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Application of Big Data Technology in Logistics Financial Safety Supervision in the Internet Era

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Abstract: *With the increasing frequency of Internet applications, the use of Internet-related technologies has also been comprehensively developed. In terms of logistics financial safety supervision, people also urgently need to supervise and control it to a certain degree. This article aims to study the application of logistics financial security supervision in the Internet era. To this end, this paper proposes a big data supervision method and a pipe network model, and through the use of big data, the financial monitoring and risk control of the logistics industry are carried out. It also uses the pipe network model to systematically analyze and calculate related financial security, and designs related experiments and analyses to explore some factors. The experimental results of this paper show that in the context of big data monitoring, customers' transaction costs have been reduced by 4.7%, transaction risks have been reduced by 12%, the development rate of the logistics industry has increased by 24%, and the ability to supervise related logistics industries has increased by 36%. From these values, it is not difficult to know that big data can help improve related logistics and financial security issues.*

Keywords: *Big Data Technology, Logistics Supervision, Financial Security, Internet+Logistics*

1. Introduction

As the times change, logistics companies generate a large amount of financial data every day. In order to save and process these data, it through the establishment of a logistics financial security information platform with big data as the background, strengthen information sharing and supervision, and realize the systematic management of internal logistics and logistics financial supervision. Big data collection, analysis and monitoring of large amounts of data generated by logistics companies enables companies to quickly and accurately collect data and make decisions, effectively reduce the risks of the logistics industry in financial security monitoring, and provide guarantees for the smooth operation of logistics companies.

With the substantial increase in enterprise data, the application research of big data has become a hot spot. However, domestic research on the application of big data has just begun, and existing research focuses on theoretical aspects. Some scholars have proposed that big data can be used for decision-making in business management and application, but the research on safety management using big data technology is relatively insufficient. In order to improve the traditional method of evaluating the operation status of the hydrogenation heat exchanger, Li L proposed a new method for evaluating the operation status of the hydrogenation heat exchanger based on big data. Finally, he proposed a PCA-based system-based health scoring algorithm to help field operators evaluate the health of the hydrogenation heat exchanger [1]. In his research, Yang CT combines cloud computing with big data processing technology to build a smart campus real-time energy monitoring system. The monitoring platform collects the electricity consumption of campus buildings through smart meters and environmental sensors, and processes massive amounts of data through big data processing technology. In addition, he also compared the performance of Hive and HBase in energy data search, as well as the performance of relational databases and big data distributed databases in data search [2]. Sun W applied the GA-BPNN model to evaluate the financial security of Chinese power industry, and he selected 3 categories and 12 indicators to construct an evaluation index system. GA-BPNN is better than GM(1,1),BPNN and LSSVM, and predicts that the financial security status of Chinese power industry in 2011 will be basically safe, and put forward reasons and suggestions based on the prediction results [3]. Lyons AC uses data from the 2014 World Bank Global Financial Index and supplemented with

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macroeconomic indicators of age protection to investigate the financial security of households with different ageing populations in developed countries (OECD) and developing countries (non-OECD), and the results showed the aging effect of all measures, and for those who reported saving for old age, aging had the greatest impact [4]. Houkamau CA studied the relationship between the cultural effectiveness of the New Zealand Maori, retirement savings and the perception of future financial security. The results show that Maori with higher levels of cultural effectiveness are less likely to participate in KiwiSaver, which shows the resilience of some Maori's collectivist cultural values. The Maori worldview is still holistic, and it is necessary to expand the understanding of Maori economic well-being in order to recognize these cultural orientations [5]. Piotrowska M believes that applying the concept of identity to study whether consumer behavior is important to the family's financial security. He established a financial security index and used it to determine the level of financial security experienced by Polish working-age families, while simulation results based on econometric models were used to find answers to the questions. The results show that whether financial insecurity is more due to the need to show up in higher levels of consumption rather than the average income group, and people are its members, or want to stand out in their own income group [6]. He W borrowed and analyzed the author's recent research on 242 Chinese court judgments, and explored the nature and scope of the term "financial security" used in Chinese judicial judgments. He provided a way to classify the use of the term financial security, which may help to better understand the judgments of Chinese courts in the contemporary and future context [7]. Valaei N studied the relationship between job satisfaction and employee performance in the media industry, and the role of demographic variables as a classification regulator on this relationship. He collected a total of 220 valid questionnaires from employees in the Malaysian media industry to examine the pros and cons of model fitting, symbolic uncertainty, and the structural relationship between measurement models and constructs [8]. The above-mentioned literatures are related to big data technology, financial security and logistics supervision, but they are not well integrated into one article for research and discussion. And there are some cases in the literature that have not verified their conjectures through experiments, but have speculated on their own research on the basis of theory, and there is still room for improvement.

The innovation of this article lies in the theoretical support of Internet financial risk management and the technical support of big data technology to make a general plan for the financial safety supervision of the logistics industry. At the same time, it introduces a pipe network model to systematically analyze and calculate logistics financial security to ensure the reliability and referenceability of related data.

2. Financial Security Supervision Methods

2.1 Big Data Technology

The first organization that proposed the arrival of the big data era was the world-renowned consulting company McKinsey [9]. His survey report pointed out that big data has penetrated into all production lines, Ik and business function areas, and has gradually become an important factor of production, and people use large amounts of data to increase productivity and a new wave of consumer excess is coming [10].

Figure 1 The difference between big data and small data

Big data refers to the need to quickly obtain, process, analyze, large-scale and diverse transaction

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data, interactive data, and sensor data to elicit its value. "Big data era" pointed out that big data is not random analysis (sampling survey), but refers to the use of all data. Figure 1 shows the difference between big data and small data.

In today's world economy, in order to discover new profit opportunities, companies rely more on insight into consumer preferences. In the process of discovering these preferences and mining, a large number of complex structures and various data are generated. The integration and sharing of these data paths, and mutual reuse, become valuable economic information resources, forming a knowledge resource and knowledge service function.

Methods of extracting information from huge scientific data sets, discovering its main characteristics, and understanding the relationships between them are crucial. Related technologies include hyper-parallel processing (MPP) databases, data mining grids, decentralized file systems, decentralized databases, cloud computing platforms, the Internet, and scalable storage systems. In order to achieve a stronger decision-making function, a new processing method is needed to optimize it. The specific situation of the big data analysis method is shown in Figure 2:

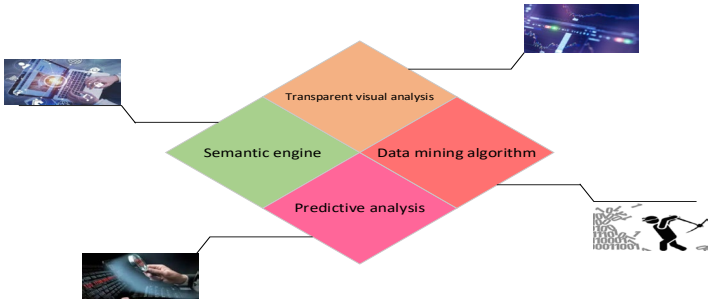

Figure 2 Big data analysis method

(1) Transparent visual analysis: The users of big data analysis include experts and general users of big data analysis. The most basic requirement of big data analysis is to be able to intuitively express the characteristics of big data, easy to be accepted by readers, and simple and clear visualization.

(2) Data mining algorithm: The core of big data is data mining algorithm. Various data mining algorithms are based on various data types and forms, which can show the characteristics of the data more scientifically.

(3) Predictive analysis: Mining information from big data, establishing scientific models, and predicting future data through models.

(4) Semantic engine: To extract necessary information from unstructured data and diversified data, sufficient artificial intelligence is required.

The big data technology system has a complex structure and various functions, and the logistics system can be abstracted into the main parts of decentralized big data cloud storage technology, decentralized big data processing technology, large-scale data application and management technology .

(5) Distributed big data cloud storage technology

Data storage is the basic application of big data, and the cloud storage technology of big data needs to be designed and analyzed according to actual applications, and traditional data management systems cannot meet this point. This technology mainly stores and manages data through related links and partition storage, but a large number of file management and storage are not enough. In order to make up for this shortcoming, many file management systems such as GFS, which are suitable for distributed big data cloud storage management, have been developed. This technology uses memory to read metadata and improves the efficiency of data storage and retrieval. And by adding a buffer layer, the cloud display technology of decentralized big data has entered the cluster management.

2.2 Pipeline Network Model Diagram Method

(1) Basic concept of pipe network diagram

Graph theory: using to express the relationship between the research objects, the system is abstracted by two elements: points and edges, and the dots represent objects, and the edges represent

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the connections between objects. Application of graph theory: using network structure characteristics for system analysis and calculation, calculation of transportation, logistics organization, financial supervision, engineering planning and other issues.

Pipeline network diagram theory: using diagram theory to analyze and calculate the intelligent cloud computing network system model. The nodes and parts of the pipe network correspond to the points and edges of the network that constitute the structural elements of the pipe network, and function as the main part of the pipe network, and are studied as the research object.

(2) Analysis of the pipe network diagram

Generally, in a planar network with J points and P independent edges, the number of independent closed loops Q is:

$$Q = P - J + 1 \tag{1}$$

The value of each element is as follows:

$$A_{ij} = \begin{cases} 1 \\ -1 \\ 0 \end{cases} \tag{2}$$

The structure of the pipe network model is shown in Figure 3:

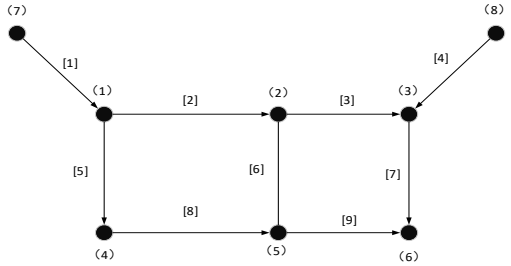

Figure 3 Pipe network model

In the pipe network model, all nodes are associated with several pipe sections. According to the law of conservation, the sum of the inflow of the node should be equal to the sum of the outflow of the node, expressed as:

$$\sum_{i \in s_j} (\pm q_i) + Q_j = 0, j = 1,2,3,\cdots N \tag{3}$$

(3) Basic equation of pipe network calculation

The hydraulic calculation of the water supply network is summarized into the following three simultaneous equations: nodal equation, pressure drop equation, and loop energy equation.

1) Nodal equation

The nodal equation is the flow continuity equation of each node, or Ketchhoff's first law, which can be expressed as:

$$\sum q_{ij} + Q_i = 0 \tag{4}$$

The node flow equation is:

$$A_q + Q = 0 \tag{5}$$

2) The pressure drop equation is expressed by an exponential formula:

$$H_i - H_j = h_{ij} = s_{ij} q_{ij}^n \tag{6}$$

If considering the direction of water flow and assuming that the signs of h and q are the same, it can be written as:

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$$h_{ij} = s_{ij}\left|q_{ij}\right|^{n-1} q_{ij} \tag{7}$$

3) Ring equation

The ring equation is the energy balance equation of the closed ring, or Kirchhoff's second law, expressed as:

$$\sum h_{ij} - \Delta H_k = 0 \tag{8}$$

Expressed as a matrix:

$$RT \cdot h = 0 \tag{9}$$

The flow at the node satisfies Kirchhoff's theorem, and the flow into the node is equal to the flow out of the node. It is assumed that the node has no savings function, and if the inflow flow is greater than the outflow flow out of the subsequent pipe section, overflow must occur at this node. As a result, the demand for the subsequent pipe section is affected by the flow rate of the previous pipe section.

$$L_3 = L_1^* + L_2^* \tag{10}$$

The valve plays a role in regulating the output flow of the pipe section in the pipe section system. In order to prevent the decrease of the overflow rate and control the corresponding output flow to increase the flow in the pipe section, the output flow of the pipe section can be controlled through the adjustment of the valve. Through the corresponding control structure or valve control, the valve control model is obtained:

$$q(s,t) = CaBu(t)\sqrt{2gY(s,t)} \tag{11}$$

The Matlab software is used to establish the model of the four nodes and three pipe sections in Figure 3, and obtain the conditions required for theoretical calculation through simulation, and then calculate the flow rate of each pipe section. The two cases of pipe sections without valve control and valve control are simulated and compared to control the flow of each pipe section. The relevant parameters of the model are shown in Table 1.

Table 1 Related parameter table

	Distance between nodes	Input flow
Pipe section 1	100	200
Pipe section 2	100	100
Pipe section 3	200	

2.3 Internet Financial Risk Management

Internet finance first appeared in the 1990s with the symbol SFNB, the "Safety First Internet Bank" in the United States, and became the first Internet bank to appear in the world. Since then, in some European countries such as Britain and Germany, as well as countries such as Japan in Asia, Internet finance has also begun to gradually appear and develop.

About the connotation of Internet finance

Internet finance is the penetration of the Internet spirit into traditional finance, which brings about changes in the business model and business philosophy, and the new financial model it produces is a financial innovation. Internet finance is not just a simple application of Internet technology in the financial industry, nor is it just a change in sales and service channels. Its core meaning is to use Internet technology as a means to build finance based on Internet operation ideas.

Regarding the definition and main content of Internet finance, foreign scholars have not reached a unified conclusion so far. Since the 21st century, under the background of the rapid development of science, technology and financial industry, the connotation of electronic finance and online finance has emerged.

With the emergence and development of Internet finance, although foreign academic circles have continued to pay attention and research on it, however because the domestic personal credit

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information system is lower than that in Western countries, the barriers to financial communication and transactions are higher, and the degree of marketization of business operations is lower. Therefore, Internet finance has not produced similar effects in foreign countries, and so far there has not been a unified and clear definition of Internet finance in foreign countries.

After rigorous sorting, it is found that the current research on Internet financial risk management is a hot issue, and there are many results. However, there are very few systematic researches from the perspective of the entire Internet financial risk formation and management, especially for the logistics industry, and there are few related researches that need to be further deepened.

3. Big Data Analysis and Logistics Financial Safety Supervision Experiment

In the era of big data, data is growing explosively, and logistics companies can obtain a large number of customers, partners, and their own business data information. Big data has the ability to creatively transform the financial safety supervision of logistics enterprises, and increasingly fierce data are being generated all over the world. The storage and analysis of big data information has become an important way for companies to ensure their profits. The financial safety supervision potential of big data is recognized by logistics companies, and it provides a new perspective for logistics companies to create and protect value and obtain value, and it is an important entry point for logistics companies to conduct financial safety supervision. The impact of big data on the financial safety supervision of logistics enterprises is reflected in the elements of the business model of logistics enterprises. Using grounded theory to qualitatively research, the application of big data to logistics enterprises is embodied in three aspects: big data analysis, big data forecasting and big data driving. It extracts the elements of the business model of logistics enterprises, including the two top-level elements of value creation and delivery, and value acquisition. Big data provides important means for logistics companies to carry out key activities and resource innovation, value network innovation, business model innovation, financial security supervision, cost structure innovation, and resource allocation innovation.

3.1 The Impact of Big Data Analysis on Key Activities and Resources

Big data analysis helps logistics companies realize the visualization and intelligence of corporate business operations, and plays a role in promoting the information sharing and circulation of corporate key activities and resources. Logistics companies use big data to analyze the transportation information and operation of each link of logistics, analyze customer consumption patterns, equipment maintenance, and future development trends of the company. While reducing logistics costs, it provides an important basis for enterprises to make intelligent decisions. For example, logistics companies use big data to analyze and understand the carrying conditions and transportation paths of logistics trucks in advance, which can effectively avoid high empty-load rates and overload rates, and improve and optimize logistics transportation paths; based on the analysis of big data, it optimizes the allocation and reasonable planning of logistics resources, realizes the forward-looking effect of logistics enterprise operations, and meets the huge logistics information needs of logistics enterprises. This paper conducts a correlation analysis of the big data analysis category and key activities and resource-related concept nodes. The analysis results are shown in Table 2:

Table 2 Big data analysis and the relevance of key activities and resources

category	Node A	Node B	Correlation coefficient
A12	A48	A-1	0.894625
	A49		0.823647
	A50		0.652231
	A51		0.742694
	A52		0.871126
	A53		0.854699
	A54		0.912291

According to the correlation coefficient value in Table 2, we can know the correlation between node B's big data analysis and node A's key activities and resource-related original concepts. The correlation coefficient between big data analysis and talent, technology, warehousing business, transportation business, and delivery business shows a strong correlation; strong correlation with organizational structure, users, and presentation. According to the results of the correlation analysis between the two variables of big data analysis and key activities and resources, it is concluded that big data analysis can

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promote key activities and resource innovation, and big data analysis can obviously promote the innovation of dispatching business activities.

3.2 The Impact of Big Data Analysis on the Value Network

Table 3 Relevance of Big Data Analysis and Value Network

category	Node A	Node B	Correlation coefficient
A13	A55	A-1	0.891262
	A56		0.801176
	A57		0.651362

According to the correlation coefficient value in Table 3, the correlation between the node B big data analysis and the original concept of the value network of node A can be known. The correlation coefficient between big data analysis and the supply chain and value chain shows a strong correlation, and it shows a strong correlation with the industrial chain. According to the results of the correlation analysis between the two variables of big data analysis and value network, it is concluded that big data analysis has a significant role in promoting value network innovation, and big data analysis can significantly promote supply chain innovation.

The key to business model innovation for logistics companies lies in the effective use of large amounts of data and information, and the efficient use of big data for analysis. In the process of big data analysis, logistics companies can discover new opportunities, improve corporate operational efficiency, create new revenue streams, increase competitive advantages, realize new business models, and rationalize the supply chain by effectively resolving problems in business activities.

Table 4 The correlation between big data analysis and business model

category	Node A	Node B	Correlation coefficient
A14	A58	A-1	0.894697
	A59		0.823694
	A60		0.858891

According to the correlation coefficient value in Table 4, we can know the correlation between the node B big data analysis and the original concept related to the node A business model. The correlation coefficients between big data analysis and diversification, vertical cooperation and horizontal cooperation show a strong correlation. According to the results of the correlation analysis between the two variables of big data analysis and business model, it is concluded that big data analysis has a significant role in promoting business model innovation, and the use of big data analysis by logistics companies will promote the diversified development of business models.

3.3 The Impact Mechanism of Big Data Analysis on Value Acquisition

Big data analysis is conducive to the use of data and information for logistics enterprises to make intelligent decisions, optimize prices, and reduce costs. Value acquisition is the result of value creation, and value acquisition includes three components: income model, cost structure, and resource allocation. Big data analysis acts on the income model of logistics enterprises, which can formulate flexible and flexible income models for enterprises and establish a dynamic price system for customers. The change in the income model of logistics enterprises has triggered changes in the cost structure of enterprises. Companies use big data analysis to optimize the cost structure, which in turn brings benefits to the optimization of revenue models, and use big data to analyze resource allocation and lay the foundation for enterprises to develop new businesses and new fields. The impact of big data analysis on value acquisition is analyzed and studied from three aspects: income model, cost structure and resource allocation.

The impact of big data analysis on income models

Table 5 The correlation between big data analysis and income model

category	Node A	Node B	Correlation coefficient
A15	A61	A-1	0.842697
	A62		0.871364
	A63		0.882683

According to the correlation coefficient value in Table 5, the correlation between node B's big data analysis and the original concept of node A's income model can be known. The correlation coefficient

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between big data analysis and key business income and value-added business income shows a strong correlation. According to the results of the correlation analysis between the two variables of big data analysis and income model, it is concluded that big data analysis has a significant role in promoting income model innovation. Logistics companies use big data for analysis, which can effectively increase the income of value-added services, and at the same time, the understanding of income models can better promote the supervision of financial security.

4. Logistics Financial Security Risks

4.1 Customer Transaction Analysis

(1) Customer transaction costs

In order to better understand the cost of customers in the logistics industry in the past transaction process and the cost changes of logistics financial security under the supervision of big data, this article conducts research and analysis on the financial statements of enterprises that adopt logistics finance. The statistics of its transaction costs are compared with the previous transactions, and the statistics are shown in Figure 4:

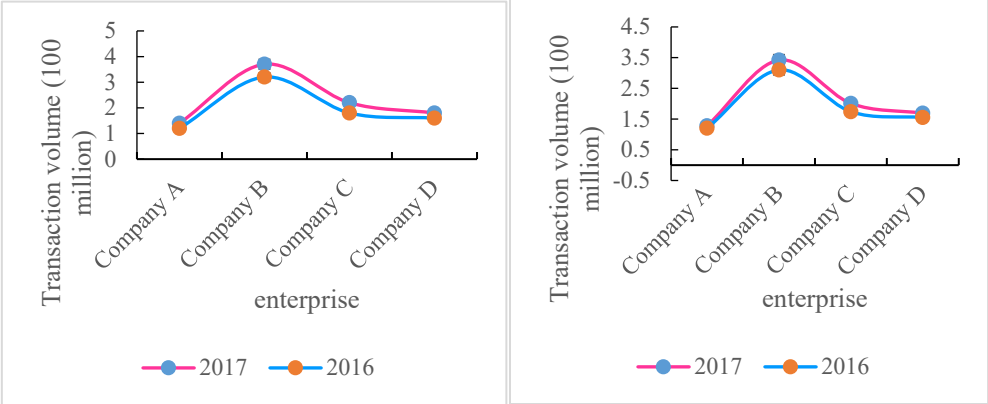

Figure 4 Comparison of past transaction costs and transaction costs under improved financial security supervision

As we can know from the figure above, in the past transaction process, the transaction costs of several major companies were compared with the transaction costs of the improved financial security supervision based on big data technology, and the transaction costs of the improved four major companies have been reduced to varying degrees. It can be clearly seen that the advantages of this method can reduce transaction costs in the transaction process.

(2) Customer transaction risk

For customer transaction analysis, it not only refers to the comparison of transaction costs, but more to optimize the risks that exist in the transaction process. In the same way, the transaction risk in the transaction process of the above four companies is counted, and the situation is shown in Figure 5:

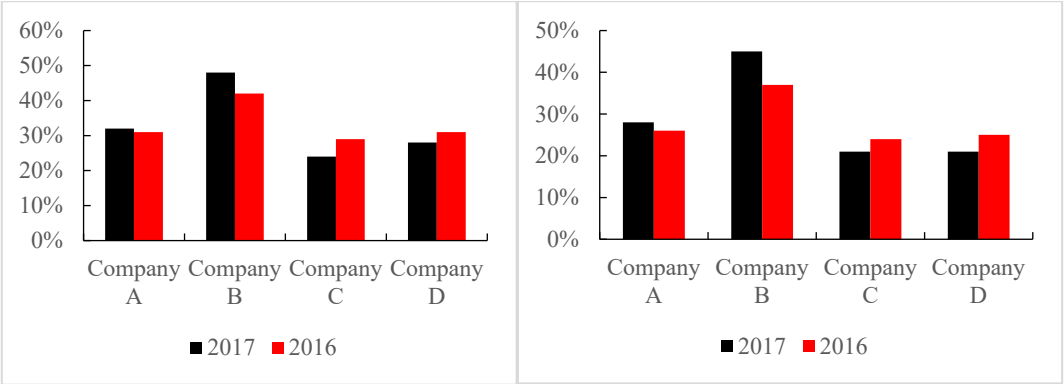

Figure 5 Comparison of risks in past transactions and risks under financial security supervision

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Based on the above two comparison diagrams, it is not difficult to know that the logistics financial security supervision based on big data technology is significantly better than the previous logistics transaction mode in terms of the reduction of transaction costs and the reduction of transaction risks, and can greatly improve the risks that logistics customers take in the actual transaction process.

4.2 The Scale of Development of the Logistics Industry

In recent years, the domestic modern logistics industry has developed rapidly, and changes have taken place in the structure of road transportation and the division of labor and cooperation among specialties. "Logistics centers" or "logistics parks" have become a trend in the development of the logistics industry, from the traditional mode of transportation management to the development of the logistics industry. The logistics industry has caught up with a wave of development dividends in the era of the Internet of Things, and under the monitoring of big data, the monitoring of logistics financial security can be well guaranteed. This article makes a general statistics on the logistics industry scale in the two main economic regions of the Yangtze River Delta and the Pearl River Delta. Statistics before 2010 and comparing the scale of logistics in these two regions with the scale of the regional logistics industry 15 years later, the statistics are shown in Figure 6:

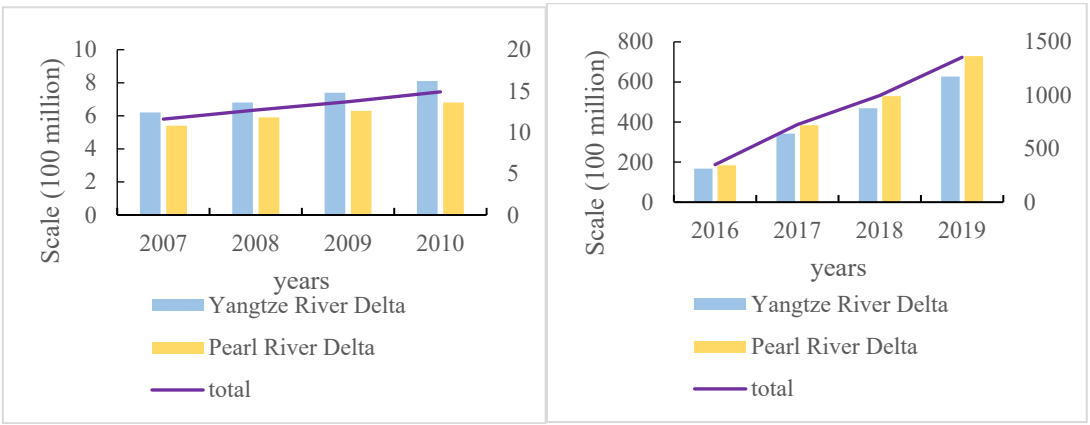

Figure 6 Comparison of the logistics scale of the two economic regions under two different modes

As can be seen from the above figure, between 2007 and 2010, big data monitoring technology has not yet begun to be popularized in the logistics industry, while the growth rate of the logistics industry in the two economic regions has been relatively slow during the four years. After 2015, logistics financial security under the monitoring of big data technology has been significantly improved, which has also greatly promoted the development of the logistics industry. In the past four years, the growth of the logistics industry has been significantly faster than in previous years, and the entire logistics industry has been developing at an extremely fast pace.

4.3 Comparison of Logistics Financial Safety Supervision Capabilities

In order to conduct a detailed understanding and comparison of the regulatory capabilities in the Internet era under two different regulatory models, a general statistics are made on the regulatory capabilities and regulatory scales of the two sub-years. The statistical results are summarized, as shown in Figure 7.

As can be seen from the above figure, the regulatory capacity in 2007 was 14%, and the regulatory scale was US$450 million; in 2008, the regulatory capacity was 16%, and the regulatory scale was US$460 million; in 2009, the regulatory capacity was 15%, and the regulatory scale was US$490 million; in 2010, the regulatory capacity was 17%, and the regulatory scale was US$510 million. After 2015, within a few years after big data supervised logistics financial security: in 2016, the regulatory capacity reached 47%, and the regulatory scale reached 11.4 billion U.S. dollars; in 2017, the regulatory capacity was 64%, and the regulatory scale was 27.6 billion US dollars; in 2018, the regulatory capacity was 71%, and the regulatory scale was US$41.3 billion; in 2019, the regulatory capacity reached its highest peak at 82%, and the regulatory scale also reached a peak of US$59.7 billion.

Through the analysis and comparison of the above aspects, we can easily know that through the intervention of big data technology, the financial security of the logistics industry has been greatly

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improved. Its customer transaction cost control and transaction risk control in the logistics industry, as well as the development speed of the logistics industry and the ability to supervise logistics financial security have been significantly improved compared to the original model, effectively solving the development problems of the logistics industry.

Figure 7 Comparison of logistics financial security supervision capabilities

5. Conclusions

The main research content of this paper is to supervise logistics financial security through the use of big data technology in the context of the Internet to ensure financial security. For the use of big data technology, this article analyzes big data separately, compares the risk analysis capabilities of big data and the risks brought by big data itself, and makes reasonable plans. At the same time, this article understands the knowledge related to risk control, understands the problems and solutions faced in the process of risk control, and uses it reasonably in the logistics financial security monitoring. This article also designs an experimental analysis to compare and analyze the development of the relevant logistics industry, and the analysis results show that under the monitoring of big data technology, the financial security of the logistics industry has been significantly improved. Among them, customer transaction costs have been reduced by 4.7%, transaction risks have been reduced by 12%, the development rate of the logistics industry has increased by 24%, and the ability to supervise related logistics industries has increased by 36%, indicating that risks can be well controlled.

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