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Original Paper

Research on the Application of Blockchain in SMEs Credit Risk

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Abstract

The credit of an enterprise is related to its own development. This paper mainly discusses the relationship between the credit risk of small and medium enterprises (SMEs) and the application degree of blockchain. 64 listed companies with block chain technology as the core theme are selected to analyze their comprehensive financial data. Factor analysis is used to quantitatively evaluate the application degree of blockchain in SMEs, and then the Logistic model is used to evaluate the credit risk of SMEs. Finally, combining the application degree of blockchain in small and medium-sized enterprises and the credit risk assessment of these two groups of data. It confirms the conclusion that the higher the degree of blockchain application, the closer the supply chain finance relationship, and the better the credit status.

Keywords

Blockchain, factor analysis, Logistic model, credit risks

1. Introduction

In the process of China's rapid entry into the era of credit and digital economy, the credit risk in the market also arises. China has more than 80 million enterprises, 27 million small and medium-sized enterprises, and the average life expectancy is less than three years. The big reason for this is the problem of enterprise credit risk. Because smes are small and do not disclose much information, they fail to meet the requirements of financial institutions for audit and transparency of loans, and miss opportunities to obtain financing and expand business. Enterprise credit plays a vital role in the survival and development of enterprises, and the evaluation of enterprise credit risk is the key to the problem.

For example, as Nie Yan pointed out, there is asymmetric information of risk and return in the loans of smes, which makes it difficult for smes to obtain financing. In order to reduce enterprise credit risk, Nie Yan proposed some measures such as the establishment of a loan guarantee company for small and medium-sized enterprises. In 2010, Wang Chengfang proposed that smes should not only pay attention to their own construction, but also further improve the external environment for financing. In order to better evaluate the credit risk of enterprises, Tian Qiuli chose the Logistic model to measure the credit risk of small and medium-sized enterprises. Zu Xiaoqing analyzed the establishment of the social credit system for smes, the improvement of the guarantee system and the development of loan credit insurance, and discussed their effect on reducing the credit risk of smes. In 2013, Wu Huiyong selected representative indicators and further improved the enterprise credit risk measurement model by using partial least square method and Logistic model.

The above method cannot fundamentally solve the measurement problem of credit risk, and the new technology blockchain can better characterize the problem due to its own advantages of decentralization and immutable. As Wang Xu pointed out, blockchain can fundamentally optimize the financial credit investigation system and reduce credit risks. Blockchain technology can be useful in many areas. For example, in 2020, Rijanto used the blockchain system credit risk model to find that blockchain technology can have an impact not only on the financing model of agricultural enterprises, but also on the banks, insurance and other financial institutions involved in the supply chain. In 2021, Yang Peibei took advantage of the characteristics of blockchain decentralization and immutability to introduce this technology in ship mortgage financing to complete the control of credit risk. Zhang used blockchain technology to establish a distributed intelligent information transaction model, which can provide an open and transparent credit evaluation mechanism for all parties to a transaction, reduce the credit risk of enterprises, and achieve higher transaction efficiency, fewer violations and a more orderly transaction mode in the market. It can be seen that in the research at home and abroad, the combination of blockchain and credit risk has received widespread attention, and there are corresponding results in theoretical and practical research. Blockchain is not only valued in developed countries such as Japan and the United States, but also included in China's "13th Five-Year" National Informatization Plan, elevating it to the national strategic level. At present, blockchain technology has attracted the attention of all walks of life, playing a crucial role in solving industry problems and realizing enterprise innovation and development. As a disruptive technology, its wide market application prospect can make great contributions to enterprise management transformation and national informatization construction.

This paper mainly discusses the relationship between the credit risk of smes and the degree of application of blockchain, and discusses how blockchain can help smes grow rapidly through factor analysis and Logistic regression model.

2. Blockchain and Credit Risk Index Selection

A series of valid time-stamped transaction blocks form the blockchain, which is recorded and maintained by multiple parties. The infrastructure of blockchain is shown in Figure 1, where each level contains specific content, and each module is connected to each other, forming a unique infrastructure model of blockchain. Blockchain technology has immutability, transparency, to ensure the truth of the data, can be better applied in credit evaluation. The characteristics of blockchain technology can be utilized to solve various problems existing in the financial data of smes and reduce the credit risk of smes.

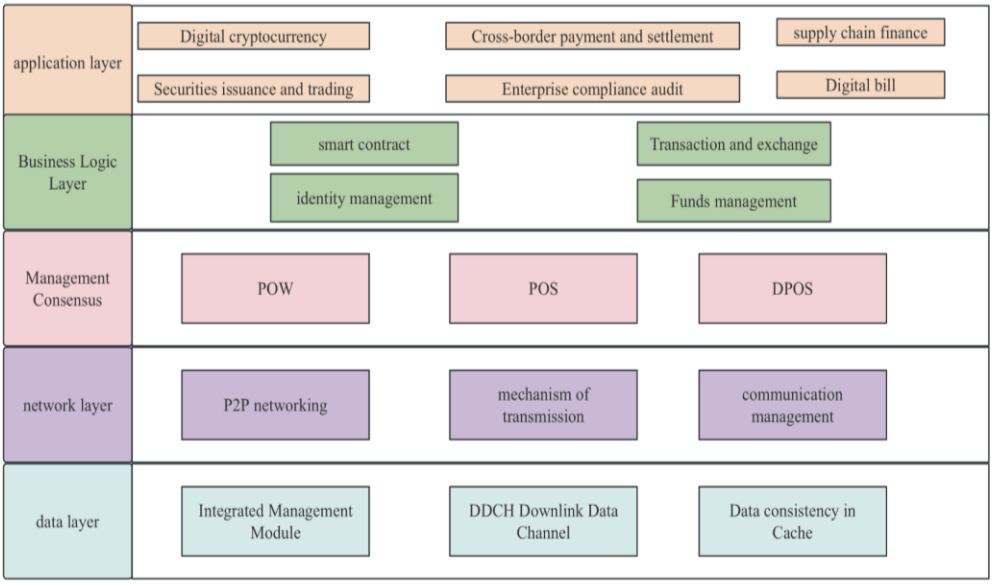

Figure 1. Blockchain Infrastructure Model

A company's performance and credit risk are often reflected in its financial statements. In order to study the degree of application of blockchain in smes and its relationship with enterprise credit risk, this paper selects listed companies with blockchain technology as the core subject and studies the data in their financial analysis tables. Select 8 representative data. For example, current ratio, return on equity, etc. These indicators are used to study the trustworthy rate of small and medium-sized enterprises. The corresponding indicators are described in Table 1. At the same time, 10 variables are selected to describe the basic situation of a certain company. For example, core competitiveness, shareholders' equity, etc., these variables are used to study the application degree of blockchain in small and medium-sized enterprises, and the specific variables are shown in Table 2. Taking the three major statements announced by listed companies in 2020 as the research object, 64 enterprises in the blockchain sector were selected, including 50 non-ST enterprises, indicating that their credit status was good; 14 ST enterprises, representing their poor credit status.

Table 1. Selected Indicators

serial number	financial index	computational formula
1	liquidity ratio (m_1)	Current assets/current liabilities
2	Current liabilities ratio of net cash flow from operating activities (m_2)	Net cash flow from operating activities/current liabilities
3	equity ratio (m_3)	Shareholders' equity/total assets
4	total assets turnover (m_4)	Net income from main operations/average total assets
5	rate of stock turnover (m_5)	Main business cost/average inventory balance
6	turnover ratio of account payable (m_6)	(Main operating costs ending inventory - beginning inventory)/ Average accounts payable
7	return on equity (m_7)	Total profits/average shareholders' equity
8	Profit margin of main business (m_8)	Net profit/net income from main business

Table 2. Declaration of Variable

variable	variable declaration
x_1	core competitiveness
x_2	important business issues related to blockchain (item)
x_3	current liabilities (billion)
x_4	current assets (billion)
x_5	expansion project (item)
x_6	net income from main business (billion)
x_7	total assets (billion)
x_8	shareholders' equity (billion)
x_9	main business cost (billion)
x_{10}	is it relevant to the computer industry
p	the company's trustworthiness rate

3. Blockchain Factor Analysis

Factor analysis is an extension of principal component analysis, which synthesizes a series of complicated variables into a small number of factors, so as to reproduce the mutual relationship between the original variable and the factor, and can further classify the variable according to different factors. In order to synthesize the financial information of multiple variables x_1 to x_{10} into a few factors, factor analysis is selected here to further classify the variables according to different factors. Meanwhile, the application degree of blockchain in smes is explained through the score of factor analysis, and the trustworthiness rate of smes in Section 4 is compared and analyzed.

3.1 Factor Analysis Model

Factor analysis, as an extension of principal component analysis, is a commonly used dimensionality reduction method in multivariate statistical analysis. The model is as follows:

$$x_i = \mu_i + \alpha_{i1}F_1 + \cdots + \alpha_{im}F_m + \varepsilon_i, i = 1, 2, \cdots, p$$

Where, x_i is the measurable variable, $F_1, F_2, \cdots F_m$ is the common factor, ε_i is called a special factor of x_i called the special factor.

Let $F_{ij}, i = 1, 2, \cdots, n; j = 1, 2, \cdots, m$ represent the score of the i th firm for the j th factor F_j. By measuring the public factors, the value of the public factors is obtained, and the linear combination of the public factors is used to represent the degree of influence of blockchain on the selected company.

The factor score function is as follows:

$$F_{ij} = c_j + \beta_{j1}x_{i1} + \beta_{j2}x_{i2} + \cdots + \beta_{jp}x_{ip}, i = 1, 2, \cdots, n; j = 1, 2, \cdots, m.$$

The comprehensive factor score formula is as follows:

$$F_i = k_1F_{i1} + k_2F_{i2} + \cdots + k_mF_{im}, i = 1, 2, \cdots, n.$$

The degree to which the selected listed company is affected by blockchain is calculated.

3.2 Establishment and Analysis of Factor Analysis Model

In order to analyze the use of blockchain in a company, a factor analysis model is established for 10 variables describing listed companies (Table 2), and the results are shown in Table 3.

Table 3. Total Variance Interpretation Table

	Initial eigenvalue			Extract the sum of squared loads			Rotating load sum of squares		
ingredient	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %
1	6.043	60.427	60.427	6.043	60.427	60.427	5.966	59.663	59.663
2	1.225	12.247	72.674	1.225	12.247	72.674	1.244	12.44	72.104
3	1.019	10.185	82.859	1.019	10.185	82.859	1.076	10.756	82.859
4	0.845	8.449	91.309						
5	0.51	5.097	96.406						
6	0.153	1.53	97.935						
7	0.117	1.172	99.107						
8	0.066	0.664	99.771						
9	0.022	0.22	99.991						
10	0.001	0.009	100						

It can be seen from Table 3 that 10 factors are selected, and through factor analysis, the first three eigenvalues are greater than 1, and the corresponding variance contribution rates are 60.427%, 12.247%

and 10.185%, respectively. Their cumulative variance contribution rates reach 82.859%, indicating that extracting these common factors can explain most of the information of the original variables. So just extract the first three factors.

In order to divide the factors more objectively, choose to rotate the factors orthogonal. The component matrix after rotation is shown in Table 4, and then the factors are given practical meaning, and the correlation coefficients corresponding to each element of the three factors are obtained. For example, 0.987 is the correlation coefficient between the total assets after rotation and factor F_1. As can be seen from Table 4, factor F_1 has a large load in $x_3, x_4, x_5, x_6, x_7, x_8, x_9$, which reflects the profit and loss of the company's profit and the liabilities of its assets, and can be named as the company's financial factor. Factor F_2 has a large load in x_2, reflecting the association between the company's events and the blockchain, and can be named as the blockchain association factor. Factor F_3 has a large load in x_1, x_{10}, reflecting the company's main business and competitiveness, and can be named as the core theme factor.

Table 4. Component Matrix after Rotation

variable		Component 1	Component 2	Component 3
x_1	core competitiveness	0.044	-0.724	0.269
x_2	important business issues related to blockchain (item)	0.141	0.813	0.191
x_3	current liabilities (billion)	0.973	-0.019	-0.115
x_4	current assets (billion)	0.971	0.14	-0.054
x_5	expansion project (item)	0.689	0.054	0.159
x_6	net income from main business (billion)	0.914	-0.096	-0.138
x_7	total assets (billion)	**0.987**	0.042	-0.088
x_8	shareholders' equity (billion)	0.93	0.143	-0.034
x_9	main business cost (billion)	0.944	0.049	-0.111
x_{10}	is it relevant to the computer industry	-0.118	-0.049	0.941

Table 5. Component Score Coefficient Matrix

variable		Component 1	Component 2	Component 3
x_1	core competitiveness	0.063	-0.585	0.233
x_2	important business issues related to blockchain (item)	0	0.669	0.229
x_3	current liabilities (billion)	0.164	-0.068	-0.04
x_4	current assets (billion)	0.161	0.066	0.026
x_5	expansion project (item)	0.131	0.018	0.207
x_6	net income from main business (billion)	0.156	-0.129	-0.069
x_7	total assets (billion)	0.166	-0.017	-0.01

x_8	shareholders' equity (billion)	0.155	0.071	0.043
x_9	main business cost (billion)	0.156	-0.01	-0.035
x_{10}	is it relevant to the computer industry	0.051	0.005	0.898

The component score coefficient matrix is shown in Table 5. According to Table 5, the factor expression is as follows:

$F_1 = 0.063x_1 + 0.164x_3 + 0.161x_4 + 0.131x_5 + 0.156x_6 + 0.166x_7 + 0.155x_8 + 0.156x_9 + 0.051x_{10}$,

$F_2 = -0.585x_1 + 0.669x_2 - 0.068x_3 + 0.066x_4 + 0.018x_5 - 0.129x_6 - 0.017x_7 + 0.071x_8 - 0.01x_9 + 0.005x_{10}$,

$F_3 = 0.233x_1 + 0.229x_2 - 0.04x_3 + 0.026x_4 + 0.207x_5 - 0.069x_6 - 0.01x_7 + 0.043x_8 - 0.035x_9 + 0.898x_{10}$,

$F = 0.59663F_1 + 0.72104F_2 + 0.82859F_3$.

The three factors correspond to different aspects, and factor F_1 focuses on the profit and loss of the company's profits and assets liabilities, including current liabilities, current assets, expansion projects, net income from main business, total assets, shareholders' equity, and main business costs. Factor F_2 focuses on the relevance of the company's matters to blockchain, including significant matters related to blockchain in the business. Factor F_3 focuses on the company's main business and competitiveness, including core competitiveness and whether it is related to the computer industry.

According to the factor score ranking, among the 64 enterprises, Chenming Paper Industry has the largest application degree of blockchain in small and medium-sized enterprises, followed by Dongxu Blue Sky, Guangdian Express, Xinhua Wenxuan, Changshan Beiming. At present, there are five major domestic pulp production lines, Chenming Paper industry accounted for three, is the largest domestic pulp and paper enterprises. In 2019, Chenming Paper invested in Beijing Consensus Digital Technology Co., LTD., whose main business is to provide blockchain solutions and product development. This provides technical support to Chenming Paper industry, Chenming Paper industry uses the advantages of scale, product advantages and technical equipment advantages to maintain a strong profitability. Among the 64 enterprises, the smallest degree of blockchain application in small and medium-sized enterprises is ST Opu, although the company explores the application of blockchain concept and some technologies, but the application of the technology is still mainly investment, so its influence is small.

Table 6. Component Score Table

Rank	company	F	Rank	company	F
1	Chenming Paper	185.651	33	Rendong Holdings	8.062
2	Dongxu Blue Sky	67.833	34	Anjubao	7.916
3	Broadcasting Express	54.313	35	Merson culture	7.886
4	Xinhua Wenxuan	48.403	36	dicarboxyline	7.803
5	Chang Shan North Ming	45.765	37	Rongji Software	7.672

6	Meinian Health	43.429	38	Alto Electronics	7.44
7	Gao Hong Stock	28.054	39	ST net force	7.334
8	Longsun Technology	24.846	40	Cairn shares	7.272
9	VTEC	21.982	41	Haoyun Technology	6.625
10	Tianyuan Dico	20.658	42	ST spike	6.62
11	Yinjiang Stock	19.96	43	International today	6.319
12	Mei Yingsen	19.783	44	Gao Weida	5.921
13	ST data	17.214	45	Channel innovation	5.06
14	ploton	17.022	46	Positive element intelligence	4.656
15	Step	14.864	47	ST Smooth	4.491
16	ST contact	14.315	48	Easymedia	4.327
17	Dash Intelligence	14.24	49	ST Modern	4.267
18	ST Hua Ying	13.729	50	Asian Union development	4.24
19	Runhe software	12.492	51	Guao Technology	4.094
20	Qingdao intermediate	11.437	52	Royal silver Stock	4.051
21	Golden Crown	10.949	53	Rongyu Group	3.838
22	High beam software	10.425	54	Xinchen Technology	3.561
23	Tianyang Technology	10.35	55	Guangbo Stock	3.455
24	Creative information	10.308	56	Zhongke Information	3.187
25	Genvict	10.215	57	ST Contemporary	3.158
26	Mesopelagidae	10.014	58	Jinyun laser	3.136
27	Shenzhen Chase	9.917	59	ST Chenxin	2.82
28	ST julon	9.815	60	ST 35	2.269
29	Visual China	9.723	61	ST Qunxing	1.934
30	Jincai Internet	9.522	62	ST Rawton	1.208
31	Henghua Technology	9.444	63	Baibang Technology	0.389
32	Hezong technology	8.463	64	ST Opal	-3.787

4. Evaluation of Credit Risk of Smes Based on Logistic Model

Logistic model is suitable for analyzing attribute response variables and can predict the probability of class. Through this model, 8 financial indicators m_1 to m_8 and factor analysis are used to predict the trustworthy rate of smes. In order to test the accuracy of the prediction of the Logistic model, 64 companies using blockchain technology were selected in this paper, among which 50 non-ST companies were recorded as category 1 and 14 ST companies were recorded as category 0 to further verify the good prediction effect of the model. Thus, the credibility rate is compared with the degree of application of blockchain in smes in Section 2.

4.1 Logistic Model

Logistic regression model is a generalized linear model that connects the expectation of the random part, that is, the expectation of the dependent variable *y*, with the predictor through the change of the correlation function logit. A binary variable with an expectation of class 1, whose probability is denoted *p*, then the probability of class 0 is *1-p*, and the predictor is denoted $X=(x_1,\cdots,x_p)$. So the Logistic model is:

$$\text{logit}(p)=\ln\left(\frac{p}{1-p}\right)=\alpha+\beta' X,$$

Where $\beta=(\beta_1,\cdots,\beta_p)'$. The above formula is deformed to obtain the formula for calculating the probability of each class:

$$p=\frac{e^{\beta' X}}{1+e^{\beta' X}}.$$

The probability formula is used to conveniently solve the probability of each class, and then according to the size of the probability to judge the class to draw a conclusion.

4.2 Establishment of Logistic Model

In order to analyze the degree of credit risk of a company, factor analysis of financial indicators is carried out. It is found that factor M_1 has a large load in m_1, m_3 and m_6, reflecting the ability of the company's capital flow, and can be named as the company's financial data factor. Factor M_2 has a large load in m_7, reflecting the level of corporate profitability, and can be named as corporate income quality factor. Factor M_3 has a large load in m_2, m_4, m_5 and m_8, reflecting the size of the company's turnover capacity, and can be named as the company's business indicator factor.

The resulting factor expression is as follows:

$$M_1=-0.499m_1+0.040m_2-0.599m_3+0.298m_4+0.129m_5+0.484m_6+0.049m_7+0.221m_8,$$

$$M_2=0.357m_1+0.166m_2+0.1m_3+0.053m_4-0.25m_5+0.474m_6+0.734m_7-0.077m_8,$$

$$M_3=0.124m_1+0.787m_2+0.134m_3+0.387m_4+0.255m_5-0.209m_6-0.032m_7+0.296m_8,$$

$$M=0.65-0.216M_1+0.764M_2+1.169M_3.$$

The Logistic regression model expression of the company's trustworthiness rate is as follows:

$$\hat{p}=\frac{1}{1+e^{-(0.65-0.216M_1+0.764M_2+1.169M_3)}}.$$

The three factors correspond to different aspects, and factor M_1 focuses on the company's capital flow ability, including the current ratio, shareholders' equity ratio and accounts payable turnover ratio. Factor M_2 focuses on the level of profitability, including return on equity. Factor M_3 focuses on the size of the company's turnover capacity, including current liabilities, operating activities, net cash flow ratio.

The $\hat{p}$ value was calculated according to the Logistic regression model. If $\hat{p}\le 0.5$, believe that the enterprise trustworthiness is poor. If $\hat{p}>0.5$, that the enterprise trustworthiness is better. The prediction probability of sample data is shown in Figure 2.

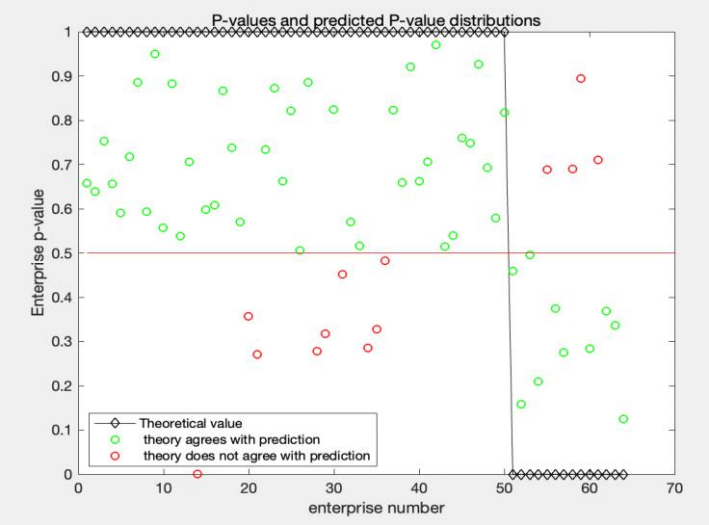

Figure 2. Sample Prediction Probability Diagram

The enterprise credit is evaluated based on Logistic regression model. The credit status is closely related to the business level of the enterprise and the ability of capital flow. The better the liquidity of funds, the stronger the solvency, the higher the degree of protection for debtors and investors. When investors choose investment objects, the business level of the enterprise and the liquidity of funds are often the primary considerations. The accuracy of the model is as high as 83%, which can provide better decision basis for debtors and investors, and also provide useful decision information for enterprise managers.

5. Empirical Result

In section 3, the paper calculates the application degree F of blockchain in small and medium-sized enterprises based on the factor model. At the same time, in section 4, the enterprise credit risk situation p is calculated according to the Logistic regression model. Compare the two types of data to further explore the application of blockchain in SME credit risk, as shown in Figure 3.

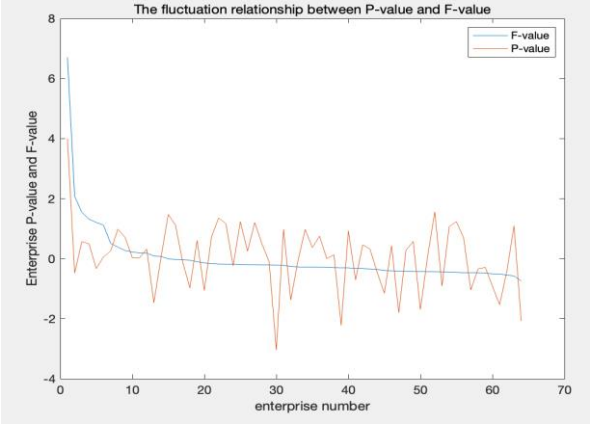

Figure 3. Fitting Diagram of Blockchain Application Degree and Enterprise Credit Status

As can be seen from Figure 3, the higher the degree of blockchain application, the better the credit status of smes, and the closer the relationship between supply chain finance, the more sound the development of blockchain financial system.

This paper mainly studies the application degree of blockchain in smes and its relationship with enterprise credit risk. Through factor analysis and Logistic regression model, it is found that blockchain does promote the rapid growth of smes. As a disruptive technology, blockchain can fundamentally optimize the financial credit information system and reduce credit risk, so enterprises using blockchain develop better, have a higher trustworthy rate, and financing is relatively easy. The good application prospect of this technology will make great contributions to the national information construction and the transformation of enterprise management.

6. Conclusion

This paper establishes a factor analysis model suitable for measuring the degree of application of blockchain in Chinese enterprises, which can evaluate the degree of application of blockchain in small and medium-sized enterprises. At the same time, the Logistic model is also established, which can be used to evaluate the credit risk of enterprises with its complex pattern classification ability and excellent multi-dimensional function mapping ability. By combining the two models and taking listed companies in 2020 as research samples, it is confirmed that the higher the degree of blockchain application of smes, the closer the relationship between supply chain finance and the better the credit status.

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