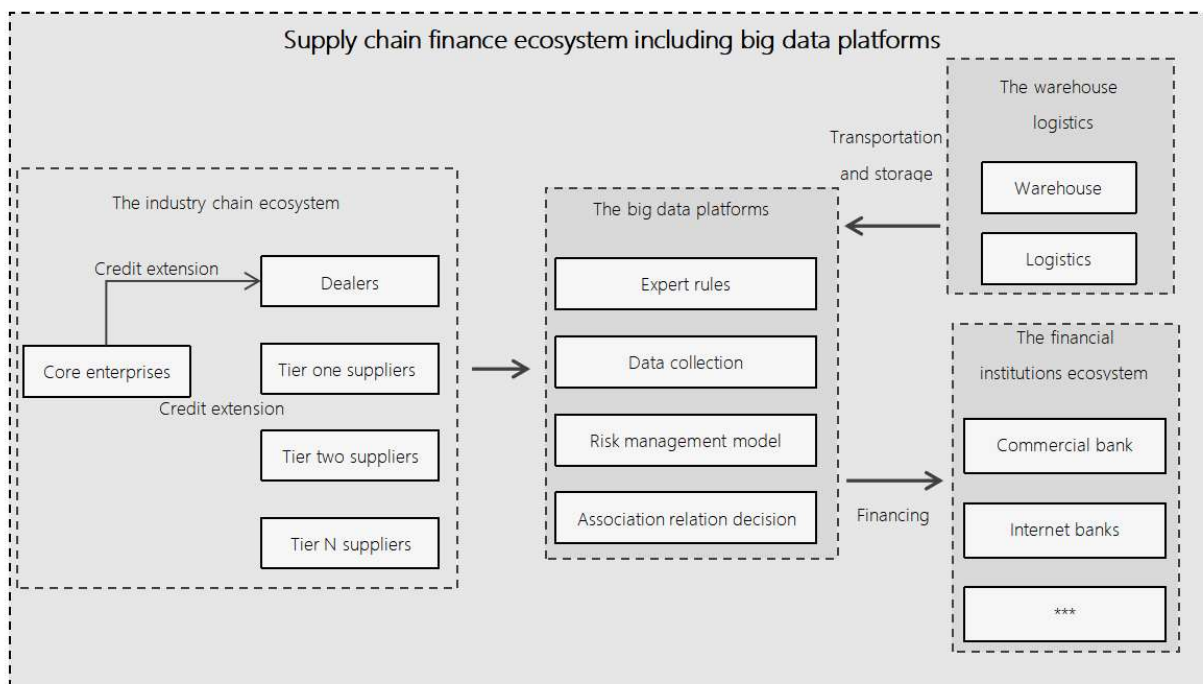

Figure 2. Supply chain finance credit risk management ecosystem including big data platforms.

The following are the primary functions of each subject constitution in the supply chain finance credit risk ecosystem with big data platforms:

The big data platforms are the overall risk masters of supply chain finance. Each subject constitution's relevant data is aggregated into big data, and valuable credit risk information is mined using the data risk control model. This function is assumed by financial institutions in the supply

chain 1.0 mode, by core enterprises in the supply chain 2.0 mode, and by third-party service platforms in the supply chain 3.0 mode.

The industry chain ecosystem mainly includes credit providers, as well as upstream and downstream capital demanders. In the supply chain finance mode, core enterprises play the role of credit providers while upstream and downstream SMEs are capital demanders. In the accounts receivable financing mode, SMEs need to submit cooperative orders to obtain credit financing. In the prepayment financing mode, SMEs need to submit margin to obtain the right to pick up goods for credit financing. In the inventory pledge financing mode, SMEs need pledges to obtain credit financing.

The financial institutions ecosystem includes commercial banks and Internet banks and other financial institutions. In the supply chain finance, the ecosystem plays the role of capital providers, mainly responsible for issuing funds to SMEs. In the traditional mode, the capital providers are in charge of supervising risk, formulating standards and issuing capitals.

The warehouse logistics ecosystem mainly includes in-transit material transport service providers and pledge custodians. In-transit material transport service providers generally refers to the third-party logistics company, and pledge custodians generally refer to the warehouse storage institutions. The logistics service providers or the pledge custodians shall properly place the pledges and are able to evaluate the value of the pledges.

4.3. Operation Mechanism of Big Data in Supply Chain Finance Ecosystem

In traditional supply chain finance, banks and other financial institutions need to assume the responsibility of credit supervision and fund release. The supply chain finance ecosystem including big data platform is still based on traditional supply chain finance business mode. However, in comparison to the traditional business model, the innovation of the system designed in this paper lies in the risk manager's transition from the traditional model of banks and other capital providers to a big data platform.

Big data has the characteristics of large quantity, high value. Relying on data storage technology, big data platforms can record various information of all participants in the supply chain finance ecosystem, which include capital demanders, credit providers and capital providers. All the data between the different participants form big data. Through the control tower, appropriate risk control models such as machine learning and deep learning are selected to conduct multi-agent association relationship mining to obtain accurate risk portraits of this node, and ultimately provide intuitive decision-making assistance for decision makers, based on the risk assessment rules set by experts. The big data platform enables financial institutions to effectively control information flow, logistics and capital flow, thus improving the operation efficiency of the entire supply chain finance ecosystem, so as to realize the coordinated development of the industrial chain ecosystem, financial institutions ecosystem and logistics and storage ecosystem.

Figure 3 shows the risk early warning system integrated that is integrated with big data. Risk managers use big data technology to collect relevant data of credit assessment subjects, and use data mining technology to comprehensively depict the credit risk of each participant in the supply chain network, so as to realize risk management visualization. Simply relying on big data technology to monitor all the SMEs' credit status is insufficient. The actual financial scenario must be digitized, i.e., transaction terminals and other IoT sensors obtain data to form a large data stream into the control

tower, and the data is processed and monitored in real time through blockchain and distributed storage technology, thus realizing the digitization of the transaction process and the physical world. With the help of blockchain technology and Internet of Things technology, the supply chain finance credit risk monitoring system including big data platforms can effectively avoid the problem of associated risk caused by a financing transaction participant breaking trust and the problem that the logistics and storage service provider breaking trust that cannot be detected.
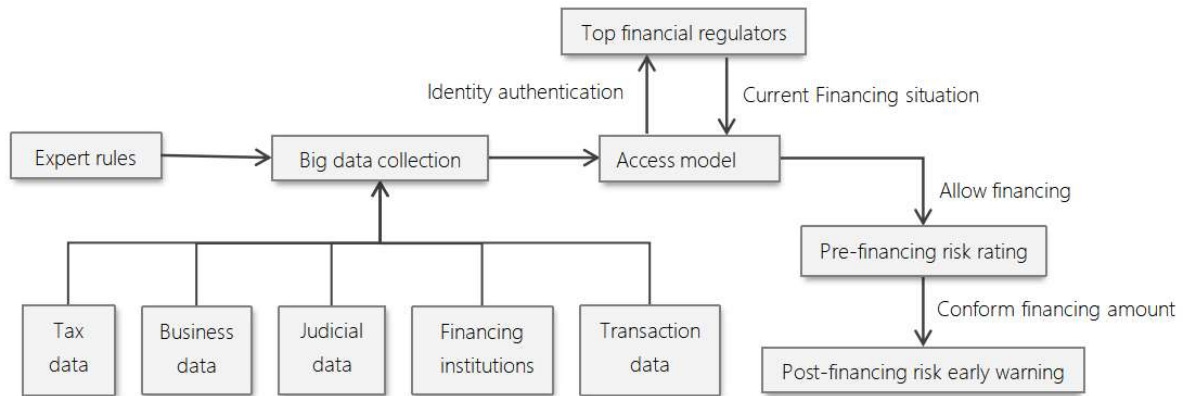
Figure 3. Risk early warning system of big data integration.

4.4. Application of Supply Chain Finance Credit Risk Management Ecosystem Including Big Data Technology

4.4.1. Distributed Data Storage Drives Digitization of Supply Chain Finance Transaction Processes

Enterprise "triangular debt" can cause a chain reaction due to the default of funds between enterprises. Big data technology can digitize transaction processes with the help of distributed storage technologies such as blockchain. This process mainly includes three parts: the common identification of participant, the common identification of asset right and the common identification of transaction. The transactions process in each stage of the system realize the digitization of the whole supply chain transactions with the help of standardized digital vouchers. Digital transaction vouchers are similar to newly issued standardized bills, which can play a role as a means of payment. Digital vouchers can be split and transferred among various subject constitutions of supply chain finance, thus realizing multi-pole credit penetration among enterprises. In addition, each transfer of digital transaction vouchers will offset a part of accounts payable and resolve a debt, so as to help enterprises in the supply chain effectively clear the triangle debt, optimize the financial situation between enterprises, and reduce the associated risk caused by the trust-breaking problem of a financing transaction participant.

4.4.2. Digital Twins: Leading the Physical World by One Virtual World of Data

With the help of the Internet of Things technology, the supply chain finance credit risk ecosystem including big data platforms can achieve effective supervision of the pledge transport process. Sensors and other tools become the link between logistics supervision and digital management. The big data platforms can monitor the stored goods through sensors and other tools, such as temperature sensors, humidity sensors and other GPS positioning devices, and digitizes the physical environment of the products. The dynamic matching of transportation logistics, goods storage and financing

transaction orders with the help of artificial intelligence technology can solve the problem of separation of logistics supervision and financing orders in the traditional state, that is, the dynamic combination of each financing order and each logistics document. When credit default occurs in financing orders, the intelligent system can lock the pledged chattel in real time.

5. Conclusions and Suggestions

The information asymmetry between the participants of supply chain finance restricts the supervision of credit risk. Emerging fin-tech provides a new solution to the problem of credit risk management in supply chain finance. Big data technology can realize the functions of data collection, data storage, data mining and accurate portrait, which can realize the "visualization" management of credit risks in supply chain finance. The accurate early warning function of big data technology can reduce the cost of supervision and management and increase the efficiency of credit risk management. The conclusions are summarized as follows:

5.1. Bridging the "Information Gap" to Reduce Credit Risk

The supply chain finance credit risk management system based on big data technology integrates the business transaction flow, information flow and logistics of traditional supply chain finance to form a big data flow. Combined with block chain technology and distributed storage technology, it fully mines the internal information of big data flow and achieves accurate portrait of big data. Real-time monitoring and early warning also can be carried out on the operating conditions and credit risks of SMEs participating in financing. It effectively narrows the "information gap" between the credit subjects upstream and downstream of the supply chain and banks and other financial institutions, ensures the authenticity of the full-cycle trade transaction process, reduces the negative impact of information asymmetry in the financing of supply chain SMEs. Moreover, it solves the credit mismatch problem that cannot be avoided by traditional supply chain finance, and reduces credit risk. Further, the system effectively reduces the audit cost and supervision cost of banks and other financial institutions. It has significant practical value and reference significance for maintaining national financial security, as well as preventing and resolving systemic risks.

5.2. Realize the Precise Issuance and Supervision of Capital Flow

Banks and other financial institutions need to take the responsibility of credit supervision and fund issuance in traditional supply chain finance. The risk supervision system of supply chain finance based on big data technology separates the supervision work from banks and makes banks become professional fund providers. Banks can issue funds to upstream and downstream enterprises in the supply chain according to their accurate credit risk portraits, realizing the service goal of universality and precision that traditional supply chain finance cannot achieve. It effectively solves the problem of difficult and expensive financing for SMEs in the supply chain and lowers the threshold for obtaining funds for long-tail enterprises. In addition, through the accurate portrait of credit subjects, it can fit their liquidity needs, improve the efficiency of capital use, and effectively avoid the liquidity mismatch problem faced by traditional supply chain finance. It as well as highly fits the demand for financial services for high-quality development and is conducive to traditional financial reform.

5.3. Promote the Further Integration of Big Data Technology and the Real Economy

Supply chain finance is an important field to carrying out supply-side structural reform. The supply chain finance supervision system based on big data technology can promotes the further integration of big data technology and the real economy. The traditional supply chain is empowered by big data technology, and the vendors, third-party logistics and storage institutions in the supply chain are jointly connected to the big data platform, which can enhance the competitiveness of key links in the industrial chain, improve the supply chain system of key industries, and become the fulcrum for transforming and upgrading traditional industries. The credit participants of the supply chain get the funds needed for developing can enhance the competitiveness of enterprises, which is conducive to deepening the structural reform on the supply side. It as well as can stimulate the vitality of the real economy, enlarge and strengthen the domestic real economy. As a result, it is easier to build a new development pattern with the domestic grand cycle as the main body and the domestic and international double cycles promoting each other.

Based on the above research conclusions, the following suggestions are put forward.

First, to accelerate the construction of new infrastructure to build a firm foundation of digital economy. Upstream and downstream enterprises in the supply chain should actively promote the digitization of enterprise and access their respective data to the supply chain finance supervision platform and realize the interconnection of data. The supply chain finance supervision system based on big data technology cannot be separated from new infrastructure networks such as 5G, Internet of Things and block-chain, while the construction of new infrastructure will also drive the rapid growth of local economy in the short term. Central government and local governments should pay attention to the huge potential of the digital economy and do their best to support the construction of new infrastructure driven by technological innovation and based on information networks to help upgrade the structure of traditional industries and realize the digitization and digital development of the economy.

Second, to promote data interconnection and construction of information-based regulatory platform. The government should follow the principle of "open and sharing, multi-technology synergy and diversification of adaptive subjects" for the future development mode of supply chain finance. Drawing on the current case of Nanjing Economic Development Zone and the Bank of Jiangsu's "Yuan Rong Project" and the Hangzhou Municipal Government's collaboration with Boer data to share the "anti-fraud risk list" to banking institutions for free, government departments should take the initiative to seek changes and increase support for new financial technology. Integrate various kinds of data, such as the data of industry and commerce, tax data and other data scattered outside the supply chain finance, into the supervision platform and converge them into big data. Through data mining, make full use of the high-value characteristics of big data to realize accurate risk portraits of credit subjects and achieve the purpose of credit risk supervision and early warning.

Third, to attach importance to data security and formulate industry standards. It is considerable to attach importance to cyber security and strengthen data regulation. The aggregation of various data into big data streams through multiple paths is likely to infringe personal privacy and data security. Regulatory platforms should attach importance to the contradiction between information security and data sharing, so as to make data "invisible when available". The government should adhere to the idea of promoting the development of digital economy with equal emphasis on data security and utilization, increase the supervision of big data platforms, strengthen the ability to protect key data resources, and guarantee data security. To build a supply chain finance credit risk

management system based on the big data platform and establish a supply chain finance ecology suitable for the development of China's industrial chain, industry standards and codes of conduct should also be formulated as soon as possible to promote the collaborative development of technology. The standardized and orderly development of supply chain finance products will help achieve the goal of high-quality supervision of credit risk for all subjects in supply chain finance. This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

[1] Luo, H.; He, R.K. Design Innovation Driven by Big Data Thinking. *Packaging Engineering* **2017**, 38(12), 136-140.

[2] Song, H. Innovative Trends of Supply Chain Finance Based on Industrial Ecology. *China Circulation Economy* **2016**, 30(12), 85-91.

[3] Wang, J.; Yang, L.L. The Ecological Construction of Supply Chain Finance in the Context of Data-driven Technology Revolution. *Banker* **2019**, (06), 68-70.

[4] Ding, Q.L.; Zhang, S.W.; Mei, Y.; Bao, Q. Data-driven Intelligent Supply Chain Ecosystem Construction. *Business Economics Research* **2020**, (18), 38-41.

[5] Wen, L. Research on the Construction of Supply Chain Ecosystem of Aviation Manufacturing Industry in the Context of Big Data. *Business and Management* **2020**, (08), 95-99.

[6] Guo, Y.J. Research on Innovation of Agricultural Supply Chain Finance Model from the Perspective of Industrial Internet. *Journal of Sichuan Light Chemical University (Social Science Edition)* **2020**, 35(02), 33-52.

[7] Zhao, C.G.; Jiang, W.X. Construction of Risk Management System of Supply Chain Finance from the Perspective of Financial Ecology. *Finance and accounting communication* **2021**, (06), 130-133+171.

[8] Jing, J.; Feng, L.; Song, X.L. Research on Supply Chain Finance Model Based on Industrial Ecological Platform: Theoretical Analysis and Case Empirical Evidence. *Financial Development Research* **2021**, (02), 80-87.

[9] Wang, C.L.; Hu, C.H.; Zhang, Y.; Wu, H.H.; Chen, X. Supply Chain Control Tower Enables Digital Transformation of Enterprises. *Intelligence Theory and Practice* **2019**, 42(09), 28-34.

[10] Song, H. Innovation of Supply Chain Finance Model Empowered by Digital Platform. *China Circulation Economy* **2020**, 34(07), 17-24.

[11] Tang, L.L. Theory and Practice of Digital Supply Chain Control Tower. *Supply Chain Management* **2020**, 1(02), 60-72.