Exploration on the Application of Blockchain Technology in Improving Financial Transparency

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Abstract

This paper focuses on the application of blockchain technology in improving financial transparency. With the development of the economy, the importance of financial transparency has become increasingly prominent, while the traditional financial management methods have problems such as information asymmetry. The decentralization, non-tampering and traceability of blockchain technology make it possible to solve these problems. This paper discusses the help of blockchain technology to improve financial transparency and expounds the application of blockchain technology in the financial field through the automation and transparency of financial audit, the real-time and accuracy of financial report and the optimization and transparency of asset management. At the same time, the case and practical results of blockchain technology in improving financial transparency are expounded through the case of improving government policies and supervision and the practice of promoting transparency in industry collaboration. Finally, the relevant summary is made, which mentions that with the continuous development and improvement of blockchain technology, its application in the financial field will create a more transparent and efficient financial management environment for enterprises and promote the innovation and development of the financial industry.

keywords

Blockchain, Financial transparency, Financial management

Introduction

In today's digital age, financial transparency is very important for the sustainable development of enterprises and the establishment of social trust. However, traditional financial management has many challenges in information sharing, data security and trust mechanism [1]. With the rise of blockchain technology, it provides new ideas and possibilities for solving these problems.

As a decentralized and distributed ledger technology, blockchain technology has the characteristics of being tamper-proof, traceable, safe and reliable. Applying it to the financial field is expected to break the information island, realize real-time sharing and transparency of financial data, and improve the efficiency and accuracy of financial management [2].

The purpose of this study is to deeply explore how blockchain technology can bring changes to the improvement of financial transparency. Through the in-depth analysis of the principle of blockchain technology and the case analysis of its application in the financial field, it will show the great potential of blockchain technology in solving financial information asymmetry, preventing financial fraud and

enhancing audit effectiveness [3]. Through the study of these problems, I hope to provide useful reference and suggestions for enterprises and related institutions in applying blockchain technology to improve financial transparency. Therefore, this study aims to provide a platform for professionals, scholars and readers interested in blockchain technology in the financial field to fully understand the application of blockchain technology in improving financial transparency [4-5].

Theoretical overview

Overview of blockchain

Blockchain is an innovative technical architecture. Through a brand-new information recording and dissemination mode, different computers are connected together to form a safe and efficient information storage and transmission system. Its technical system involves cryptography, data structure, network communication and other fields, showing unprecedented security and transparency. The abstract structure of blockchain data is shown in the following figure:ransparency. The abstract structure of blockchain data is shown in the following figure:
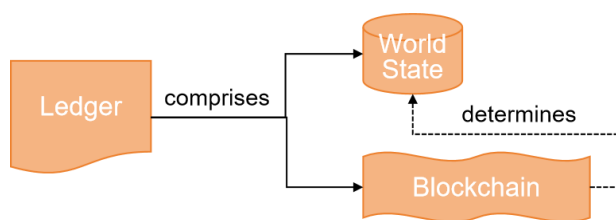

Figure 1. Abstract structure of blockchain data.

Blockchain, also known as chain data structure, records information in the form of blocks, and links these blocks together through specific algorithms to form a continuous chain. Each block contains certain information, such as transaction records, time stamps, etc., and is protected by cryptographic algorithms. This unique structural design makes the data on the blockchain highly secure and tamper-proof.

Blockchain has the following four characteristics: (1) Security: The encryption algorithm of blockchain ensures the security of data transmission and effectively prevents data from being tampered with or stolen. (2) Transparency: All data recorded in the blockchain is open and transparent, and anyone can query and verify it. (3) Distributed: Blockchain does not depend on centralized servers or institutions, and each participant has complete data on the chain. (4) Non-tampering: Once the data is recorded in the blockchain, it can hardly be tampered with or deleted.

Blockchain technology is widely used in finance, supply chain management, public services and other fields. For example, it can be used in the issuance and trading of digital currency to improve the efficiency and security of financial transactions; It can also be used to track and verify the commodity information in the supply chain and improve the transparency and credibility of the supply chain. From 2014 to 2023, the registration volume and growth rate of China's blockchain-related enterprises are shown in the following figure:
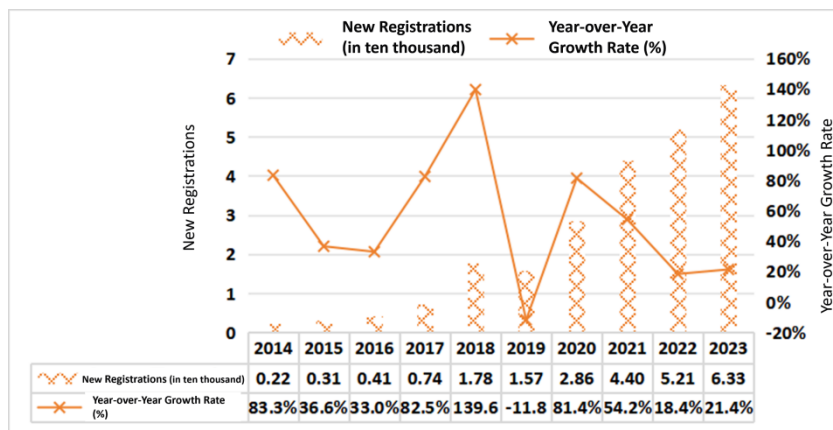
Figure 2. The registered quantity and growth rate of China's blockchain-related enterprises from 2014 to

2023.

Overview of financial transparency

Financial transparency refers to the degree and quality of disclosure of financial information by enterprises, so that stakeholders can clearly and accurately understand the financial situation, operating results and cash flow of enterprises [6].

An enterprise with high financial transparency will disclose its financial information in a clear and easy-to-understand way, including financial statements, notes to financial reports, management discussion and analysis, etc. This can help investors, creditors, employees, suppliers, customers and other stakeholders make more informed decisions. Improving financial transparency is of great significance in many aspects. First, it helps to enhance the confidence of investors. When investors make investment decisions, they need to fully understand the financial situation and operational risks of enterprises [7]. High financial transparency can reduce information asymmetry, reduce investment risks and attract more investors. Second, financial transparency helps to improve the credibility and reputation of enterprises. An open and transparent corporate image is more likely to gain market recognition and trust, which is conducive to the long-term development of enterprises. Third, financial transparency is also conducive to strengthening the internal management of enterprises [8]. Transparent financial information can encourage management to operate enterprises more cautiously, improve the level of financial management and prevent internal corruption and improper behavior.

However, it is not easy to achieve high financial transparency. Enterprises need to establish a sound financial management system to ensure the accuracy and reliability of financial information [9]. At the same time, it is necessary to follow the relevant accounting standards and regulations and standardize the disclosure process of financial information. Therefore, financial transparency is an important guarantee for the healthy development of enterprises, which is of great significance to the sustainable development of enterprises and the stable operation of the market [10].

Blockchain technology to help improve financial transparency

In today's digital age, blockchain technology has attracted wide attention from various industries. Among them, it has significant help to improve financial transparency. The core characteristics of blockchain technology are tamper-proof and open and transparent. These two characteristics have great application value in the financial field [11]. Tampering means that once the data is recorded in the blockchain, it cannot

be modified or deleted, which effectively avoids the risk of financial fraud and forged records. Openness and transparency ensure the transparency of all transactions and records, so that every transaction can be seen by all participants. The basic situation of representative listed companies in the blockchain industry is shown in the following table:

Table 1. Basic information of representative listed companies in blockchain industry.

Stock abbreviation	stock code	Listing plate
Skyworth digital	000810.SZ	Main board of Shenzhen stock exchange
Neusoft group	600718.SH	Main board of Shanghai stock exchange
Shenzhou information	000555.SZ	Main board of Shenzhen stock exchange
Softcom power	301236.SZ	Main board of Shenzhen stock exchange
Nantian information	000948.SZ	Main board of Shenzhen stock exchange

In the traditional financial system, due to the lack of effective audit mechanism, the authenticity and accuracy of financial information are often questioned. However, the application of blockchain technology has completely changed this situation. By using blockchain technology, enterprises can record all transaction and financial information and ensure that this information cannot be tampered with. In addition, due to the openness of the blockchain, this information can be verified by anyone at any time. This has greatly improved the transparency of financial information and enhanced the trust of investors and stakeholders in the enterprise. In addition, blockchain technology can also realize automated auditing and supervision processes through smart contracts [12,14]. By writing specific program codes, smart contracts can automatically perform operations under certain conditions, such as triggering payment or automatically sending notifications. This automated process reduces the risk of human error and fraud, thus improving the accuracy and efficiency of the audit.

Therefore, blockchain technology provides a powerful tool and solution for improving financial transparency. Through its non-tampering, open and transparent characteristics and the application of smart contracts, blockchain technology can ensure the authenticity and accuracy of financial information, improve the efficiency and accuracy of auditing, and bring more trust and confidence to all stakeholders [15].

Application of blockchain technology in the financial field

Automation and transparency of financial audit

With the continuous development of science and technology, the automation and transparency of financial audits is becoming a trend. The automation of financial audit is mainly reflected in the use of advanced information technology and software tools to improve the efficiency and accuracy of audit work. For example, by using data analysis software, auditors can quickly process and analyze a large number of financial data and find potential problems and anomalies. Automation can also reduce the errors caused by manual operation and improve the quality of audit work. The transparency of financial audit emphasizes the openness and understandability of audit process and results. This means that audit institutions need to disclose audit methods, procedures, found problems and suggested improvement measures to stakeholders in a clear and easy-to-understand way. Transparency can enhance the credibility of audit and improve the

trust of stakeholders in audit results.

Realizing the automation and transparency of financial audit has many advantages. For example, automation can greatly shorten the audit cycle, reduce the audit cost, and enable enterprises to obtain audit results in a timelier manner. Moreover, transparency can promote the internal financial management of enterprises to be more standardized and compliant and reduce the occurrence of financial fraud. In addition, transparent audit process and results also help investors, creditors and other stakeholders to make more informed decisions. In order to realize the automation and transparency of financial audit, audit institutions need to constantly improve their technical ability and professional level. At the same time, enterprises need to actively cooperate with the audit work, provide accurate and complete financial information, and establish a sound internal control system. Therefore, the automation and transparency of financial audit is an important way to improve audit quality and enhance market confidence, which is of great significance to promote the healthy development of enterprises and maintain the order of market economy.

Timeliness and accuracy of financial reports

Real-time and accuracy of financial reports are two very important aspects of enterprise financial management. Real-time means that financial reports can reflect the financial situation and operating results of enterprises in a timely manner. In today's rapidly changing business environment, timely financial information is very important for enterprises to make decisions. Real-time financial reports can help management to quickly understand the operation of enterprises, find problems in time and take corresponding measures. At the same time, for investors, creditors and other external stakeholders, real-time financial reports can also make investment decisions or adjust credit strategies faster. Accuracy is the core requirement of financial reporting. The data in the financial report must truly, reliably and completely reflect the actual financial situation of the enterprise. If there are errors or deviations in financial reports, it may lead to mistakes in decision-making and bring serious losses to enterprises and stakeholders. In order to ensure accuracy, enterprises need to establish a sound financial accounting system and internal control system to ensure the rigor and standardization of the process of collecting, recording, summarizing and reporting financial data.

However, it is not easy to realize the real-time and accuracy of financial reports at the same time. In the process of pursuing real-time, data processing may not be detailed enough because of time constraints, thus affecting accuracy. On the contrary, too much emphasis on accuracy may prolong the preparation time of the report and reduce the real-time performance. Therefore, enterprises need to find a balance between the two. In order to improve the real-time and accuracy of financial reports, enterprises can adopt a modern financial management information system to realize automatic collection and processing of financial data, reduce manual intervention and improve the accuracy and timeliness of data. At the same time, strengthening the training and quality improvement of financial personnel and improving their professional ability and sense of responsibility are also important measures to ensure the quality of financial reports.

Optimization of asset management and improvement of transparency

The optimization of asset management and the promotion of transparency are of great significance to the sustainable development of enterprises and organizations. The optimization of asset management aims to improve the efficiency and benefit of asset utilization through rational allocation of resources. This includes the scientific management of purchase, use, maintenance and disposal of assets. When purchasing assets, it is necessary to conduct sufficient market research and demand analysis to ensure that the purchased assets

meet the actual needs and strategic planning of the enterprise. In the process of using assets, we should establish a sound management system, standardize the use and operation of assets, and reduce waste and damage. At the same time, we should strengthen the maintenance of assets, extend the service life of assets and reduce the maintenance cost. In the process of asset disposal, it should be carried out in accordance with the prescribed procedures to ensure the legality and compliance of asset disposal and maximize the value of assets [16].

The improvement of transparency requires enterprises to disclose relevant information to internal and external stakeholders in a timely and accurate manner in the process of asset management. Internally, it is necessary to let the management and employees know about the status and management of assets, so as to make better decisions and implement the work. Externally, it is necessary to provide clear and transparent asset management information to investors, creditors, regulators, etc., and enhance their trust and confidence in enterprises. In order to improve transparency, enterprises need to establish a sound asset management information system to ensure the accuracy and timeliness of data. At the same time, internal audit and supervision should be strengthened to prevent irregularities and corruption in the process of asset management. In the second quarter of 2024, the ranking of R&D funds for blockchain application stocks is shown in the following table:

Table 2. Ranking of R&D funds for blockchain application stocks in the second quarter of 2024.

serial number	Securities code	Securities abbreviation	R&D expenses (yuan)
one	600050	China Unicom	2.994 billion
two	600570	Hengsheng electronic	1.162 billion
three	600839	Sichuan changhong	1.072 billion
four	600588	Yongyou network	1.064 billion
five	688012	Zhongwei company	568 million
six	600718	Neusoft group	444 million
seven	002063	High beam software	363 million
eight	002668	TCL zhijia	285 million
nine	000948	Nantian information	206 million
ten	300002	Shenzhou taiyue	193 million

The optimization of asset management and the improvement of transparency promote each other. Optimizing asset management can improve the efficiency and value of assets and provide strong support for enhancing transparency; The improvement of transparency can promote the standardization and scientificity of asset management and further optimize asset management. By optimizing asset management and improving transparency, enterprises can better cope with market competition and achieve sustainable development.

Cases and practice of blockchain technology in improving financial transparency

Improvement cases of government policies and supervision

In addition to enterprise-level applications, the government has also played an important role in promoting blockchain technology to enhance financial transparency. At the policy and regulatory level, the

government has provided strong support for the application of blockchain technology by formulating relevant regulations and standards.

(1) Domestic policies and regulatory cases

China Municipal Government has played an active guiding role in promoting the development of blockchain technology. For example, the government has issued a series of policy documents on promoting the development of blockchain technology and industry and strengthening financial supervision. At the same time, the government has also set up special institutions to promote the research and development and application of blockchain technology. These measures have provided clear guidance and support for enterprises in applying blockchain technology and effectively promoted the improvement of financial transparency.

(2) Foreign policy and regulatory cases

In European and American countries, the government's support for blockchain technology is mainly reflected in strengthening financial supervision and promoting technological innovation. For example, the US government issued a series of regulations on digital currency and blockchain technology, which provided a clear legal framework and operational guidelines for financial institutions. At the same time, some governments have also cooperated with private enterprises to jointly establish a public blockchain platform to support a wider range of financial information transparency needs. In addition, the EU is also promoting the implementation of regulations on data protection and privacy to protect the security and privacy of personal data.

To sum up, blockchain technology has played an important role in improving financial transparency, whether at home or abroad, whether at the level of enterprises or governments. By introducing blockchain technology, enterprises and governments can better manage financial information, improve data transparency and strengthen financial supervision. In the future, with the continuous development and application of technology, financial transparency will be further improved. At the same time, it also provides a reference for other industries.

Practice enhancing the transparency of industry collaboration

In today's business environment, blockchain technology is playing a huge role in many fields with its unique advantages. Especially in terms of improving financial transparency, blockchain technology provides unprecedented possibilities for industry collaboration. And with the development of science and technology, the transparency of financial information has become an important cornerstone of cooperation between enterprises. In many industries, especially in supply chain management, financial services and public sector, the importance of collaborative work is self-evident. However, due to the asymmetry of information and the limitations of traditional recording methods, the transparency of industry collaboration is often challenged.

Taking supply chain management as an example, blockchain technology provides a shared and transparent information platform for participants in all links. On this platform, each participant can view and verify the transaction information, ensuring the authenticity and accuracy of the information. For example, in the food supply chain, every link from production to sales can be recorded and tracked through blockchain technology. Once there is a food safety problem, relevant personnel can quickly find the source of the problem, which not only improves the synergy efficiency of the industry but also protects the rights and interests of consumers. In the field of financial services, blockchain technology also plays a key role in

improving the transparency of collaboration. Traditional financial transactions usually involve multiple intermediaries and complex transaction processes, which leads to information being easily lost or tampered with during transmission. Blockchain technology provides a safe and transparent trading environment for financial institutions through its decentralized and tamper-proof characteristics. This not only improves the efficiency of trading but also reduces the risk of trading.

In general, blockchain technology has great potential in improving the transparency of industry collaboration. By providing a shared and transparent information platform for all participants, blockchain technology not only improves the efficiency of collaboration, but also protects the rights and interests of all parties. In the future, with the continuous development and improvement of blockchain technology, its role in enhancing the transparency of industry collaboration will be more significant.

Conclusion

In the research process of "Application Exploration of Blockchain Technology in Improving Financial Transparency", it fully embodies the great changes and potential brought by blockchain technology to the financial field.

Through the study of blockchain technology, we can understand its characteristics such as decentralization, non-tampering, traceability, etc., and can effectively solve the problems of financial information asymmetry, data security and trust, thus significantly improving financial transparency. In practical applications, blockchain technology can realize real-time sharing and updating financial data and ensure the accuracy and integrity of information. At the same time, the application of smart contracts can automate the implementation of financial processes, reduce human intervention, and reduce the risk of errors and fraud.

In the future, more enterprises and institutions will actively explore and apply blockchain technology to promote the innovation and development of the financial industry. At the same time, it is hoped that academia and industry can strengthen cooperation, jointly study and solve the problems faced by blockchain technology in financial application and contribute to achieving a higher level of financial transparency and sustainable development of the industry.

All in all, blockchain technology has brought new opportunities and hopes for the improvement of financial transparency. Moreover, in the near future, blockchain technology will become an important support in the financial field and play an active role in building a more transparent and credible financial environment.

Acknowledgements

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Financial Accounting Management Based on Computer Network Environment

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Abstract

With the application of computer technology in the financial management of enterprises, the environment and means of its management have changed greatly, and many problems have been effectively solved, thus enhancing the competitiveness of the enterprises.

Keywords

Introduction

Artificial intelligence is the mathematical logic, fuzzy mathematics, computer science, cybernetics, information theory, many disciplines of management science, physiology, psychology, linguistics and philosophy of mutual penetration of a new discipline comprehensive and developed. Enterprise has accumulated a lot of financial data in the process of information development, but the commercial value of these financial data has not been fully excavated and utilized. The current situation is the massive financial data information about the potential depth is not enough in-depth traditional diagnostic methods and using [1]. Data mining as an efficient tool, its advantage is the ability to quickly from a large number of missing, noisy, fuzzy and random data in the capture of valuable but not known information. On this basis, the unique business rules behind these data, and these rules are summarized into a model. Modern enterprise financing theory originated from the famous MM theory. This theory started the modern enterprise financing efficiency theory of the first of its kind [2].

A profound discussion is put forward in the article, which has attracted the attention of many scholars in the theoretical circle. The article points out that the enterprise market value and the choice of the way of financing the enterprise is not related, that is to say the different financing methods will not cause the difference in the market value of the enterprise. This thesis puts forward a perfect market system, which is put forward under the condition of strict hypothesis, that is, there exists a perfect competition market and the existence of information symmetry [3]. It can be known that it is not possible to fully meet these assumptions in the real environment. So, the theory has great limitation in practical application. But if we only consider its theoretical significance, the basic framework of modern enterprise financing theory is put forward. It can be said that after the scholars for the theoretical study provides a way of thinking. So many scholars have made further research on the enterprise financing problems on the basis of the development of the theory on the basis of the theory, which makes the theory has been extended [4,5].

Corporate finance refers to the behavior of the listing corporation to raise funds from the inside and outside of the company to realize the organization goal. As a kind of special form of enterprise organization, listing Corporation's financing behavior has its own characteristics, but also has the characteristics of general

enterprises. Comprehensive analysis, listing Corporation financing behavior has the following characteristics [6]. With diversified financing target, listed company's diverse financing goal is mainly manifested in two aspects: one, if in order to enhance the value of the company for the purpose of, so the financing behavior of listed companies sub goal can be diverse, including obtaining long-term stable money supply, lower capital cost, adjust the capital structure [7].

With flexible financing, listed companies because it directly faces to the capital market, and have a strong financing autonomy, while the listed company can be flexible use of financial instruments, such as bank credit, bonds, and stocks to raise capital. With complex financing decision-making mechanism, phase due to the listed company's financing decision as an important financial decision, usually need after discussion of managers, and then to vote by the board of directors and the general meeting of shareholders to through [8]. The relatively large size of the listed company, the financing way is flexible, the stakeholders involved in the financing behavior more influence on society.

Methods and materials

Artificial intelligence data mining

(1) Artificial intelligence

Artificial intelligence is mathematical logic, fuzzy mathematics, computer science, cybernetics, information theory, many disciplines of management science, physiology, psychology, linguistics and philosophy of mutual penetration of a new discipline comprehensive and developed [9]. The expert system of financial management is a program system of financial management knowledge, experience and skills, which is used to solve various problems in the financial field. Specifically, the expert system of financial management is mainly used to replace financial management experts for complex financial management process description, diagnosis, analysis and verification, as a combination of technology, philosophy and the environment of financial management and make the final decision (Figure 1).
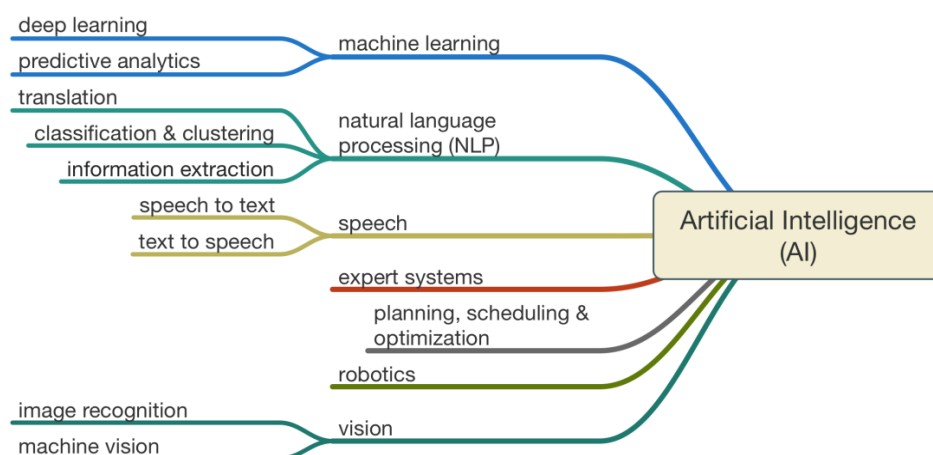

Figure 1. Artificial intelligence.

The idea of the financial management expert system is to decompose complex financial problems into some easier sub problems and then solve them by searching and solving the problems [10,11]. Intelligent expert system of financial management is the intelligent expert system, intelligent expert system of financial management in the financial management of the content can be divided into financing management expert system (including capital management), investment management operation management expert system, expert system (including risk management, crisis management and distribution management expert system). Each of these systems can also be embedded in the financial planning and forecasting subsystem, the

financial decision-making subsystem, the financial budget subsystem, the financial control subsystem and the financial analysis subsystem [12]. Through the integration of the system, the expert system of financial management functions plays the most incisive, financial prediction is more accurate, more scientific financial decision-making, financial budget will be closer to the actual financial control in place, a more thorough financial analysis, financial management is more comprehensive, comprehensive management of easy at the instant (Figure 2).

Figure 2. Financial management.

(2) Clustering method

The information obtained from financial analysis can provide decision basis for investors and managers [13]. The financial analysis mainly includes the analysis of financial data distribution, the structure factor and the index ratio. The main feature of data mining is that it can solve the problem of model and high efficiency by extracting, transforming and analyzing all kinds of financial data [14]. This requires enterprises to comprehensively analyze the internal and external business development situation and trends, the effective disclosure of financial information. Therefore, the use of data mining technology for the company's financial analysis and diagnosis is efficient and important (Figure 3). This paper on the basis of research results of scholars proposed data mining in the financial analysis diagnosis mainly used in one is the use of cluster analysis combined with financial ratios analysis can be sample enterprises are classified according to the clustering and grouping variables standard, can use comprehensive financial ratios, such as Z value comprehensive scores [15]. Second, to find the strong association rules, namely in the clustering analysis based on, enterprises will be different according to the condition of financial divided into several classes, then, use association analysis algorithm, to find the effect of each enterprise's financial situation of a variety of factors, through the inductive analysis, the strong association rules.
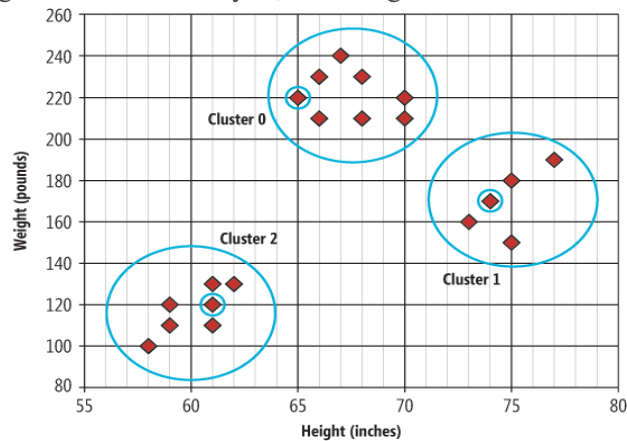

Figure 3. Cluster analysis.

Decision tree is a treelike structure that is similar to the flow chart, and it is an inductive learning algorithm based on an example. Using the decision tree method to classify, can be more intuitive to see the classification rules from the decision tree. The decision tree method has advantages of high speed, high precision and easy to generate results when processing a large number of data sets [16]. Decision tree technology can be classified in this paper and the study of the case of the company's financial situation (Figure 4). From the root node to a leaf node of the recursion calculation and comparison tests in the process of attribute values, by different attribute value down recursive judgment, and ultimately in the leaf node of the decision tree obtained relevant conclusions by decision tree algorithm [17]. Decision tree algorithm can be divided into two categories: Based on information theory (including the ID series algorithm and C5.0 algorithm) and the minimum GINI index algorithm (including CARPT, SLIQ and SPWNT algorithm).
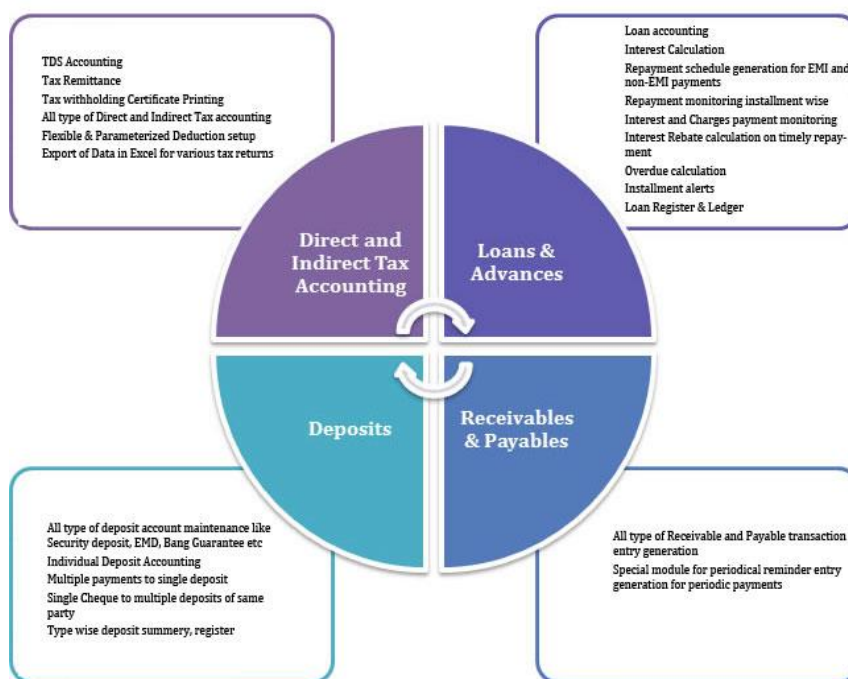

Figure 4. Financial management systems.

Financing efficiency evaluation model

Construction of input output index

In the selection of the input indexes of corporate financing efficiency, considering the company gets financial capacity of input indicators should be the inclusion of asset size, capital structure, financing cost. These three aspects respectively for the total assets of the company, assets and liabilities rate, total operating costs [18,19].

Total company assets (Xl): The larger the size of the company, it is easier to raise funds to meet the needs of the company's production and operation. And then the scale of the company needs to raise the cost of financing the lower the company's financing efficiency is higher. Therefore, the index represents the size of the company's assets, can reflect the company's overall financing situation.

Asset liability ratio (X2): Asset liability ratio, also known as the financial leverage coefficient, from the perspective of capital structure reflects the impact on the efficiency of corporate finance.

Total operating cost (X3): Total operating cost is the company's daily operations and production activities; all costs must be put into operation. And the cost of the company's investment will affect the amount of

output, thus the size of the total operating cost determines the size of the profit. The company's financing costs and the company's ability to fund operations can be represented by the index.

In order to clearly evaluate the efficiency of corporate finance output indicators, this paper is from the company's operating performance and efficiency of the use of funds to reflect the two aspects. Companies to raise funds for the use of funds efficiency, net assets yield as an indicator to represent, and operating performance is used to represent the net profit and operating income of the two indicators.

Net profit (Y1): Net profit is the final result of a company's production and operation. The more often the net profit is, the better the performance of the company's production and operation performance is, and the less the net profit is, the worse the performance of the company's production and operation is. Net profit is the main index to measure the performance of the production and operation of the listing corporation.

Total revenue (Y2): Operating income is the main business of the company; it is an important guarantee for the company to make profits. The indicators can be integrated into the capital, the results of production and business activities.

Return on net assets (Y3): Refers to the profit margin and the average shareholder's equity ratio, the higher the index means the higher the income of the investment, and the higher the index, the weaker the profitability of the owners' rights and interests. The indicator reflects the company's ability to obtain net income from its own capital. It's an important indicator to measure the profitability of a listing corporation.

Descriptive statistics

Through preliminary statistics and finishing this paper selected 20 manufacturing listed companies in 2013 to 2015 annual financial report, to the selected input indicators (total assets, assets and liabilities rate, business total cost) and output indicators (net profit, operating revenues, net assets income rate), simple data processing. Results are shown in Table 1 and Table 2.

Table 1. Manufacturing listing corporation DEA investment indicators.

Input index	statistical indicators	year		
		2013	2014	2015
Total assets	Maximum value	31720299	31863318	28504460
	minimum value	271030	226854	163688
	average value	3590843	3365043	2984349
Asset liability ratio	Maximum value	0.91	0.9017	0.9069
	minimum value	0.3008	0.3203	0.3256
	average value	0.59245	0.59774	0.62247
Total operating costs	Maximum value	45708769	40624659	34344447
	minimum value	225003	239829	196513
	average value	3957860	3737180	3331653

Table 2. Manufacturing listing corporation DEA output indicators.

Input index	statistical indicators	year		
		2013	2014	2015
Net profit	Maximum value	2075176	2022186	1372852
	minimum value	2173	3104	3956
	average value	181360	191583	172718
Total operating income	Maximum value	48097967	43480394	31337628

	minimum value	232039	9573121	200756
	average value	4106747	3918217	3244227
Return on net assets	Maximum value	0.966	0.4058	1.5996
	minimum value	0.0036	0.0301	0.07
	average value	0.14888	0.14602	0.27801

Results and analysis

DEA evaluation model

First, assuming that there are no decision-making units (DMU), any one of the decision-making units has an input vector X, an output vector Y. The decision-making unit (DMU), which satisfies the axiom of minimal and ineffective, can be produced.

$$T = \left\{ (X,Y) \middle| \sum_{j=1}^{n} \lambda_j X_j \le x, \sum_{j=1}^{n} \lambda_j Y_j \le y \right\} \tag{1}$$

The following DEA model can be obtained.

$$\begin{cases} \min\left[\theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_i^+ \right) \right] \\ s.t. \quad \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta_x \\ \sum_{i=1}^{n} y_{rj}\lambda_j - s_r^+ = y_r \\ \theta, \lambda, s_i^-, s_i^+ \ge 0 \end{cases} \tag{2}$$

θ is a scalar, λ is the N×1-dimension constant vector. The θ is the DMU efficiency value, $0 \le \theta \le 1$. If these θ=1, then the DMU is in the efficiency frontier, which indicates that the DMU is in active state. Get technical efficiency (TE), through the comparative observation and analysis of manufacturing listing Corporation, if the level of technical efficiency is relatively high, it shows that it will be a variety of integration into the ability of the output in the middle level. By increasing investment, any enterprise can be proportional to expand production scale, which is returns to scale invariant (CRS) assumptions underlying meaning, namely technical efficiency value is not affected by the size of the enterprise. This does not conform to the actual situation. Therefore, based on the basic model of the previous DEA, we try to build the BCC model of financing efficiency.

$$T = \left\{ (X,Y) \middle| \sum_{j=1}^{n} \lambda_j X_j \le x, \sum_{j=1}^{n} \lambda_j Y_j \le y, \sum_{j=1}^{n} \lambda_j = 1, \lambda_j \ge 0 \right\} \tag{3}$$

And then we can get the following DEA model.

$$\begin{cases} \min\left[\theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum s_i^+ \right) \right] \\ s.t. \quad \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta_x \\ \sum_{i=1}^{n} y_{rj}\lambda_j - s_r^+ = y_r \\ \sum_{j=1}^{n} \lambda_j = 1 \\ \theta, \lambda, s_i^-, s_i^+ \ge 0 \end{cases} \tag{4}$$

Calculation result

Under the above the DEA evaluation model on financing efficiency, through the use of data envelopment analysis software MaxDEA5.2 on the collected data processing, first of all to get 2013-2014 20 manufacturing listed company's overall efficiency, the technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE), specific calculation results are shown in Table 3 shows.

Table 3. Overall efficiency measurement results.

No	TE Score			PTE Score			SE Score			RTS		
	2015	2014	2013	2015	2014	2013	2015	2014	2013	2015	2014	2013
1	0.912	0.917	0.891	1.000	1.000	0.952	0.912	0.917	0.936	irs	irs	irs
2	0.842	0.904	1.000	0.851	0.912	1.000	0.989	0.991	1.000	drs	drs	-
3	1.000	0.838	0.915	1.000	0.839	0.916	1.000	0.998	0.999	-	irs	drs
4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-	-	-
5	0.849	0.873	0.867	0.859	0.877	0.875	0.989	0.996	0.990	irs	drs	drs
6	0.901	1.000	1.000	0.903	1.000	1.000	0.998	1.000	1.000	drs	-	-
7	0.749	1.000	1.000	0.947	0.990	1.000	1.000	0.791	1.000	irs	-	-
8	0.880	0.895	0.894	1.000	1.000	1.000	0.895	0.880	0.894	irs	irs	irs
9	1.000	1.000	0.985	1.000	1.000	0.985	1.000	1.000	1.000	irs	-	drs
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-	-	-
11	0.842	0.904	1.000	0.851	0.912	1.000	0.989	0.991	1.000	drs	drs	-
12	1.000	0.838	0.915	1.000	0.839	0.916	1.000	0.998	0.999	-	irs	drs
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-	-	-
14	0.849	0.873	0.867	0.859	0.877	0.875	0.989	0.996	0.990	irs	drs	drs
15	0.901	1.000	1.000	0.903	1.000	1.000	0.998	1.000	1.000	drs	-	-
16	0.749	1.000	1.000	0.947	0.990	1.000	1.000	0.791	1.000	irs	-	-
17	0.880	0.895	0.894	1.000	1.000	1.000	0.895	0.880	0.894	irs	irs	irs
18	1.000	1.000	0.985	1.000	1.000	0.985	1.000	1.000	1.000	irs	-	drs
19	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-	-	-
20	1.000	0.933	0.894	1.000	1.000	1.000	1.000	0.933	0.894	-	irs	irs

According to the estimated results of the financing efficiency of the 20-manufacturing listing Corporation before the calculation results, this paper is divided into the statistics and classification, the results see Table 4.

Table 4. Financing efficiency.

year	Sample Firms	TE Score		PTE Score		SE Score	
		no	Proportion	no	Proportion	no	Proportion
2015	effective	7	35%	10	50%	8	40%
	Non effective	13	75%	10	50%	12	60%
2014	effective	8	40%	11	55%	8	40%
	Non effective	12	60%	9	45%	12	60%
2013	effective	9	45%	12	60%	11	55%

Non effective	11	55%	8	40%	9	45%

The effective ratio of financing efficiency of China's manufacturing listing Corporation is relatively high. Among the 2013, 20 manufacturing listing Corporation, there are 9 companies that are both pure technology effective and effective, accounting for 45% of the number of enterprises, while the financing efficiency of non-effective enterprises accounted for 55%. In 2014, 20 manufacturing listing Corporation, there are 8 companies are both pure technology effective and effective, accounting for 40% of the number of all enterprises, while the financing efficiency of non-effective enterprises accounted for 60%. It can be known, 2013-2014, the overall efficiency of the overall financing of the listing corporation to maintain a relatively high level, but with a slight downward trend.

Conclusion

(1) The survival and development of enterprises mainly rely on their own management ability, an enterprise wants to grow and develop, and it must have a high degree of understanding of its own illnesses and potential crisis, corporate financial data, in particular, need to pay attention to. With the development of enterprises, the importance of financial diagnosis for enterprise management is becoming more and more important. With the advent of the information age, information technology and application, the enterprise has entered a period of rapid development, if the information is the lifeline of the enterprise; the data is the blood flow. Enterprises in the development process have accumulated a large number of business data, and the mining of these data will affect the business managers in a timely and accurate way to get the information needed for financial decisions. But at present, the commercial value of this business data has not been fully excavated and utilized. Therefore, the use of data mining technology in the financial diagnosis of a large number of financial data, from which to obtain an effective early warning, planning information, is the development trend of risk-oriented enterprise financial management.

(2) The perfect capital market and financial market system play a fundamental role in the financing decision of the listing corporation. Therefore, various measures should be taken to optimize the capital market and financial market. First, continue to promote the reform of the state-owned commercial banks. The key to improving the safety and efficiency of bank loan funds is to promote the reform of the state-owned commercial banks. Second, enhance the bank's ability to control the camera. The bank's camera management mainly includes the prior reverse selection criterion, the moral hazard control in the event and the ex-post reorganization. Enterprise more by the internal financing turn for the stock market financing, which means that in the enjoyment of a wide range of social resources at the same time, and also to accept from the external supervision of market, the financing of enterprises not only to be more transparent in the data and also on the independence of the challenge. Generally speaking, financing enterprises should expand financing channels, such as bonds, multi joint role, to provide effective protection for the development of enterprises.

Acknowledgements

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Financial Risk Early Warning Model of Internet Financial Companies Based on SMOTE-Random Forest

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Abstract

Taking my country's Internet financial, on the basis of the home and abroad, combined with the characteristics of Internet financial companies, the SMOTE algorithm is used and combined with random forests to establish the financial management of Internet financial companies. Risk early warning model. Research shows that the random forest early warning model has stable recognition accuracy and good prediction performance, so it has a wide range of practical value. The improved SMOTE algorithm based on PCA can realize the equalization of unbalanced data sets and use random forest as a classifier to classify and predict geological data. Because the noise data in the original data set may cause the change of the data distribution after interpolation, it is proposed to combine the PCA algorithm and the SMOTE algorithm, first perform noise reduction and dimension reduction, and then perform data interpolation to improve the classification performance of imbalanced data sets. my country's Internet financial listed companies conduct experiments on research samples, algorithm can better improve the classification accuracy and provide new ideas for the classification and prediction of unbalanced data.

Keywords

Smote algorithm, Random forest, Financial risk early warning

Introduction

Internet finance is a tool that relies on electronic payment and third-party platforms to realize a new financial model of financing [1]. Compared with the traditional financial business model, Internet finance is obviously different [2]. It utilizes powerful back-office and information technology to have a wider business scope and more optimized services and products [3]. However, due to the short development time of my country's Internet finance and prominent network insecurity problems, this has led to the relatively backward risk response of Internet finance, and various supervision and management systems are not perfect, which fully demonstrates the development of my country's Internet finance There is more room for healthy development [4].

Since the rise of finance, traditional finance has been leading the development of finance, but it has always been limited by its own characteristics [5]. A traditional financial institution, such as a bank, has a fixed transaction location, but cannot realize transactions in different locations [6]. It can handle business for users, but it needs to charge users a certain amount of service [7]. However, services have also been innovated and developed. Through the network platform, traditional financial transactions can be simplified, such as order transactions, transaction information query, online customer service, etc., which greatly reduces the cost of financial institutions cost.

The operation mode of the Internet-based platform of traditional financial business includes one is an independent operation mode, which mainly cooperates with other enterprises through the Internet; the other is a platform operation mode, which is mainly related to e-commerce websites. Mainly based on website operation [8].

The transaction process of the financial service model based on the Internet platform is completely dependent on the Internet [9]. Its online trading platform is huge and has many users, from companies to individuals [10]. On this network platform, network information is constantly developing, which allows investors and financiers to conduct financial transactions conveniently [11]. This model completely changes the traditional financial model, trades in a brand-new way, and relies entirely on online transactions, such as P2P network credit [12]. This model is free and convenient to trade and is a good choice for investors and financing investors [13].

The new Internet financial model is not actually a financial business, it is a third-party payment platform, but it is Internet-based financial support [14]. There are various types of financial services, both offline and online, and offline financial service functions are transformed into the Internet [15]. When customers receive information about various transaction services, their understanding of transaction services also increases [16]. This kind of integration and coordination between financial institutions and customers has greatly improved the efficiency of financial support for Internetization [17]. This efficient Internet-based financial support model will also reduce the information asymmetry between institutions and customers, promote innovation in Internet financial services, and optimize the structure of Internet finance [18].

Because in Internet finance, the information protection of both financial institutions and users is more stringent, and the flow of personal assets and funds cannot be completely transparent [19]. At this time, Internet finance is equivalent to online banking, which limits the role and power of banks [20]. It makes the bank unable to grasp the flow of funds in detail, which affects the bank's capital operation and affects the bank's capital structure. Information disclosure is an important part of Internet financial security. Without information disclosure, there will be no security in the Internet financial environment. To protect the security of users' personal information, the information disclosure of Internet finance needs to be highly transparent. However, due to the lack of transparency in information disclosure, the problem of information asymmetry in the process of Internet financial transactions is very prominent, and some companies use this information asymmetry to defraud the interests of customers, which affects the Internet financial industry. healthy development. ambiguity of its regulatory body has always existed. Multiple departments are endowed with direct supervision and management capabilities, and each institution has different management responsibilities, but there are overlapping parts, which also restricts the rapid development of Internet finance. Because Internet finance has the characteristics of complicated and easy access to information, and it can also for transactions, which leads some illegal users to conduct illegal operations through loopholes in Internet laws, for example, stealing customers through non-compliant financial ports Information conducts cybercrime, which ultimately damages the interests of customers and disrupts the order of my country's Internet finance. The current lack of self-supervision of Internet financial companies and platforms has directly resulted in a large number of violations and illegal operations not being able to be detected, warned and dealt with in a timely and effective manner.

From an essential point of view, there is a certain connection between Internet finance and finance, which inevitably involves the core topic of risk control. There are three main risks involved in the Internet finance industry: first, market risk; second, network technology risk; third, management and operational risk. In terms of market risk, it is divided into two points: First, the government's macro-policy intervention in finance, such as monetary policy. Secondly, the corresponding risks brought by the market's own

competition and bubbles to Internet finance. Because China's capital market is not developed enough, compared with other European and American countries, my country's market is very prone to bubbles and vicious competition. For cyber risk, it is the centre of Internet financial risk, mainly because cyber risk is closely related to Internet security and reliability. Internet finance is an emerging industry based on the Internet. If the security problems existing on the Internet cannot be solved and controlled, it will have a negative impact on the entire financial industry. In addition, in terms of managing operational risks, it is the easiest to control and solve, mainly including reputation risk, specific operational risk and customer credit risk.

State of the art

Overview of internet finance

In a broad sense, Internet finance generally refers to Internet financial tools with cloud computing, cloud payment and search engines as the core, which can not only realize the integration and interoperability of funds but also use information exchange and payment as intermediary business. Under normal circumstances, Internet finance generally refers to the construction of open and new financial formats and service systems with cloud computing and big data technology as the background, with the Internet as the core, and based on the Internet platform, and formed on this basis. financial activity.

The characteristics of Internet finance are as follows: (1) Innovation. Under the background of science and technology and the information age, people's daily life has undergone relatively great changes. Whether it is daily work or entertainment, the Internet has been widely used, and the financial industry is no exception, which makes Internet finance emerge as the times require. In fact, Internet finance relies on social networks, cloud computing and other emerging technology platforms to carry out financing, payment and other businesses, which is a financial innovation model developed on the basis of traditional financial institutions. (2) High efficiency. Internet finance generally uses computers to carry out related business operations, and the operating procedures are gradually becoming standardized and standardized, which greatly improves the efficiency of business processing. (3) Low cost. Internet finance can use the network platform to match, trade, identify and price information on both sides of the supply and demand of funds, and has the characteristics of no transaction costs and no monopoly profits. At the same time, Internet finance can also get rid of the operating costs and capital investment required to open business outlets.

Common risks of internet finance

In the development process of the information age, Internet financial risks are two-sided. There are not only traditional financial risk types, but also Internet risk types. In the development process of Internet finance, the common types of risks are as follows: (1) Credit risk. In the process of development of Internet finance, it will not only encounter various credit risks existing in traditional finance, but also new credit risks. The payment and transaction of Internet finance are generally completed through the network platform. This form will lead to the lack of the identity of the trader, increase the difficulty of information verification, and further increase the credit risk due to information asymmetry. my country's existing Internet financial credit risk prevention system is not perfect, and it relies too much on guarantees and rigid payment, which further exacerbates Internet financial credit risks. (2) Technical risk. Since Internet finance can simply be regarded as the combination of the financial industry and the Internet industry, both customers and enterprises have paid attention to capital gains. In the process of choosing investment, most people value the quality of financial services, and therefore, put forward higher requirements for Internet finance. At this time, the insecurity of the Internet may cause serious risk losses, and the defects of computer and Internet technology will also increase the risk of viruses infringing on the information system, thereby inducing technical risks.

(3) Manage risks. Since the Internet is borderless, and there are certain differences in the management systems of different countries, it is very likely to cause management conflicts. At present, Internet finance needs continuous improvement and improvement in many places. For example, the service system on the Internet cannot meet the basic needs of customers, the main responsibilities are not clear, and the obligations and rights of both parties to the transaction are unclear, etc. All these will increase financial risks. incidence.

Reasons for the formation of internet financial risks

The current progress of interconnected technology, the reform and the change of customer groups have promoted the rapid. At the same time, the combination of the financial industry and national policies reflects the concept and value of inclusive finance, satisfying all Potential needs of customer groups. Internet finance can services, combine finance and the Internet to meet the needs of the public for new types of finance, solve the problems of high financing threshold and high financing costs, and indirectly promote the development of the real economy.

In order to avoid the occurrence of Internet financial risks, it is necessary to do a good job in the prevention of Internet financial risks according to the actual situation, and to refine and improve the Internet financial supervision system. First, it is necessary to analyze the causes of Internet financial risks and gradually analyze and put forward reasonable suggestions. To analyze Internet financial risks, we can analyze the causes of Internet financial risks from macro, meso and micro perspectives, and risks from the perspectives of national attitudes and regulatory policies, the characteristics of the Internet industry, and the individual level of the public. Explore.

(1) Macro level

In the process of analyzing the risks of Internet finance, it is necessary to give a comprehensive and systematic analysis of the development process of the Internet and consider my country's attitude towards Internet regulation and the basis of Internet development from a historical perspective and seek suggestions from existing experience.

Analysis from a macro perspective shows that my country's Internet finance emerged relatively late, developed rapidly, and achieved rapid development and improvement in a short period of time. However, there is a certain gap between the formulation of relevant laws and regulations and the development of the industry. Although the Chinese government has issued many policies and suggestions, it has further clarified the risks and incentives of Internet finance, and put forward corresponding countermeasures, but under the rapid development of Internet finance, its own shortcomings and drawbacks are difficult to solve, and related loopholes are not easy to solve. The lack of improvement and treatment, coupled with the lag of national policies and laws and regulations, makes Internet finance difficult to supervise on a macro level, which provides conditions for the formation of Internet financial risks.

(2) Meso-level

Internet finance draws on the basic forms of the Internet and finance, uses the Internet as a tool to spread and develop finance, innovates business, technology, and transaction methods, and increases the number of customers. The main functions of Internet finance are still financing, price discovery, payment and settlement, etc., which are completely consistent with traditional finance. Therefore, it also has great risks. Even due to technical limitations and imperfect management systems, it faces local risks. much larger than traditional finance. Therefore, at the mesa level, we should combine the characteristics of the Internet industry to explore the reasons for the formation of Internet financial risks. Under normal circumstances, the Internet industry itself is virtual, and it is easy to amplify the risk of trust in exchanges and transactions; Internet technology is fragile and easily attacked by network hackers and viruses, and finance involves a

large amount of corporate information and personal information. Improvements can easily leak information and exacerbate systemic financial risks; Internet encryption technology may impact the original ecological pattern and lead to the reconstruction of the original system's credit.

(3) Micro level

Through the analysis of Internet financial risks from the micro level, it is found that it generally analyses the public's personal behaviour in all aspects and obtains the incentives for Internet financial risks. It is found that the following factors will aggravate financial risks: 1. Lack of relevant knowledge. With the continuous capital market, although it has achieved certain results, it is still in its infancy. The public's own capabilities are limited, and their limited financial management knowledge leads to an incomplete understanding of the risks and benefits of the capital market. my country's basic deposit interest rate is low, the public to increase income through assets. Therefore, when high-yield Internet financial products appear, most of the public will use bank deposits to purchase high-yield Internet financial products but ignore the Internet. The risks of financial products cause most of the public to have low returns or even losses. ② the herd effect of the public. Internet finance shows its good development by attracting some public investment online. Although some public have some doubts about its income, it will be purchased and recommended by the surrounding public, pushed by relevant APPs, and updated in real time. and other influences, making more customers join the crowd buying Internet financial products.

To sum up, under the combined action of various factors from macro, mesa and micro perspectives, Internet financial risks are gradually generated and formed.

Methodology

Weighted oversampling

In the classic oversampling class sample is the same, which will generate many samples with little value for class distinction. Because the samples closer to the center of the category can better represent the characteristics of this category. These two samples contain more More classification information is more valuable to classification. It is hoped that the class and boundary can be fully utilized. the samples close to the class center and boundary can generate more new samples. For this, the Euclidean distance of each minority class sample relative to the remaining minority class samples is used to determine the relative position of each sample, assigning a different weight. Make Samples close to the class center and class boundary have greater weights.

(1) Weight calculation steps

Let the contains C features. (1) each sample and other samples, as shown in formula (1):

$$D_{ij}(x_i, x_j) = \sqrt{\sum_{k=1}^{C}(x_{i,k} - x_{j,k})^2} \quad (1)$$

In the formula, i=1, 2…, M, j=1, 2…, M, i≠j, $D_{i,j}(x_i,x_j)$. (2) Calculate the sum D_i of the distances from the sample x_i to other samples. The larger D_i is, the closer x_i is to the boundary, and the smaller D_i is, the closer x_i is to the center, as shown in formula (2):

$$D_i = \sum_{j=1, j \neq i}^{M} D_i(x_i, x_j), i = 1, 2, \cdots, M \quad (2)$$

Normalize D_i, as shown in formula (3):

$$ND_i = \frac{D_i - D_{\min}}{D_{\max} - D_{\min}}, i = 1, 2, \cdots, M \quad (3)$$

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Calculate RNDi, which is the absolute value of the difference between each element in ND and the mean value of ND. The larger the RNDi. The number of new samples should be larger, as shown in formula (4):

$$RND_i = | ND_i - \frac{\sum_{i=1}^{M} ND_i}{M} |, i = 1, 2, \cdots, M \tag{4}$$

Calculate the weight of each sample, as shown in formula (5):

$$W_i = \frac{RND_i}{\sum_{i=1}^{M} ND_i}, i = 1, 2, \cdots, M \tag{5}$$

Wi is the weight value of the ith sample. multiplied by this weight is the final number of new samples generated from this sample.

(3) Weighted SMOTE algorithm steps

1) For the ith sample xi neighbor samples.

2) For the ith sample xi, randomly select Nw=[N×Wi] samples {x1, x2…, xn} from its k nearest neighbor samples, and [] is rounded down.

3) Among the Nw samples selected in (2), generate Nw new samples about the minority sample xi according to formula (6).

$$x_{new} = x_i + rand(0,1) \times | x_i - x_n | \tag{6}$$

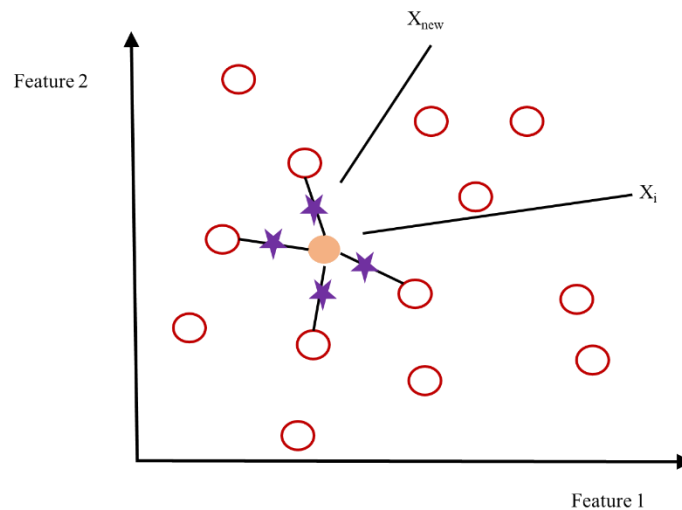The schematic diagram of weighted SMOTE is shown in Figure 1.

Figure 1. Schematic diagram of weighted SMOTE.

Weighted random forest

(1) Random forest algorithm

The random proposed by BreimanL. It is an integrated machine learning method. The essence is to combine the Bagging algorithm and the randomsubspace algorithm to build a classifier composed of multiple uncorrelated decision trees. In order to avoid the shortcoming that decision trees are prone to over-fitting, the training samples adopt the Bootstrap technique. From the original data set, N samples are randomly selected and repeatedly selected as the training set of a tree, and each time the training set is randomly selected. A part of the sample features constructs a decision tree, and each decision tree is not pruned during the training and growth process, and finally the final result of the classifier is determined by voting.

For example, for a trained random forest model, the test set is X, the number of categories is C, and the number of decision trees is T, then the output of the model is:

$$H(X) = \arg\max\{\sum_{t=1}^{T} I(h_t(X) = y)\} \quad (7)$$

Among them, and I(.) is an indicator function.

The Seg, glass and wine data sets in the UCI database are used to verify the algorithm, and the selected data sets show obvious imbalance. Algorithm tests are performed on the Seg, glass and wine datasets, and the datasets are subjected to random forest classification on the direct initial data, the SMOTE processed data, and the PCA-SMOTE processed data, and the AUC values of the experimental results (described in detail in Section 3.3) are analyzed. Analysis (Figure 2), Seg, glass and wine data sets after PCA-SMOTE processing, the classification results are better than the classification results after SMOTE processing. Therefore, the random forest algorithm based on PCA-SMOTE algorithm has better classification performance.
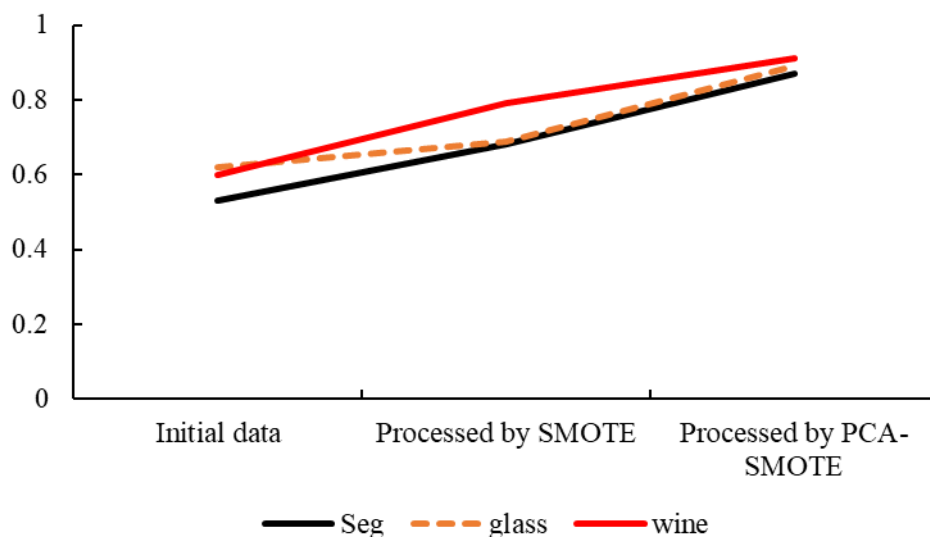

Figure 2. The AUC values of the experimental results of the Seg, glass and wine datasets.

(2) Weighted random forest algorithm

It can be seen from formula (7). It will further affect the classification effect of the decision tree, making some trees with poor effect cast the wrong number of votes, thus affecting the classification ability of the random forest. For this reason, this paper proposes a weighted random forest model. The main method is to evaluate the classification effect of the decision tree in the decision tree training stage and assign a weight to each tree. When the random forest algorithm votes, each tree must be multiplied by the corresponding Weight value, which can reduce the influence of the decision tree with low training accuracy on the entire model. Therefore, the model output in Equation (7) is rewritten as.

$$H(X) = \arg\max\{\sum_{t=1}^{T} I(h_t(X) = y) \times w_t\} \quad (8)$$

where wt is the weight value of the t-th decision tree.

Replacement and the number of samples is equal to the number of samples in the original training set. Since there is This part is called the bag The number of out-of-bag samples is usually one third of the original number of samples. The out-of-bag samples are used as the test set to make the classification performance better. have greater weight.

For classifiers using imbalanced data, the commonly used evaluation metric of classification accuracy is

not a good measure of classification ability, because it only considers the situation of correctly classified samples and considers that the classification errors of the majority class and the minority class are equally important. Therefore, the Kappa coefficient (Kappa Coefficient, CK) is used to evaluate the overall classification ability of the decision tree. CK is an index proposed by Cohen et al. in 1960 to evaluate the degree of consistency of judgment. It also considers various missed and misclassified samples. Represents the ratio of classification and completely random classification to produce error reduction, and its calculation result is (−1, 1), but usually CK falls at (0, 1), and the larger the CK value, the more consistent the predicted result and the actual result. The higher the sex, the better the classifier performance. The calculation of CK is shown in formula (9).

$$CK = \frac{ACC - CK_C}{1 - CK_C} \quad (9)$$

Among them, ACC (accuracy) is the classification accuracy, indicating the actual consistency ratio of the classification, and CKc is the accidental consistency ratio of the classification.

In the confusion matrix, TP (TruePositive) indicates the actual positive class, and the prediction is also positive class.

$$ACC = \frac{TP + TN}{TP + FN + TN + FP} \quad (10)$$

$$CK_C = \frac{(TP + FN)(TP + FP)(FP + TN)(FN + TN)}{(TP + FN + TN + FP)^2} \quad (11)$$

In order to assign larger weights to more capable classifiers, literature studies have shown that: if a set of independent classifiers L1, L2..., LM are independent of each other, and the accuracy is p1, p2..., pM, then each the relationship between the classifier weight and the corresponding accuracy is shown in formula (12).

$$w_t \propto \ln \frac{p_t}{1 - p_t}, t = 1, 2, \cdots, M \quad (12)$$

Replace pt in formula (12) with CK. Since the value range of CK is (−1, 1), formula (12) is rewritten as formula (13).

$$w_t^{CK} = \ln \frac{1 + CK_t}{1 + CK_t}, t = 1, 2, \cdots, M \quad (13)$$

For unbalanced datasets, the classification accuracy cannot comprehensively evaluate the classification effect. Specificity, CK, and G-mean are used to evaluate the classification accuracy. The specificity is used to evaluate the correct rate of classification of minority samples. CK and Gmean are used to evaluate the overall classification performance of the imbalanced dataset. which maximizes the two classes while maintaining the balance of the classification accuracy of the majority class and the minority class. precision.

$$specificity = \frac{TN}{FP + TN} \quad (14)$$

$$G - mean = \sqrt{\frac{TP \times TN}{(TP + FN)(TN + FP)}} \quad (15)$$

Resylt analysis and discussion

Experimental data and environment

This paper selects a total of 63 Internet financial listed companies including 3 ST companies and 60 normal operating companies as the research objects and uses the financial data of each quarter of 63 Internet financial companies from 2017 to 2019 as the research sample. After deleting some missing values, a total of 752 sets of data were obtained, including 32 sets of ST companies and 720 sets of normal companies. ST company refers to a company that has been specially treated by the stock exchange because the company has suffered losses for two consecutive years, which can be regarded as having a high financial risk (Rise database).

When selecting financial indicators, this paper first refers to the research of Zhao Nan et al. The 18 indicators in this paper have passed the significance test; then 23 financial indicators selected by Yang Shu'e and Wang Leping are considered; finally, combined with the random forest itself algorithmic properties. This paper finally uses a total of 27 financial indicators in seven categories as research variables. These 27 financial indicators reflect the per-share indicators, operating capacity, profitability, solvency, cash flow, capital structure and growth capacity of Internet finance companies respectively. It can fully reflect the financial status of Internet financial companies.

Because the data of 3 ST companies and the data of 60 normal companies in the early warning indicators are relatively serious unbalanced data, in order to solve the impact of unbalanced data on the random forest model, this paper uses the SMOTE algorithm to balance the unbalanced data. After that, random forest is used to carry out the data of the division. The test set contains the data of 220 groups of normal companies and the data of 12 groups of ST companies. After the data is balanced by the SMOTE algorithm, the new training set contains data from 270 groups of normal companies and 200 groups of data from ST companies, and the ratio is close to 1:1.

The significance of variables was analyzed using the reduction of average accuracy and the reduction of average impurity, respectively. The results show that the net profit margin of sales, net assets per share and growth rate of net assets are the top three in the two-importance analysis, and the importance is higher. Therefore, for enterprises, they should focus on these three financial indicators to accurately reflect the company's financial status.

Experimental results and analysis

From Table 1, we can see that the overall prediction accuracy of the random forest model constructed from unbalanced data reaches 95.27%, while the prediction accuracy for ST Company is only 46.17%. According to the random forest model, the prediction accuracy of ST company is as high as 76.41%, and the overall accuracy is 97.35%. Judging from the prediction results, this prediction model, as the financial risk early warning model of Internet financial companies, is an ideal financial risk early warning model with good stability and practical value.

Table 1. Prediction results of training samples and test samples.

group		category	Predicted value/piece		Accuracy/%
			normal	ST	
unbalanced	actual value	normal	212.62	4.38	97.98
		ST	6.46	5.54	46.17
	total		219.08	9.92	95.27
balance	actual value	normal	213.76	3.24	98.51
		ST	2.83	9.17	76.41
	total		216.59	13.41	97.35

The training set and the test set are obtained, and the PCA-SMOTE algorithm is applied to the training set in order to achieve a data balance state, and the random forest is used as the classifier for classification. At the same time, direct sample classification, SMOTE algorithm post-processing, PCA algorithm post-classification are performed on the training set, and the results are compared with PCA-SMOTE classification, including the majority class misjudgment rate, minority class misjudgment rate, Fmeasure value, AUC value, Gmean value and ROC curve, as shown in Figure 3. If the original data set is directly classified by random forest without any operation, the classification effect is relatively poor, Gmean=0.783, AUC=0.53; after the SMOTE algorithm balances the data set, the classification result Gmean=0.8, AUC=0.67; and after PCA - After the SMOTE algorithm balances the dataset, the Gmean=0.962 and AUC=0.90 of the classification result. The analysis shows that the classification effect of the PCA-SMOTE algorithm is significantly higher than that of the other two algorithms, which indicates that the improvement of the algorithm proposed in this paper is valuable. During the experiment, the change of parameters will also cause large fluctuations in the results of SMOTE and random forest. In the random forest algorithm, ntree=500 is used in this experiment. Since the new samples in the SMOTE method are interpolated, not real samples, perc.over and perc.under should be appropriately selected to avoid the degradation of the classification quality of the dataset. Reasonably improve the classification accuracy.
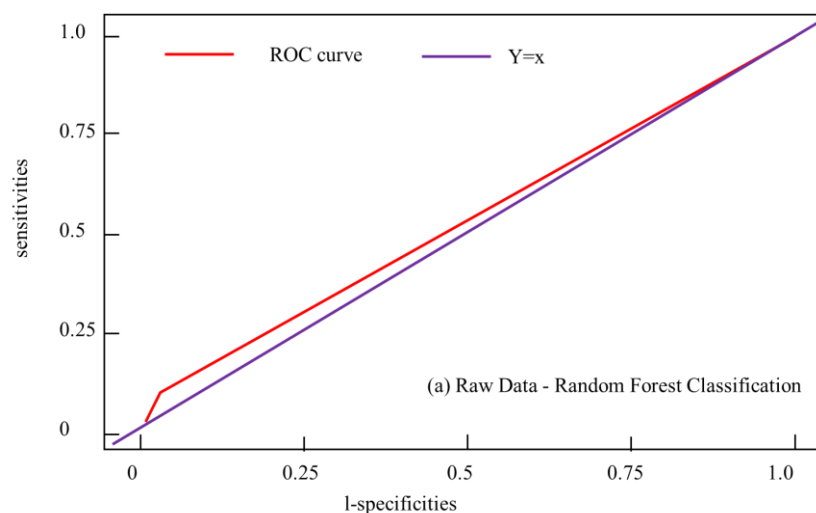

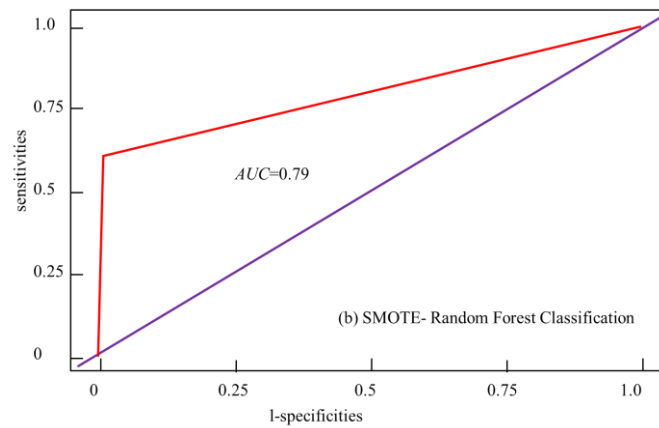Figure 3. Actual output and expected output.

Figure 4. Output value of the test sample.

After feature selection, the random forest. In the process of model building, two parameters, the maximum number of features, need to be determined. Figure 5 shows the error distribution of models with different number of decision trees. the error of the model gradually decreases. When the number of decision trees is equal to 20, the error in the model is basically stable. For the sake of safety, the decision-making is determined. The number of trees is 40. predicted as complaint with the decision tree, and the green curve represents the change of the error predicted as non-complaint with the decision tree.
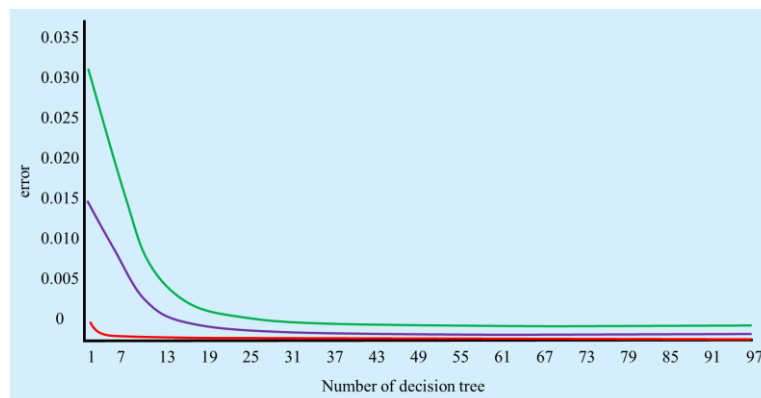

Figure 5. Error distribution of models with different number of decision trees.

Algorithms formed by different combinations of SMOTE (SM), weighted SMOTE (WSM), random forest (RF), and weighted random forest (WRF), namely SM+RF, WSM+RF, SM+WRF and the algorithm in this article (WSM+WRF) For comparison, experiment the classification results of these four algorithms on the vehicle0 dataset. In the data set, 70% of the majority class samples and minority class samples are taken as the training set and 30% as the test set. Two common parameters in the random forest algorithm are the number of decision trees (ntree) and the number of randomly selected features (mtry). With the increase of ntree, the classification error of random forest will tend to be stable. Since random forest will not overfit, set ntree large enough. mtry is used to reconcile the balance between classification performance and diversity, and mtry is set as the square root of the total number of features. Figure 6 and Figure 7 show the specificity and G-mean comparison results of the four algorithm combinations on the vehicle0 dataset. It can be seen from the figure that when the number of decision trees in the random forest algorithm increases to about 100, the specificity and Gmean tend to be stable. In the performance of these two indicators, the WSM+RF algorithm is better than the SM+RF algorithm, the WSM+WRF algorithm is better than the WSM+RF algorithm, and the SM+WRF algorithm is better than the WSM+RF algorithm. The results show that the random forest classifier is used. In the case of, weighted SMOTE is more effective than SMOTE in

processing unbalanced data. After training, more minority class samples can be correctly distinguished, which helps to improve the overall classification ability of the classifier. The weighted random forest has better classification ability than the random forest when both use weighted SMOTE to process the data.
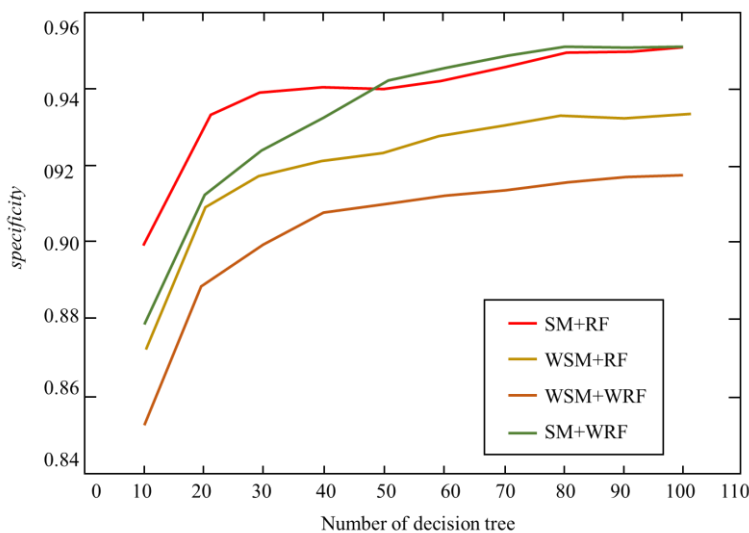

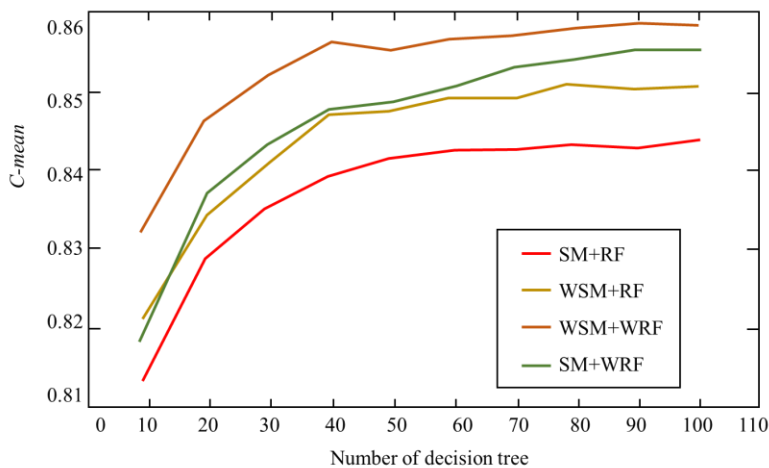Figure 6. Vehicle0 dataset specificity comparison chart.

Figure 7. G-mean comparison chart of vehicle0 data set.

Conclusion

With the popularization of Internet technology, Internet platforms meet consumer demand, the Internet-based financial system has developed rapidly, and the model of Internet finance is constantly innovating. but in the meanwhile, A series of questions about Internet finance also followed. The paper mainly starts with the development model of my country's Internet finance and then analyses the current situation of my country's Internet finance development and analyses the existing problems. Through the financial risk early warning model of Internet financial companies established by SMOTE-random forest, the following conclusions and suggestions can be drawn. First, by referring to the financial risk early warning model established in this article, regulators and investors can take the financial risk status of Internet finance companies as a reference and then make choices to reduce some financial losses; banks can also selectively lend. Second, the relevant government regulatory departments should strengthen supervision and information disclosure mechanisms and improve relevant laws and regulations. For

example, the company is required to publish information such as the company's shareholders and operating conditions, which does not involve the company's confidentiality, and can also provide data support and basis for later financial risk early warning.

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Digital Economy Driving Rural Revitalization: Current Status, Challenges, and Future Pathways

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Abstract

With the rapid development of information technology, the digital economy has become a significant driver of global economic growth. In China, the digital economy not only fosters urban development but also plays a crucial role in rural revitalization. This paper, based on a detailed analysis of elements such as digital public infrastructure, the level of digitalization of public services, and the digital transformation of industries, explores the foundational realities and implementation pathways of the digital economy empowering rural revitalization. The study summarizes the successful experiences of the digital economy in supporting rural revitalization and provides policy recommendations for future development. The research in dictates that the digital economy is gradually becoming the core driving force for rural revitalization, aiding in the sustainable development of rural areas in China.

Keywords

Rural revitalization, Digital economy, Rural transformation, Information technology, Public services, Level of digitalization

Introduction

In recent years, the rapid rise of digital economy has become an important engine of global economic growth. Report to the 20th CPC National Congress of the Party clearly pointed out [1] that "the most arduous and arduous task of building a socialist modern country in an all-round way is still in the countryside", which highlighted the importance and urgency of promoting rural revitalization in the new era. In the new journey towards the goal of the second century, it is of great practical significance to explore the realization path of rural revitalization from the perspective of digital economy. This is not only a key measure to promote the digital transformation of rural areas in China, but also an important link to promote the coordinated development of urban and rural areas.

According to the White Paper on Global Digital Economy (2022) issued by China Institute of Information and Communication, by the end of 2023, the scale of digital economy in China has exceeded 33 trillion-yuan, accounting for more than 60% of GDP [2]. The rapid development of digital economy has profoundly changed people's lifestyle and production mode, and at the same time brought unprecedented new opportunities for rural revitalization. The Party's Report to the 20th CPC National Congress further clarified that it is necessary to "comprehensively promote rural revitalization and accelerate the

modernization of agriculture and rural areas", with special emphasis on the digital upgrading of rural infrastructure and public services. This provides a solid policy foundation and a clear development direction for the digital economy to empower rural revitalization.

Although the digital economy in urban areas is quite mature, the degree of digitalization in rural areas is still relatively backward. The construction of digital infrastructure in rural areas is weak, the digital literacy of farmers is uneven, and the digital transformation of agricultural production and rural industries faces many challenges [3]. Therefore, how to effectively use the power of digital economy to promote rural revitalization has become a key issue to be solved urgently.

Empowering rural revitalization with digital economy is not only an important way to realize rural economic growth, but also a key means to improve farmers' living standards and promote the modernization of rural social governance. By deeply studying the application path of digital economy in rural revitalization, we can explore effective strategies to optimize rural economic structure, increase farmers' income and improve rural living environment. This paper aims to enrich the theoretical framework of digital economy and rural development research by systematically analyzing the role of digital economy in rural revitalization and explore how to solve rural development through digital means [4-7].

Feasibility of structural problems. This paper provides theoretical support for the government to formulate relevant policies, especially in improving rural digital infrastructure, improving farmers' digital literacy and promoting industrial digital transformation [8].

Analysis on the necessity of empowering rural revitalization by digital economy

In the process of building a socialist modern country in an all-round way, the digital economy has become the core engine to promote social and economic development, especially in solving the "three rural issues" and promoting the coordinated development of urban and rural areas [9]. The empowerment of digital economy has injected new kinetic energy and path choice into rural revitalization. This paper will systematically analyze the necessity of digital economy empowering rural revitalization from three aspects: the demand of national strategy implementation, the urgency of rural transformation and upgrading, and the necessity of improving farmers' living standards [10,11].

The demand for national strategy implementation

With the sustained development of China's economy, the imbalance between urban and rural development has become increasingly prominent. Due to weak infrastructure, lack of public services and single industrial structure, the gap between urban areas.and rural areas are widening in rural areas. In order to solve this problem, the state has implemented a series of strategic measures in recent years, trying to promote the coordinated development of urban and rural areas through rural revitalization. Digital economy empowerment has become a key force to promote rural modernization and narrow the gap between urban and rural areas [12].

The Outline of Digital Village Development Strategy released in 2019 [13] points out that "digital village" is an important path for rural revitalization and a key component of the construction of digital China. The outline emphasizes that digital technology should be fully utilized to promote the digital transformation of agriculture and rural areas and realize the balanced development of urban and rural public services. Since then, the digital economy has gradually become the core pillar of the rural revitalization strategy. The Digital Village Development Action Plan (2022-2025) issued in 2022 [14] defined eight key tasks, such as upgrading digital infrastructure, smart agriculture and improving digital governance capacity. In 2024, "Opinions on Learning and Applying the Experience of" Demonstrating Thousands of Villages and Renovating Ten Thousand Villages "to Effectively Promote the All-round Revitalization of Rural Areas"

[15] further emphasized the importance of promoting the deep integration of agricultural modernization and digital technology.

Digital economy not only improves the efficiency of agricultural production, optimizes the allocation of resources and increases the added value of agricultural products [16], but also improves rural social management and the quality of life of farmers through digital public services and social governance. At the same time, the digital economy shows comprehensive advantages in infrastructure construction, public services and social governance. For example, using big data, cloud computing and other technologies to realize the digitalization of the whole agricultural industry chain and improve market competitiveness; Promote rural culture through the Internet platform and promote the development of rural tourism; The application of digital technology has also shortened the gap between urban and rural public services and realized the sharing of resources such as education and medical care.

Urgency of rural transformation and upgrading

Traditional industries in rural areas generally have problems such as short industrial chain, low added value and weak market competitiveness. The involvement of digital economy can help traditional industries complete the transformation and upgrade from low added value to high added value through technological innovation and information transformation and promote the extension of industrial chain and industrial integration. Taking intelligent agriculture and digital logistics as examples, with the help of Internet of Things, big data and other technologies, the whole process of information management of agricultural production, processing and circulation can be realized, thus improving production efficiency, reducing costs and enhancing market competitiveness. At the same time, the digital economy can also promote the development of rural tourism, promote rural culture and natural resources through online platforms, attract more urban residents to spend in rural areas, and form new economic growth points.

Digital economy can promote the upgrading of rural manufacturing industry. Through industrial internet, intelligent manufacturing and other technologies, small and medium-sized enterprises in rural areas can realize automatic and intelligent production and improve product quality and market competitiveness. The application of digital economy not only optimizes the rural industrial structure but also enhances the overall efficiency of rural industries and enhances the sustainable development capacity of rural economy [17].

Digital economy cannot only transform traditional industries but also give birth to a series of emerging industries, which has become a new kinetic energy for rural economic development. The development of emerging industries such as rural e-commerce, digital travel and intelligent manufacturing has greatly broadened the growth space of rural economy and injected new vitality into the countryside. In addition, the digital economy can also promote rural employment, attract migrant workers to return home to start businesses, and further promote the optimization of rural population structure and the transformation of economic development model [18].

The necessity of improving farmers' living standards

Digital economy provides farmers with various ways to increase their income. First of all, the development of e-commerce provides farmers with a direct market-oriented channel. Farmers can directly sell agricultural products through e-commerce platforms, eliminating intermediate links and obtaining higher profits. Secondly, the digital economy has promoted the development of rural service industry, and farmers can realize diversified income by participating in emerging industries such as rural e-commerce, logistics and tourism [19].

Digital economy has promoted the transformation and upgrading of rural labor force. Through online education and skills training, farmers can learn new technologies and enhance their competitiveness, so as

to find high-paying jobs in a wider job market. The popularization of digital economy not only directly increases farmers' income, but also improves farmers' skill level, which makes it possible for rural labor force to flow and transform across regions.[20]

Digital economy provides a new path for optimizing rural public services. The popularization of digital technology can significantly improve the level of public services in rural areas such as education, medical care and culture. For example, the popularization of distance education and telemedicine has enabled rural residents to enjoy the same educational and medical resources as urban residents, further narrowing the gap between urban and rural areas and improving the quality of life of farmers [21].

The realistic foundation of digital economy empowering rural revitalization

At present, the practice of digital economy empowering rural revitalization in China has achieved initial results.

Results, but to achieve comprehensive rural revitalization, there are still many practical challenges and constraints of development foundation. The construction of digital public infrastructure, the digital level of basic public services and the digital transformation of industries are important factors affecting rural revitalization, which need to be further discussed and improved.

The present situation and challenges of digital public infrastructure construction

Digital public infrastructure is the basic condition for the development of digital economy and plays a key role in promoting rural revitalization. Although China's rural digital public infrastructure construction has made some progress, such as the improvement of network coverage and the initial construction of smart agriculture platform, it is still obviously unbalanced and insufficient [22].

First of all, the network infrastructure is not perfect. Although rural areas in some developed areas have achieved full coverage of broadband

networks and introduced 5G technology, the network infrastructure is still lagging behind in remote and economically backward areas. For example, satellite positioning technology and geographic information systems have not been popularized in some remote areas, which limits the popularization of precision agriculture technology. It not only affects the ability of rural residents to obtain digital services but also restricts the development and revitalization of rural economy.

Secondly, the digitization level of agricultural water conservancy infrastructure is low. The traditional agricultural water conservancy facilities in rural areas are old, with large water consumption and low efficiency, and it is difficult to meet the needs of modern agricultural production. The lack of intelligent and automatic water conservancy facilities makes agricultural production in rural areas vulnerable to natural disasters, which increases the risk and cost of agricultural production. This shows that it is still an urgent problem to improve the digital level of agricultural infrastructure, especially the intelligent upgrade of water conservancy facilities.

Finally, the digitalization process of rural logistics infrastructure is still in its infancy. Although some areas have explored the new mode of "internet plus Logistics", on the whole, the digital level of rural logistics still needs to be improved, and the circulation efficiency of agricultural products is low, which affects the overall development of rural economy. Therefore, it is an important task to accelerate the construction of smart logistics infrastructure and promote the digital transformation of agricultural products circulation.

Improvement and limitation of digitalization level of basic public services

Digital public service is an important means to improve the quality of life of rural residents and bridge the gap between urban and rural areas. In recent years, with the popularization and application of digital

technology, the digitization level of basic public services such as education and medical care in rural areas has been significantly improved, but there is still a certain gap compared with cities.

In terms of education, information equipment in rural schools is gradually popularized, and the application of smart classrooms is also being promoted. However, the digital literacy of rural teachers is uneven, and the distribution of teaching resources is uneven, which leads to the gap between the education quality of rural students and that of urban students. This phenomenon shows that to improve the digital level of rural education, it is necessary not only to build hardware facilities, but also to strengthen teachers' digital literacy training and the sharing of high-quality educational resources.

In terms of medical care, the promotion of telemedicine services enables rural residents to enjoy convenient medical services to a certain extent. However, the digital literacy and professional level of rural primary medical teams still need to be further improved. The allocation of medical resources is unbalanced, especially in remote areas, and there are still problems of insufficient supply and poor management of medical services. It restricts the quality and accessibility of rural medical services, and it is urgent to improve it by improving the digital level and management ability of medical teams.

Generally speaking, although the digital development of basic public services has achieved certain results, it is necessary to further narrow the gap between urban and rural digital services and improve the quality and coverage of rural public services in order to truly revitalize the countryside

Present situation and development bottleneck of industrial digital transformation

Industrial digital transformation is an important engine to promote rural economic development. However, the digital transformation of rural industries in China is still in its infancy, facing many challenges and bottlenecks.

The digital foundation of rural industries is weak. The traditional industrial chain in rural areas is short, and the products are mainly primary products, lacking effective docking with the middle and high-end market. This industrial structure not only limits the sustainable development of rural economy but also affects the depth and breadth of industrial digital transformation. To promote the digital transformation of rural industries, we must adjust the industrial structure, enhance the added value of products, and promote the deep integration of rural primary, secondary and tertiary industries.

The practical experience of digital transformation is insufficient. Although some areas have made beneficial explorations in industrial digitalization, on the whole, the digital transformation in rural areas still lacks mature models and experiences. The popularization rate of scientific and technological achievements is low, and there is a gap between digital technology and industrial management subjects, which makes the digital transformation of rural industries face great resistance. Therefore, under policy guidance and technical support, we need to actively promote successful experiences, accelerate the application of digital technology in rural industries, and enhance the overall competitiveness of rural industries.

Insufficient policy support for digital economy to empower rural industry development. Although the state has issued a number of policies to support the digital development of rural industries, in the specific implementation process, the landing effect and implementation of the policies still need to be strengthened [10]. In guiding the digital transformation of rural industries, local governments need to further strengthen the coordination of policies and the integration of resources to form a joint force for the digital development of industries.

The path choice of digital economy empowering rural revitalization

In order to give full play to the role of digital economy in rural revitalization, we must systematically explore ways to improve farmers' participation in digital application scenarios, promote the digital

upgrading of agricultural and rural production factors, and promote the digital transformation and upgrading of traditional industries.

Improve farmers' participation in digital application scenarios

Farmers are the main body of rural revitalization, and improving their digital literacy and skills is the key to realizing rural revitalization. In the Report on Investigation and Analysis of Rural Digital Literacy in China under the Background of Rural Revitalization Strategy, the score of farmers' digital literacy is only 35.1, which is about 37.5% lower than that of urban residents. To improve farmers' participation in digital application scenarios, we should first improve the digital skills training system. For example, local governments can set up skills training schools in conjunction with vocational colleges, set up characteristic agronomy classes according to the actual needs of farmers, and provide services such as agricultural technology and legal consultation. At the same time, we should also promote the digital transformation of rural infrastructure, accelerate the construction of 5G base stations and smart logistics infrastructure, and further improve the digital level of rural areas.

Promote the digital upgrading of agricultural and rural production factors

As a new factor of production, data has become a key force to promote economic development. In order to speed up the digital transformation of rural areas, it is necessary to scientifically and reasonably carry out macro-control of resource elements and ensure the rational distribution of capital, talents and other elements. First, take information as a new factor to promote the development of digital agriculture, and comprehensively manage agricultural production through information means. For example, Wuxi City, Jiangsu Province, promotes unmanned agricultural production through information technology, and Zeng Cheng District, Guangzhou City, builds "Digital Agriculture Silicon Valley" and other typical cases, which provide the whole country with experience for digital agriculture development. Second, promote the deep integration of data elements and traditional production factors.

For example, combine data elements with local cultural resources and industrial and commercial capital to further release the vitality of traditional elements and promote the high-quality development of rural economy.

Promote the digital transformation and upgrading of traditional industries

Promoting the digital and intelligent transformation of traditional industries is the key to improving the total factor productivity and expanding the new space of industrial integration. First of all, we should optimize the rural industrial structure, empower the layout of rural industrial chain through the digital economy, and promote the modern transformation of rural industries. Secondly, we should increase investment in rural industrial science and technology innovation and build a modern economic system. For example, Junlian County, Yibin City, Sichuan Province has created a sustainable development model combining ecology and economy by integrating "smart agriculture" into the tea industry park. Finally, enhance the innovation kinetic energy of rural industries. For example, the establishment of rural entrepreneurship incubation bases will

promote the digital development of rural e-commerce and cultural tourism industries and inject new development momentum into the rural economy.

Future prospect of digital economy empowering eural eevitalization

In the future development process, the digital economy will further penetrate into all fields of rural revitalization, providing sustained impetus for the all-round development of rural economy, society and culture. However, in order to achieve this goal, we need all-round support and guarantee in terms of

policies, technology, talents and funds.

The continuous strengthening of policy support

Policy is an important guarantee to promote rural digital transformation. National and local governments should continue to strengthen policy support for rural revitalization, formulate more specific and operational implementation plans, and provide a good policy environment for digital economy to empower rural revitalization. For example, relevant laws and regulations should be further improved to ensure the standardized application of digital technology in agriculture, education, medical care and other fields, and to protect farmers' digital rights and interests. At the same time, we should also strengthen policy support for rural digital infrastructure construction to ensure that all localities can smoothly promote rural digital transformation.

Deepening application of technological innovation

Technological innovation is the core driving force for the development of digital economy. With the continuous maturity of technologies such as 5G, big data and artificial intelligence, the speed and depth of rural digital transformation will be further accelerated. For example, through the Internet of Things technology, the whole process of agricultural production can be monitored and managed to improve production efficiency and resource utilization; Ensure the traceability and quality safety of agricultural products through blockchain technology; Through artificial intelligence technology to improve the effect of farmers' digital skills training and promote the improvement of rural education and medical level.

All-round promotion of talent training

Talent is the key factor to promote the development of digital economy. The success of rural digital transformation depends on whether enough digital talents can be trained and attracted. Therefore, we should strengthen the training of rural digital talents and establish a perfect talent training and introduction mechanism. For example, through vocational education and continuing education, improving the digital literacy of rural grassroots cadres and farmers; Through preferential policies and living security measures, we will attract urban digital talents to work in rural areas and promote the development of rural economy.

Diversified expansion of capital guarantee

Capital is an important guarantee for digital infrastructure construction and technology promotion. Rural digital transformation needs more diversified sources of funds; besides government financial input, it should also attract social capital and international investment. For example, through the establishment of townships Village digital economy special fund to support rural digital infrastructure and industrial construction; By establishing PPP (public-private partnership) model, attract enterprises to participate in the investment and operation of rural digital transformation projects; By introducing international cooperation projects and learning from foreign advanced experience and technology, we will accelerate the pace of rural digital transformation in China.

Conclusion

Empowering rural revitalization by digital economy is an inevitable choice for rural development in China in the new era, and it is also a strategic measure to promote rural comprehensive revitalization. By discussing the necessity, realistic basis and path choice of digital economy to revitalize rural areas, we find that digital economy has injected new kinetic energy into solving the problems of agriculture, rural areas and farmers, narrowing the gap between urban and rural areas and promoting rural digital transformation. The strategic significance of digital economy in rural revitalization is far-reaching. It not only promoted the

process of social modernization in China but also provided new development opportunities for rural revitalization. The wide application of digital technology has improved the rural infrastructure construction, enhanced farmers' digital literacy and quality of life, and significantly improved agricultural production efficiency and market competitiveness.

However, the development of rural digital economy in China is still in the primary stage and faces many challenges. Although progress has been made in the construction of digital infrastructure, the digitalization of public services and the digital transformation of industries, the coverage of infrastructure in remote areas is insufficient, the digital transformation of industries is slow, and the shortage of digital skilled personnel still needs to be solved.

This paper suggests that rural revitalization can be further promoted by increasing farmers' participation in digital application scenarios, promoting the digital upgrading of agricultural and rural production factors, and accelerating the digital transformation of traditional industries. These measures will not only improve the digital level of rural areas but also inject new vitality into rural economy and promote sustainable development.

In the future, with the development of digital economy and the wide application of new technologies, rural areas will

The connotation of revitalization will be more abundant. Governments at all levels and all walks of life should strengthen cooperation, further increase policy support and capital investment, promote the deep integration of digital technology with rural economic and social development, and ensure the full implementation of the rural revitalization strategy. This is not only an important way to achieve common prosperity, but also an important part of promoting China's social modernization.

Acknowledgements

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International Cooperation and International Finance Centre Construction Under the Great Changes of Globalization

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Abstract

This paper discusses the relationship between the construction of an international financial center and international cooperation under the major changes of globalization. By analyzing the historical evolution of financial globalization, this paper expounds the formation and development of international financial centers. This paper focuses on international finance center's international cooperation strategy under the Belt and Road Initiative, and the impact of China's financial opening, interconnection and offshore RMB hub construction on international finance center. The article points out that Hong Kong has unique advantages in the construction of "Belt and Road", and should further consolidate its competitive advantages, strengthen cooperation with the mainland and countries along the route, and promote the internationalization of RMB and the construction of financial infrastructure to cope with the complicated and ever-changing external environment and ensure the stable development of international finance center.

Keywords

Globalization, International financial center, Belt and road, Internationalization of RMB, Hong Kong

Introduction

In the contemporary globalized world, the dynamics of financial globalization and the evolution of international financial centers play a crucial role in shaping the international economic landscape. As globalization continues to transform the way financial markets operate, the construction and development of international financial centers have become increasingly important. This paper aims to explore the relationship between the construction of international financial centers and international cooperation, particularly in the context of significant changes in the global geopolitical and economic structure [1]. By examining the historical evolution of financial globalization, this paper seeks to provide insights into the formation and development of international financial centers and their strategic importance in the modern global economy. The process of modern financial globalization can be roughly divided into five stages, each marked by unique characteristics and developments.

Great changes in financial globalization and the evolution of international financial centers

Under the background of profound changes in the global geopolitical and economic structure, it is necessary to examine the construction of international financial centers from a longer historical perspective.

The process of modern financial globalization can be roughly divided into five stages, each marked by unique characteristics and developments [2].

The Dawn of Globalization (Late 19th Century to World War I)

The first stage, from the late 19th century to World War I, marked the first wave of globalization. It was based on British hegemony and the expansion of Western powers. With London as the international financial center, the global liquidity of capital was significantly enhanced under the framework of the gold standard and trade liberalization [3]. This period laid the foundation for the interconnected financial markets that would characterize subsequent eras.

Turbulence and Disintegration (World War I to World War II)

The second stage, from World War I to World War II, was marked by frequent international conflicts, the rise of protectionism, the collapse of the gold standard, and the disintegration of financial globalization. All major countries-imposed restrictions on capital outflows and strengthened domestic financial controls, leading to a sharp contraction in global trade and capital flows [4,5].

(1) Frequent International Conflicts and Rising Protectionism

The outbreak of World War I in 1914 shattered the relative peace and stability of the early 20th century. The war not only caused immense human and material losses but also severely disrupted international trade and financial flows. The global economy was thrown into turmoil, and the pre-war financial order began to unravel. The war's aftermath saw the rise of protectionist policies as countries sought to shield their economies from further instability [6]. Tariffs were raised, trade barriers were erected, and international cooperation waned, leading to a fragmented economic landscape.

(2) The Collapse of the Gold Standard

The gold standard, which had underpinned the stability of international finance in the late 19th and early 20th centuries, began to falter during this period. The strain of financing the war efforts and the subsequent economic dislocations made it increasingly difficult for countries to maintain the gold standard. The United Kingdom, which had been the linchpin of the gold standard, was particularly hard hit. The suspension of the gold standard by major economies led to currency instability and further undermined confidence in the international financial system [7].

(3) Disintegration, Retrogression, and Reconstruction

The collapse of the gold standard and the rise of protectionism accelerated the disintegration of the financial globalization that had been achieved in the pre-war era. The global financial system moved towards retrogression, with countries retreating into isolationist policies [8]. The interwar period was marked by a series of financial crises and economic downturns, culminating in the Great Depression of the 1930s. The Depression further exacerbated the decline in global trade and capital flows, leading to a sharp contraction in international economic activity.

(4) Restrictions on Capital Outflows and Strengthened Domestic Financial Control

In response to the economic turmoil, all major countries-imposed restrictions on capital outflows to varying degrees. These measures were aimed at preserving domestic financial stability and preventing capital flight. At the same time, governments strengthened their domestic financial controls, implementing stricter regulations and oversight mechanisms [9]. The focus shifted from international cooperation to safeguarding national interests, further fragmenting the global financial system.

(5) Sharp Contraction in Global Trade and Capital Flows

The combination of frequent conflicts, protectionist policies, and the collapse of the gold standard led to a dramatic decline in global trade and capital flows. International trade volumes plummeted, and cross-border investment virtually ground to a halt. The once-thriving global financial markets became increasingly fragmented, with countries operating in relative isolation. The pre-war era of financial integration was replaced by a period of fragmentation and uncertainty, setting the stage for the post-World War II efforts to rebuild the global financial order [10].

Post-War Reconstruction and the Rise of the Dollar (Post-World War II to 1970s)

The third stage: After World War II, the international governance system with the United Nations as the core became the foundation of the global order. The establishment and development of the Bretton Woods system laid the foundation for the international financial system with the US dollar as the dominant currency. Under the framework of the General Agreement on Tariffs and Trade (GATT), multilateral international cooperation made progress. After the decoupling of the US dollar from gold in the 1970s, many countries switched to floating exchange rate systems and relaxed capital controls. The United States has kept the dollar in China with its comprehensive strength [11-13].

However, by the late 1960s, the Bretton Woods system became unsustainable due to economic imbalances and the increasing need for currency flexibility. In 1971, the US suspended the dollar's convertibility to gold, effectively ending the fixed exchange rate regime. This shift led to the adoption of floating exchange rate systems by many countries, allowing currencies to adjust more dynamically to global economic conditions. The US dollar, backed by the country's economic strength, emerged as the dominant currency in the international financial system. As a result, New York gradually replaced London as the most important global financial center [14].

The New Wave of Financial Globalization (1980s to 2008)

The fourth stage, from the 1980s to 2008, saw a new wave of financial globalization. Many countries vigorously promoted economic and financial liberalization, leading to deeper integration of international trade and cross-border capital flows under the framework of the World Trade Organization (WTO). This period witnessed the rise of global supply chains, the deepening of intra-product division of labor, and rapid economic growth in East Asia. The global financial system became increasingly interconnected and complex, with the US dollar further consolidating its dominant position. This era also saw the expansion of financial markets and the development of new financial instruments, which contributed to both economic growth and increased financial volatility [15].

The Post-Crisis Era and the Challenge to Globalization (2008 to Present)

The fifth stage, from 2008 to the present, has been marked by significant challenges to globalization. The global financial crisis of 2008 led to a resurgence of protectionism and populism, questioning the foundations of the global economic order. The crisis exposed vulnerabilities in the global financial system and led to calls for regulatory reforms and increased financial stability. Since 2018, geopolitical tensions such as the US-China trade friction, the COVID-19 pandemic, and the Russia-Ukraine conflict have further exacerbated risks of fragmentation and politicization in the global trade and financial systems [16]. These events have raised concerns about the future of financial globalization, with some suggesting a shift towards "financial regionalization" and the fragmentation of global payment systems.

Hong Kong's Vibrant Economy and International Standing

Figure 1 captures the essence of Hong Kong's vibrant economy and international standing. With its iconic skyline reflecting in the deep blue waters of Victoria Harbour, the city serves as a microcosm of globalization's achievements and the challenges it now faces. Despite ongoing political and economic uncertainties, Hong Kong remains a testament to the power of human ingenuity and resilience, striving to navigate through uncertainty and continue its journey towards progress and prosperity.

Figure 1. Hong Kong's Victoria Harbour: A Symbol of Modernity and Prosperity.

Market, the international financial center assumes the function of network hub. However, in historical and realistic scenarios, financial globalization and the form of international financial centers are highly dependent on specific geopolitical and economic patterns. From the historical evolution, London was the dominant global financial center from the end of the 19th century to the beginning of the 20th century.

A Nexus of Financial Globalization

Later, with the rise of the United States and a new round of globalization, New York replaced London as the most important global financial center, while London still maintained an important position thanks to the development of offshore dollar market, forming a dual-center structure of new York and London. Since 1980s, with the rise of emerging economies in Asia, a new pattern of regional international financial centers such as Tokyo, Hong Kong and Singapore have gradually formed. Since the end of the Cold War, the global geopolitical and economic structure has generally been in the process of changing from "one superpower, many poles" to "multiploidization", but this change has different forms and unbalanced progress in different fields. In the field of international finance, the United States still maintains its leading position as a "super financial power", which is reflected in the guidance of the US dollar and the Federal Reserve's monetary policies on global liquidity, the shaping of global financial markets by large US financial institutions and financial market infrastructure, and the regulation of global financial activities by the US legal system and "long arm jurisdiction". Although the development of the European Union and East Asian economies has greatly promoted the multiploidization of the overall pattern of the global real economy, it has not yet challenged the leadership of the United States in the field of international monetary finance [17,18]. The bursting of Japan's bubble economy and the adjustment of the euro zone after the debt crisis have strengthened the position of the US dollar as a supplier of so-called global "safe assets". After the disintegration of the Soviet Union, "shock therapy" brought great harm to Russian social economy. The

rise of China has had a profound impact on the global political and economic structure, but the internationalization of RMB and China's financial opening still face many structural challenges. In 2020, the United States accounts for about 25% of global GDP and 11% of global trade, but accounts for about 60% of global foreign exchange reserves, more than 80% of global foreign exchange transactions and nearly 50% of global payments. In 2022, the size of the US bond market is more than twice that of China and more than four times that of Japan, and the size of the US stock market is much higher than that of the European Union, China and Japan combined.

"One Belt, One Road" and international finance center's International Cooperation Strategy

Challenges and Opportunities for Hong Kong

In the past few years, faced with the COVID-19 epidemic and the complicated international geopolitical situation, Hong Kong's social economy has experienced multiple challenges. Although Hong Kong's core competitiveness and development foundation as an international financial center are still solid, and it has shown strong resilience in the face of challenges, under the background of profound changes in the external environment, Hong Kong should deepen its integration into China's national development strategy by enhancing cooperation with mainland provinces on infrastructure connectivity and regulatory alignment, thereby creating new market opportunities for the Belt and Road Initiative [19].

Building the "Belt and Road" has provided new opportunities for the mutually beneficial development of all countries in the world, opened new space for international cooperation for China's open development, and provided China's plan for improving the global economic governance system and providing global public goods. In recent years, the economic and trade exchanges between China and countries along the Belt and Road have been deepening, and two-way investment has grown steadily. As an international financial, trade and shipping center, Hongkong is an important bridge connecting the mainland of China and the international market and has a unique hub advantage in the process of building the Belt and Road Initiative. Hong Kong, with its mature business environment, international-standard financial and legal systems, extensive professional network, and free flow of funds, goods, and information, is well-positioned to serve as a core hub for the 'Belt and Road' initiative, leveraging its familiarity with both the mainland and international markets. However, to give full play to Hong Kong's advantages and promote the construction of the "Belt and Road", it is necessary for the Hong Kong SAR government and all sectors of society to reach a consensus, form a systematic and long-term strategic plan and layout, and turn it into a concrete action plan.

Strengthening International Cooperation

In terms of international cooperation, Hong Kong needs to develop its strengths and make up for its weaknesses and actively explore new international networks and economic and trade ties on the basis of consolidating its existing advantages. Hong Kong has a solid foundation and traditional advantages in linking the mainland of China with the markets of developed economies such as Europe, the United States and Japan. However, Hong Kong needs to make further efforts in developing market links with developing countries. Regionally, Hong Kong has relatively strong links with Southeast Asia, South Asia and the Middle East, but weak links with Central Asia, West Asia and Central and Eastern Europe. Hong Kong needs to further deepen its international ties with countries along the Belt and Road Initiative, actively participate in and sign bilateral and multilateral economic and trade agreements, extensively explore

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communication channels and enhance the convenience of exchanges. Among them, the urgent task is to complete the accession to the Regional Comprehensive Economic Partnership Agreement (RCEP) as soon as possible. As a regional trade agreement covering major economies in the Asia-Pacific region, RCEP involves 15 economies, covering about 3.5 billion people in the world, with a GDP of 23 trillion US dollars, accounting for about 32% of the global economic scale and 29% of the global trade volume. Joining RCEP is of great significance for Hong Kong to consolidate its hub advantages and deepen international cooperation with economies along the Belt and Road in the Asia-Pacific region.

Professional Services and Financial Infrastructure

In terms of professional services, Hong Kong is the world's largest offshore RMB business hub and a leading international asset management center and risk management center in the Asia-Pacific region. With the deepening of international cooperation under the "Belt and Road Initiative", the restructuring of international industrial chain and the internationalization of RMB are the general trend. In the new geopolitical and economic environment, building the "Belt and Road" will inevitably require a more efficient and reliable comprehensive service platform. Hong Kong needs to strengthen the construction of a safe and controllable financial infrastructure that is in line with international standards, give play to the advantages of an offshore financial center and a free trade port, and provide various Comprehensive professional services, promote trade and two-way investment between China mainland and countries along the Belt and Road, and participate in and guide the restructuring and development of international industrial supply chains and innovation chain.

In deepening cooperation with the mainland, Hong Kong needs to further integrate into the overall situation of national development, strengthen cooperation with mainland provinces in infrastructure connectivity and docking of rules and mechanisms, and jointly explore new market space for the Belt and Road Initiative. The state will speed up the construction of an efficient, standardized, fair competition and fully open national unified market, break local protection and market segmentation, and promote the unification of market basic system rules and high-standard connectivity of market infrastructure. At the same time, the state will accelerate the high-level opening up, promote the coordinated development of internal and external demand, import and export international two-way investment, and make more efficient use of global resource elements and market space. Hong Kong should give full play to its advantages as a hub and strengthen its function of connecting the internal and external double cycles in the overall situation of building a unified national market, promoting institutional opening and jointly building the "Belt and Road".

China's Financial Opening, Interconnection and Offshore RMB Hub

The Dual Structure of China's Financial System

In the process of reform and opening, China's financial system has formed two plates: onshore finance and offshore finance. The differences between the two sectors in currency, supervision, law, market infrastructure, market main body structure and capital flow are the basic characteristics and constraints of China's financial opening and shape the overall operating environment of international finance center. China's onshore finance is mainly reflected in the "internal circulation" of RMB financial activities supervised by the central government. Hong Kong is the key hub of China's offshore financial activities, while Guangdong-Hong Kong-Macao Greater Bay Area is the connecting zone that combines domestic and

international double cycles. There are long-standing barriers between onshore and offshore financial systems, such as market separation, regulatory separation and cross-border currency non-circulation.

High-Level Opening and Financial Stability

China is promoting high-level opening to the outside world and accelerating the construction of a new development pattern with domestic big circulation as the main body and domestic and international double circulation promoting each other. Hong Kong has a unique strategic position and role in the new development pattern, and it is a window, bridge and super contact for connecting internal and external circulation. In recent years, China mainland has strengthened and improved financial supervision, deepened the reform of financial system, smoothly defused the risks of high-risk small and medium-sized financial institutions, and resolutely held the bottom line of no systematic risks, which has also provided a solid foundation for financial stability in Hong Kong.

Hong Kong has a solid foreign exchange reserve base, a mature and stable linked exchange rate system, abundant local liquidity in the banking system, stable operation of financial institutions and healthy development of offshore RMB business. The optimized currency swap agreement signed between the Hong Kong Monetary Authority and the People's Bank of China is conducive to further deepening the development of the RMB fund pool in Hong Kong. At the same time, Hong Kong's financial system and the mainland continue to strengthen the construction of interconnection mechanisms, including the North-South two-way Shanghai-Hong Kong Stock Connect, Shenzhen-Hong Kong Stock Connect, Bond Connect, and cross-border wealth management connect. Hong Kong is also actively exploring the development of the Central Clearing System for Debt Instruments (CMU) into a major international central securities depository institution (ICSD) in Asia, providing safe and efficient asset trading channels for overseas investors through the connection between Hong Kong and mainland financial infrastructure institutions.

Future Challenges and Opportunities

For the global financial system, the biggest challenge in the future is that financial market risk and geopolitical risk may resonate. The construction of Hong Kong's international financial center needs to maintain full sensitivity to geopolitical games and financial security games and comprehensively coordinate financial development and security. Hong Kong should further play the role of "double-cycle" super contact, promote the interconnection with mainland financial markets, focus on the opportunities of "Belt and Road" and Guangdong-Hong Kong-Macao Greater Bay Area construction, guide financial markets to better cooperate with the restructuring and development of regional industrial chains and supply chains under the trend of multiploidization, and promote the internationalization of RMB. In building a safe and controllable financial infrastructure that is in line with international standards, Hong Kong should play a leading role, fully promote the innovation of financial technology and financial supervision technology, seize the opportunity of digital currency and payment technology revolution, and improve the independent, safe and controllable level of foreign-related financial infrastructure.

As China Mainland continues to promote the high-level two-way opening of financial markets and the internationalization of RMB, Hong Kong, as an offshore RMB center, will face new development opportunities in terms of market size, product range, market participants, rules and mechanisms, and will also face new competition. The internationalization of the RMB requires robust financial market

infrastructure and a pool of professional talent that meets international standards. Hong Kong, with its mature legal system and market mechanisms, is well-equipped to fulfill these requirements.

High-level professionals, while meeting the requirements of China's financial openness, security and controllability, have unique strategic value in helping RMB internationalization.

Guangdong-Hong Kong-Macao Greater Bay Area is the best entry point for Hong Kong to further integrate into the "great domestic cycle" and play the role of a bridge of "double domestic and international cycles". As far as the long-term trend of supply and demand of financial services is concerned, the potential demand for international investors to buy high-quality assets in China is still huge from the perspective of optimizing their own investment portfolio. China families' demand for diversification of wealth holdings and overseas investment is also growing rapidly, while China enterprises are further "going out" to explore the international market and lay out overseas supply chains. All these needs need all-round and multi-level cross-border financial services support. By deepening cooperation with other cities in the Greater Bay Area, such as Shenzhen, Hongkong can promote the interconnection and division of labor in Greater Bay Area's financial industry, realize the steady expansion of the cross-border financial services market and solve the problem of insufficient supply.

Looking ahead, Hong Kong will face a more complicated development environment. On the one hand, Hong Kong has an important strategic position in the new development pattern of China. The 14th Five-Year Plan clearly supports Hong Kong to enhance its status as an international financial center. China's long-term economic growth vitality, innovation driving force and industrial upgrading process will create greater development space for Hong Kong. The interconnection and coordinated development of Guangdong-Hong Kong-Macao Greater Bay Area will be conducive to the more efficient flow of talents and funds. On the other hand, Hong Kong's financial system faces complex external risks. Resisting various potential risks and effectively coping with external challenges are very important to ensure Hong Kong's prosperity and stability. The stable development of international finance center has unique strategic significance for effectively safeguarding China's financial security and deepening the overall situation of financial reform and opening up.

Discussion

The impact of globalization on the construction of an international financial center

Mutual promotion between financial globalization and international financial centers: Financial globalization promotes the transnational flow of capital and the formation and development of international financial centers. As the hub of financial globalization, the international financial center has further promoted the allocation and integration of global financial resources. However, globalization changes the pattern of international financial centers, and the rise of emerging economies challenges the status of traditional financial centers but also brings new development opportunities.

Geopolitical factors restrict the construction of international financial centers: Geopolitical conflicts and unstable factors have had an important impact on the construction of international financial centers. In order to safeguard their own interests, some countries have adopted measures such as trade protectionism and financial sanctions, which have led to the division and instability of the global financial market and increased the difficulty of building an international financial center. International financial centers need to find a balance in the complex geopolitical environment and strengthen their ability to resist risks.

The opportunities and challenges of international finance centre under the Belt and Road Initiative

Hong Kong's unique advantages in the construction of the "Belt and Road": As an international financial, trade and shipping center, Hong Kong has a mature business circle.

Environment, financial and legal system in line with international standards, a wide range of international professionals and free flow of funds, goods and information. These advantages enable Hong Kong to play an important role as a bridge in the construction of the "Belt and Road" and become an important hub connecting the mainland of China with the international market.

Challenges faced by international finance centre: Although Hong Kong has many advantages, it also faces some challenges in the construction of the Belt and Road Initiative. On the one hand, Hong Kong needs to further strengthen its market ties with countries along the route, especially its cooperation with Central Asia, West Asia and Central and Eastern Europe. On the other hand, Hong Kong needs to cope with the competition from other international financial centers and constantly improve its financial service level and innovation ability in order to maintain its leading position in the international financial field.

China's financial opening and the development of international finance centre

China's financial opening has promoted international finance center: China's financial opening has provided a broad space for international finance center's development. With the gradual opening of China's financial market, Hong Kong, as the key hub of China's offshore financial activities, can give full play to its advantages in cross-border financial services, RMB internationalization and financial innovation, and promote the interconnection between the mainland and international financial markets.

International finance center's important role in China's financial opening: international finance center plays an irreplaceable role in China's financial opening. Hong Kong's mature financial system and international business environment can provide experience and reference for the opening of China's financial market and also provide an international financial service platform for China enterprises to help China enterprises "go global". Besides, Hong Kong's mature experience in financial supervision, legal system and personnel training can also provide strong support for China's financial opening.

Conclusion

Under the background of great changes in globalization, the construction of an international financial center is facing opportunities and challenges. As an international financial center, Hongkong has unique advantages and an important strategic position in the process of "One Belt, One Road" initiative and China's financial opening. Hong Kong should make full use of its own advantages, strengthen cooperation with the mainland and countries along the route, promote the internationalization of RMB and the construction of financial infrastructure, and improve the level of financial services and innovation ability, so as to cope with the complicated and ever-changing external environment and ensure the stable development of international finance center. At the same time, the development of Hong Kong will also provide strong support for China's financial opening-up and "Belt and Road" construction and promote the common development of regional economy.

Acknowledgements

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Research on Optimal Allocation of Enterprise Resources Based on Operational Research Method

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Abstract

This paper discusses the key role of operational research methods in the optimal allocation of enterprise resources. This paper summarizes the basic theory of operational research methods and its common application in enterprises in detail and explains how to allocate resources effectively through scientific analysis methods. In particular, the classification and characteristics of enterprise resources and the objectives and principles of optimal allocation of resources are deeply studied. The effective allocation of enterprise resources is influenced by market demand, utilization efficiency and risk management. Based on this, this paper puts forward a resource allocation strategy based on market demand, puts forward action suggestions to improve resource utilization efficiency, and emphasizes the importance of strengthening risk management in resource allocation. The goal of this study is to help enterprises realize the scientific allocation of resources under the guidance of operational research methods, to maintain their competitive advantage in the fierce commercial competition and enhance their economic and social benefits.

keywords

Operational research methods, Resource allocation, Risk management

Introduction

In the management of enterprise resources, precise and accurate resource allocation has become an important cornerstone to determine the long-term development of enterprises. Therefore, it is particularly important to use professional operational research methods to study the optimal allocation of enterprise resources. Operations research, as a comprehensive subject based on mathematics, aims to systematically analyze complex problems through scientific methods and means to seek the optimal decision-making scheme [1].

Operational research methods include linear programming, dynamic programming, graph theory and other methods and models. These methods and models can provide mathematical description and model establishment of resource allocation according to the specific situation of enterprises, making the decision-making process more accurate and effective [2].

In the fierce market competition, the survival and development of enterprises often depend on the optimal allocation of resources. Specific paper, from the perspective of combining theory with practice, the optimal allocation of enterprise resources will be studied in depth, and the strategies and suggestions of resource

allocation based on operational research methods will be analyzed in detail, and relevant strategies and specific measures will be put forward from the perspective of market demand, improvement of resource utilization efficiency and risk management [3].

Theoretical overview

Overview of operational research methods

Operational research is an applied science, which uses mathematical models, statistical analysis, and algorithms to solve optimization and decision-making problems in various practical problems. It aims at rational distribution and utilization of limited resources through scientific methods and technologies to achieve the best results [4-7].

The development of operational research methods can be traced back to the last century. After years of development, a complete set of theoretical and methodological systems has been formed. It covers many fields, such as linear programming, nonlinear programming, integer programming, dynamic programming, graph theory, queuing theory and so on [8]. These methods can help people make wise decisions in complex situations and improve the efficiency of resource utilization and economic benefits. Therefore, the operational research method is a powerful tool, which can help enterprises and organizations make more scientific and reasonable decisions when facing various challenges and realize the optimal allocation of resources and the maximization of benefits [9].

Common operational research methods

Common operational research methods include linear programming, integer programming, nonlinear programming, dynamic programming, and queuing theory. Linear programming is a method to study how to optimize a linear objective function under a set of linear constraints. It is widely used in production planning and resource allocation. Integer programming is based on linear programming, which requires decision variables to take integer values. This method is often used to solve problems such as personnel arrangement and equipment allocation [10,11]. Nonlinear programming is used to deal with the optimization problem of objective function or constraint condition containing nonlinear function; Dynamic programming is a mathematical method to solve the optimization of multi-stage decision-making process, which can find the optimal solution in complex problems; Queuing theory mainly studies the performance indexes of various queuing systems to optimize the design and operation of service systems. The queuing theory model is shown in the following figure:
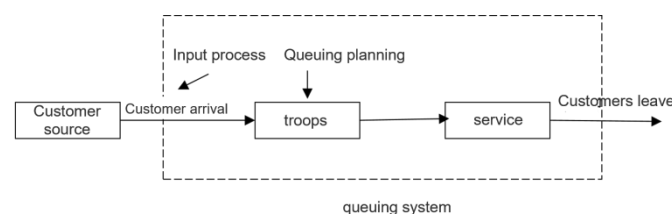

Figure 1. Queuing theory model.

These operational research methods have their own characteristics and scope of application, and enterprises can choose appropriate methods to optimize the allocation of resources according to their own actual conditions.

The role of operational research methods in the optimal allocation of enterprise resources

Operational research methods play a significant role in the optimal allocation of enterprise resources. This method can not only help enterprises to use limited resources more effectively. Through the establishment of mathematical models, production, sales, inventory, and other links of enterprises are analyzed and optimized, so that resources can be reasonably allocated, and the utilization rate of resources can be improved [12]. The method of operational research aims to solve the problem of resource allocation and optimization through mathematical models and algorithms, and the resource planning matrix can provide an intuitive and structured way to describe and analyze the relationship between resource requirements and tasks.

The resource planning matrix table is shown in the following table:

key factor		weight	Alternative strategy			
			Set up in Europe joint venture		Establish in Asia joint venture	
			AS	TAS	AS	TAS
chance	1、 The unification of Europe	0.01	4	0.40	2	0.02
	2、 Consumers pay more attention to health factors when purchasing goods.	0.15	4	0.60	3	0.45
	3、 The rise of free market economy in Asia	0.10	2	0.20	4	0.40
	4、 The demand for soup is increasing by 10% every year.	0.15	3	0.45	4	0.60
	5、 North American Free Trade Agreement	0.05	—	—	—	—
threaten	1、 The demand for food only increases by 1% every year.	0.10	3	0.30	4	0.40
	2、 ConAgra's Banquet TV food leads with 27.4% market share.	0.05	—	—	—	—
	3、 Unstable Asian economy	0.10	4	0.40	1	0.10
	4、 Canned boxes cannot be biodegradable.	0.05	—	—	—	—
	5、 The depreciation of the dollar	0.15	4	0.60	2	0.30
superiority	1、 Profits increased by 30%	0.10	4	0.40	2	0.20
	2、 The new North American branch	0.10	—	—	—	—
	3、 Successful new healthy soup	0.10	4	0.40	2	0.20

	4、The market share of Swanson TV food has increased to 25.1%.	0.05	4	0.20	3	0.15
	5、One-fifth of all managers' bonuses are based on the overall performance of the company.	0.05	—	—	—	—
	6、The utilization rate of production capacity increased from 60% to 80%.	0.15	3	0.45	4	0.60
weakness	1、Sales at Pepperidge Farm dropped by 7%.	0.05	—	—	—	—
	2、Corporate restructuring cost $302 million.	0.05	—	—	—	—
	3、The company's operations in Europe are losing money.	0.15	2	0.30	3	0.45
	4、The company's international operation is progressing slowly.	0.15	4	0.60	3	0.45
	5、The profit rate before tax is 8.4%, which is only half of the industry average.	0.05	—	—	—	—
amount to		1.00		5.30		4.32

The theoretical basis of optimal allocation of enterprise resources

Classification and characteristics of enterprise resources

Enterprise resources are the foundation of enterprise development, which can be divided into human resources, financial resources, material resources and information resources.

Human resources are the most dynamic and creative resources in enterprises, including employees' knowledge, skills, experience, and creativity. Its characteristics are subjective initiative and creativity, which can bring innovation and development impetus to enterprises. Financial resources are the material basis for enterprises to conduct production and business activities, including funds and assets. Financial resources are characterized by liquidity and risk, which need reasonable planning and management to ensure the stability of enterprise's capital chain [13,14]. Material resources are the material carriers of enterprises' production and operation activities, including raw materials, equipment, workshops, etc. Material resources are substantive and consumptive and need to be purchased and used to reduce costs and improve efficiency. Information resources are all kinds of information generated and collected by enterprises in their production and business activities, including market information, technical information, and management information. Information resources are characterized by timeliness and value and need to be collected and processed in time to support the decision-making and management of enterprises [15].

Objectives and principles of optimal allocation of resources

The goal of optimal allocation of resources is to realize the rational allocation and effective utilization of enterprise resources, to improve the economic benefits and competitiveness of enterprises. Specific

objectives include improving resource utilization, reducing costs, improving production efficiency and meeting market demand. The principle of optimal allocation of resources includes the following aspects:

(1) the principle of integrity: the various resources of the enterprise are regarded as a whole, and comprehensive consideration and optimal allocation are conducted to maximize the overall benefits. Benefit principle: Based on improving the economic benefits of enterprises, through optimizing resource allocation, reducing costs and improving output, the optimal utilization of resources can be achieved. (3) The principle of coordination: pay attention to the coordination between resources, so that all kinds of resources can match each other in quantity, quality, time, and space, and avoid the waste and idleness of resources. (4) Dynamic principle: according to the changes in the internal and external environment of the enterprise, adjust the resource allocation scheme in time to adapt to the changes in market demand and competitive situation. (5) The principle of sustainability: In the process of optimizing the allocation of resources, the sustainable utilization of resources should be fully considered to realize the long-term development of enterprises.

Factors affecting the optimal allocation of enterprise resources

There are many factors that affect the optimal allocation of enterprise resources, including the following aspects:

Market demand: the change in market demand directly affects the production and sales plan of enterprises, thus affecting the allocation of resources. Take the automobile consumption market as an example: the automobile sales volume and growth rate in China from 2015 to 2024 are shown in the following figure:

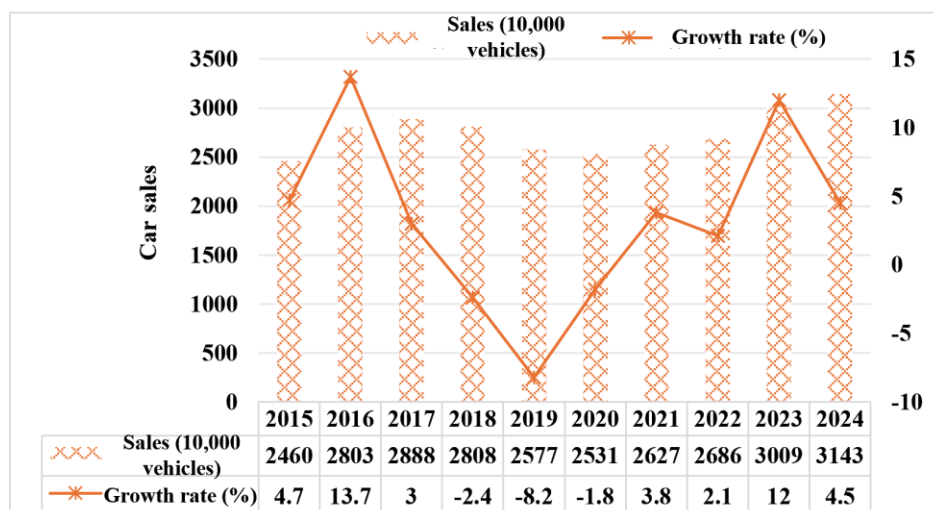|	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Sales (10,000 vehicles)	2460	2803	2888	2808	2577	2531	2627	2686	3009	3143
Growth rate (%)	4.7	13.7	3	-2.4	-8.2	-1.8	3.8	2.1	12	4.5

Figure 2. China automobile sales and growth rate from 2015 to 2024.

Enterprises need to adjust the resource allocation scheme in time according to the changes in market demand to meet the market demand. Technical level: the technical level of an enterprise determines its production efficiency and product quality and then affects the utilization efficiency of resources. Advanced technology can improve production efficiency and reduce costs, thus optimizing resource allocation. Competitive environment: The fierce competitive environment requires enterprises to continuously improve their competitiveness and optimize resource allocation to improve product quality and reduce costs. The strategies and actions of competitors will also have an impact on the resource allocation of enterprises. Enterprise strategy: the strategic goal and development direction of an enterprise determine the investment

and allocation focus of resources. Different strategic choices need different resource allocation schemes to support them. Management level: the management level of an enterprise directly affects the utilization efficiency and allocation effect of resources. Scientific management methods and processes can improve the integration ability and synergistic effect of resources and realize the optimal allocation of resources. Policies and regulations: national policies and regulations have an important impact on the production and business activities of enterprises, such as environmental protection policies and tax policies.

Strategies and suggestions for optimal allocation of enterprise resources

Resource allocation strategy based on market demand

The optimal allocation of enterprise resources should closely focus on market demand. Enterprises need to deeply understand the market trends and customer needs and accurately grasp the changes in market trends and consumer preferences through market research, data analysis and other means. On this basis, according to the scale and characteristics of market demand, the input of production resources should be adjusted to ensure that the supply of products or services matches the market demand. For example, for products with rapid market demand growth, enterprises should increase investment in production resources, including increasing raw material procurement, expanding production scale, and increasing labor force, to meet the growth of market demand. At the same time, enterprises should adjust the product structure and product line in time according to the changes in market demand, eliminate products with shrinking market demand, and concentrate resources on developing products with broad market prospects.

Suggestions on improving the efficiency of resource utilization

To realize the optimal allocation of enterprise resources, improving the efficiency of resource utilization is the key. Enterprises can improve the efficiency of resource utilization in many ways. On the one hand, enterprises should strengthen internal management, optimize business processes, and reduce the waste and idleness of resources. Through the process of optimization of production, sales, coordination and other links, operating costs are reduced, and work efficiency is improved. For example, lean production is adopted to reduce inventory backlog and waste in the production process and improve production efficiency; Optimize the coordination distribution process, reduce transportation costs, and improve coordination efficiency.

On the other hand, enterprises should strengthen technological innovation, introduce advanced production technology and equipment, improve the level of production automation, and thus improve the utilization efficiency of resources. At the same time, enterprises should also strengthen the training and education of employees, improve their skills and work enthusiasm, give full play to their potential, and improve the utilization efficiency of human resources.

Resource allocation strategy to strengthen risk management

Risk management is especially important in the process of optimizing the allocation of enterprise resources. Enterprises need to identify and evaluate various potential risks, such as market risks, technical risks, and financial risks, and adopt corresponding risk management strategies.

For market risk, enterprises can reduce the risk through diversified market strategies. For example, open new market areas and reduce dependence on a single market; At the same time, enterprises can also respond to market price fluctuations and competitive pressures through flexible pricing strategies and marketing strategies. For technological risks, enterprises should increase R&D investment, improve their

independent innovation ability, and reduce their dependence on external technology. At the same time, enterprises should also strengthen the research and prediction of technology development trends and adjust the direction of technology research and development in time to cope with the risks brought by technological changes. For financial risks, enterprises should rationally arrange capital structure, optimize financial budget, strengthen capital management, and ensure the stability of enterprise capital chain. At the same time, enterprises should also establish a risk early warning mechanism to find and deal with potential financial risks in time.

Conclusion

Through in-depth discussion on the application of operational research methods in the optimal allocation of enterprise resources, it can be found that in the current business environment, the application of operational research methods plays a vital role in the effective allocation and maximum utilization of resources for enterprises.

By using the method of operational research, enterprises can identify and evaluate the demand and supply of resources more accurately, to formulate more reasonable and effective resource allocation strategies. The resource allocation strategy based on market demand is the key to the optimal allocation of enterprise resources. In the ever-changing market environment, enterprises must flexibly adjust the allocation of resources to meet the needs of customers.

Therefore, operational research methods play a key role in the optimal allocation of enterprise resources. Through scientific and systematic analysis and decision support, enterprises can better realize the optimal allocation of resources and thus stand out in the fierce market competition. In the future, with the progress of science and technology and the change of the market, operational research methods will play a more significant role in the field of enterprise resource management.

Acknowledgements

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