### **ORIGINAL RESEARCH ARTICLE**

### **An empirical study on the prevention of financial risks in China’s agricultural supply chain based on financial data of listed companies**

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**Abstract:** Agriculture is the foundation of the national economy. Since the reform and opening up, agriculture has achieved rapid development in China and has achieved a historic leap from eating enough to eating well. However, relative to the development of the secondary and tertiary industries, due to the long-term implementation of the agricultural back-feeding industry and the “dual structure” policy system in urban and rural areas, agricultural development still lags behind the development of other industries. In addition, agriculture is greatly affected by natural disasters, which increases the risk of agricultural production and further leads to a serious shortage of investment in agriculture. Therefore, through the study of the agricultural supply chain financial model and its risk prevention, this paper uses principal component analysis and binary Logistic regression methods to select the data of listed companies in the agricultural sector. The cooperative customer’s compliance probability in the agricultural supply chain financial product area can be measured more accurately. The study will contribute to reduce the credit risk of bank loans while increase the effectiveness of supply chain systems.

**Keywords:** agricultural supply chain finance; principal component analysis; binary Logistic regression

**1. Introduction**

Agriculture is the foundation of the national economy, and the realization of agricultural modernization and the solution of “agriculture, rural areas and farmers” are of great significance to China’s modernization. The development of modern agriculture needs not only innovation in science and technology, but also support and innovation from financial aspect, financial support for agricultural development is one of the most important manifestations of finance as the core of modern economy. Financial innovation also provides a diversified choice for financial support for agricultural development. At present, the main problem facing China’s agricultural development is the lack of financial support, which is mainly reflected in the financing difficulties of agricultural-related enterprises and farmers, and the emergence of supply chain finance provides an effective way to solve this problem.

Supply Chain finance refers to the activities of transaction financing and related pricing of services implemented in people to meet the financing needs of the supply chain production organization system, aiming to strengthen the credit status of the whole supply chain, established in core enterprises and specific industries.

On the basis of real trade, it reduces financing costs and risk, improves the credit level of small and medium-sized enterprises and farmers, and promotes the development of financial services.

Agricultural supply chain finance will bind the interests of small and medium and downstream enterprises, farmers and consumers together, and with the characteristic agricultural enterprises and competitive agricultural products as the center, through scientific and rational design of financial products to meet the financing needs of all aspects of the supply chain, and systematically solve the overall coordinated operation of agricultural supply chain.

Agricultural supply chain finance has been developed by many developing countries as an important measure to reduce rural financial exclusion and expand the scope of rural financial coverage. Relevant financial institutions in the field of supply chain financial industry have launched specific products and service innovation. Established on the basis of foreign business model research, some domestic financial institutions, such as Longjiang Bank, Agricultural Bank of China, etc. have performed the following supply chain service modes: professional cooperatives + farmers + professional cooperatives / professional large / base + farmers, company + farmers, etc. based on the state of agricultural development and related regional agricultural development of regional characteristics. Through the research on the financial model of agricultural supply chain and insurance prevention, the party and the country on agriculture, rural areas and farmers, and under the background of comprehensive poverty alleviation in 2020, selected the financial data from 2014 to 2016 with 111 samples, the number of which was expanded compared with previous studies. The probability of cooperative customers and agreement is calculated according to the binary Logistic regression and principal analysis.

Different from the existing literature using ST, in terms of the default risk value of the company, Z value does not only has high accurate value, but also has advantages in accurate prediction, which effectively complements and improves the research of existing supply chain finance. Some studies on supply chain finance that have emerged abroad in recent years are representative of them. Ying Chen expounded the financial innovation service products—the basic mode of supply chain finance, and discussed the risk of supply chain finance. He used fuzzy ordered regression support vector machine to analyze the supply chain financial risk under the risk assessment index system. The results showed that it is effective and can be further improved in the future[1]. Chang Xingjian *et al.* did research on supply chain finance industry in China, introduced common financial products, and pointed out the obstacles and deficiency of the development of supply chain finance in China[2]. Martin R. Fellenz *et al.* identified and discussed solutions to improving global supply chain financial challenges, based on data collected from technology and service providers[3]. Guo Zhiyuan *et al.* studied the capital of coal companies[4]. And they came out with advance payment mechanism based on the coal power supply chain financing strategy according to income uncertainty. Xiangjun He, *et al.* classified the business model of supply chain finance in China from different perspectives and analyzed relevant business models[5]. Zhigao Liao *et al.* analyzed the perfect information game and accounts receivable financing model by building game model[6]. To solve the actual operation problem of the simulated supply chain financial system, Yueliang Su *et al.* designed the supply chain financial simulation model based on Simon limited rationality rather than absolute rationality of multiple Agent simulation technology[7]. Yang Wang, *et al.* studied and analyzed a class of supply chain financial system, mainly discussing two financing methods: direct financing and supply chain financial financing[8]. Junsheng Wang, *et al.* analyzed the characteristics of supply chain finance, expounded the research and application of blockchain technology in the field of supply chain finance in recent years, and summarized and predicted the application of blockchain technology in supply chain finance[9]. The representative research on supply chain finance in China are as follows. Chen Changbin et al. analyzed various factors affecting the credit risk of supply chain finance, and screened the credit risk evaluation indicators of supply chain finance on the basis of 3C theory, and established a relevant evaluation system[3]. Fan Rippo *et al.* introduced a neural fuzzy system in the supply chain financial model and constructed a neural fuzzy model for credit risk rating for small and medium-sized Chinese enterprises[11]. Guo Ju’e *et al.* mainly used theoretical and comparative research methods to deepen the analysis of the model evolution and risk factors of online supply chain finance[12]. Yixue Li summarized the complex risks of supply chain finance into two categories, namely: systematic and non-systemic risks[13]. Based on the supply chain financial risk evaluation, an evaluation index system is established, and it uses the hierarchical analysis method in the process of supply chain financial evaluation. Shao Xian proposed a new model of developing agricultural supply chain finance with the central wholesale market in the “vegetable basket” project as the core, and explained the Mawangdui Vegetable Wholesale Market as an example[14]. Jianping Tu *et al.* started from the background and significance of supply chain financing on the e-commerce platform, compared and analyzed the different four supply chain financial models and traditional financing modes under the e-commerce platform[15]. Xiong Xiong, *et al.* studied the credit risk evaluation in the supply chain financial model and proposed a credit risk assessment system considering debt rating and subject rating[16]. Weibin Zhang *et al.* focused on the mitigation role of supply chain finance in the financing constraint development of small and medium-sized enterprises from the perspective of cash-cash flow sensitivity[17]. Lida Zhang *et al.* provided theoretical and method support for the accounting processing of supply chain financial business and micro perspective support for the construction of supply chain financial content system[18]. Based on the analysis of the relationship between supply chain finance and industrial symbiosis, Jingfeng Zhang et al. put forward relevant suggestions and measures to establish the situation of supply chain finance in China, believing that industrial symbiosis not only puts requirements for supply chain finance, but also provides a foundation for the operation and development of supply chain finance[19].

Although the research on supply chain finance has been conducted at home and abroad has been sufficient, most of the research still focuses on the research of supply chain financial model. From the perspective of agricultural supply chain financial listed companies as the starting point of research, the research in this paper is the effective supplement and improvement of the research in this aspect. The structural arrangement of this paper is as follows: the first part introduces the financing mode of agricultural supply chain finance; the second part identifies and measures the risk of agricultural supply chain finance; the third part solves and analyzes the theoretical model; and finally is the conclusion.

**2. Agricultural supply chain financial financing model**

The development of agricultural supply chain financial business in China mainly includes: warehouse receipt pledge financing, repurchase agreement, guarantee agent and reverse guarantee payment agent, as follows:

**2.1 Warehouse receipt pledge financing**

In the warehouse receipt pledge financing model, the financing enterprises do not need to provide the corresponding credit record of the bank, only need to evaluate the value of the collateral after realization, and use it as the primary source of payment after financing[20]. Therefore, the success of bank lending primarily considers the liquidity of mortgage assets.

**2.2** **Repurchase agreement**

Through a repurchase agreement, commercial banks do not provide warehouse receipt mortgage services, instead, commercial banks purchase agricultural products Nash equilibrium was reached directly from farmers and negotiate with farmers into an early purchase agreement, which is clearly stated in the repurchase agreement, at a certain price reached in the agreement or to sell a specific amount of produce exclusively to farmers at the then market price in the future transaction[21].

**2.3 Factoring**

Factoring refers to the receivables directly transferred from the upstream provider of the bank when the upstream provider sells agricultural products to the downstream enterprise. Provide funding and other additional financial services to upstream providers after bank review.

**2.4 Reverse factoring**

Reverse factoring refers to high-quality core enterprises and banks that sign contract agreements on the supply chain and perform factoring financing services to relevant farmers in the supply chain.

**3. Identification and measurement of the financial credit risk in the agricultural supply chain**

Design of the financial credit risk assessment index system of the agricultural supply chain: this paper draws from previous results and combines the business characteristics of agricultural supply chain finance itself, 15 index variables are used to build an agricultural supply chain financial risk assessment index system, specific indicators include:

**3.1 Profitability**

Profitability refers to the profitability of an individual business, also known as the value appreciation of a company’s capital, usually showing the level of profitability of a company within a given period[22]. The indicators selected in this article are: return on net assets, net interest rate of total assets, gross sales margin and net sales rate.

**3.2 Solvency**

Solvency refers to a company’s ability to use its assets to cover long and short-term debts, and the ability of a company to provide cash or repay debts is key to a company’s survival and development. The indicators selected in this paper are: flow ratio, speed movement ratio, cash ratio, and asset-liability ratio.

**3.3 Growth capacity**

Growth ability reflects the future development prospects of an enterprise. The selection of indicators include: year-on-year growth rate of operating profit, year-on-year growth rate of income per share, and year-on-year growth rate of operating income.

**3.4 Operating capability**

Operational capability refers to the size of the role in the realization of financial objectives by building on the external market environment and combining the allocation and restructuring of internal human resources and means of production. The selection of indicators in this article includes: current asset turnover rate, total assets turnover rate, inventory turnover rate and accounts receivable turnover rate.

**Table 1** is the financial risk assessment index of agricultural supply chain based on financial indicators used in this paper.

**Table 1.** Financial risk assessment indicators of the agricultural supply chain

|  |  |  |
| --- | --- | --- |
| **Primary indicators** | **Secondary indicators** | **Third-level indicators** |
| Financial indicators | Profitability | Return on equityTotal assets net interest rate Gross margin on salesNet profit margin on sales |
| Growth capacity | The year-on-year growth rate of earnings per share year-on-year growth rateYear-on-year growth rate of operating profit |
| Operating capacity | Accounts receivable turnover rateInventory turnover rateTotal assets turnover rateCurrent assets turnover rate |
| Solvency | Current rate Quick moving ratio Cash ratioAsset-liability ratio |

**4. Logistic model analysis of financial credit risk in agricultural supply chain**

**4.1 Establish Logistic regression model**

The Logistic model assumes that the enterprise compliance probability obeys Logistic distribution, and a series of Xk, k = n is set in the supply chain financial credit risk assessment index system as independent variables. By establishing the Logistic regression model, compliance probability P, of the company has only two values in the dependent variables Y, 0 and 1, where 1 is compliance and 0 is default. Set the risk tolerance standard of agricultural supply chain financial companies according to the risk tolerance P\*, P and P\* to determine whether the cooperative enterprise compliance probability has reached the cooperation standard.

The Logistic model can be represented as: assume that there are k factors affecting values of Y, and these factors are respectively X1,X2,…,Xk, then there is:



And the k factors X1, X2, …, Xk are the argument of the Logistic model, so the Logistic regression model can be presented as:



Here, B0, B1, …, Bk are the unknown parameter to be estimated, and the above formula can be shortened as following:



By finishing the above formula, the enterprise compliance probability P can be obtained



The Logistic equation is an additional function with the range of (0-1) and the closer the P value, the better the company credit. Otherwise, the worse the credit would be.

**4.2 Analysis of main components**

Logistic regression analysis is sensitive to the multi-dimensional correlation of independent variables in the model. In this paper, the financial data of listed companies are from Wande Information, and the selected indicators have high correlation. When Logistic regression analysis is used, multiple colinearity problems will arise in the evaluation equation. Therefore, it is necessary to select representative independent variables by PCA method and then calculate the compliance rate to the Logistic regression model. **Table 2** is a descriptive statistics of the original data with spss software, including mean value, standard deviation, minimum value and maxima.

**Table 2.** Describe the statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Minimum | Max | Mean value | Deviation |
| X1 | 111 | -65.58 | 27.45 | 1.5587 | 16.56732 |
| X2 | 111 | -33 | 14 | 1.71 | 7.72 |
| X3 | 111 | -7 | 79 | 21.34 | 15.638 |
| X4 | 111 | -1436 | 450 | -4.94 | 144.769 |
| X5 | 111 | -4518 | 900 | -133.16 | 689.003 |
| X6 | 111 | -91 | 248 | 3.95 | 38.717 |
| X7 | 111 | -2611 | 1751 | -15.56 | 386.165 |
| X8 | 111 | 3 | 3932 | 67.69 | 377.686 |
| X9 | 111 | 1 | 22 | 3.77 | 3.361 |
| X10 | 111 | 0 | 2 | 0.57 | 0.36 |
| X11 | 111 | 0 | 4 | 1.25 | 0.837 |
| X12 | 111 | 0 | 27 | 2.7 | 4.169 |
| X13 | 111 | 0 | 23 | 1.95 | 3.398 |
| X14 | 111 | 0 | 6 | 0.77 | 0.982 |
| X15 | 111 | 3 | 93 | 39.72 | 19.337 |
| Valid N | 111 |  |  |  |  |

In **Table 3**, the value of the spherical test x2 is 1187.7 (degrees of freedom are 105) to a significant level, so the original hypothesis is rejected. The Sig value is less than 0.05, indicating that there are common factors in the total correlation matrix, suitable for factor analysis. The test results in Table 3 that KMO=0.572> 0.5 is suitable for factor analysis. The spherical test Sig value of Bartlett is 0.000 less than 0.05, indicating a strong correlation of various financial indicators and suitable for factor analysis. Table 3 Inspection of KMO and Bartlett is 0.000 less than 0.05, indicating a strong correlation of various financial indicators and suitable for factor analysis.

**Table 3.** Inspection of KMO and Bartlett

|  |  |
| --- | --- |
| **Sample a sufficient Kaiser-Meyer-Olkin measure** | .572 |
| Spherical test of the Bartlett | Approximation of the carddfSig. | 1187.700105.000 |

In fact, the previous variable correlation coefficient indicates multiple collinearity. This test is to further investigate the partial correlation between the variables, and the value is between 0–1. If it reaches 0.5 and above, the main component analysis method can be used, where the value is 0.572, indicating that the sample is suitable for the main component analysis.

**Table 4** explains the variance statistics of the main component, and it can be seen that the eigenvalue of the first 5 components accounts for 75.295% of the total variance, and the contribution of the subsequent eigenvalue is getting smaller and smaller. In general, the eigenvalue greater than 1 is selected as the extraction condition of the main component. According to this standard, 5 main components are obtained with the eigenvalues, and they respectively are 4.036, 2.965, 2.056, 1.217, 1.021.

Through the gravelly diagram, we can intuitively observe the size of each eigenvalue, where the horizontal line with eigenvalues 1 indicates the cut-off points of composition analysis needing to be retained while emphasizing the unimportance of component 6–16 in this case.

**Table 4.** Main component interpretation variance statistics

|  |  |  |
| --- | --- | --- |
| **Composition** | **Initial** **eigenvalue** | **Extract the square and the load** |
| Total | The % ofthe variance | Accumulating% | Total | The % ofthe variance | Accumulating % |
| 1 | 4.036 | 26.907 | 26.907 | 4.036 | 26.907 | 26.907 |
| 2 | 2.965 | 19.765 | 46.672 | 2.965 | 19.765 | 46.672 |
| 3 | 2.056 | 13.705 | 60.377 | 2.056 | 13.705 | 60.377 |
| 4 | 1.217 | 8.111 | 68.488 | 1.217 | 8.111 | 68.488 |
| 5 | 1.021 | 6.807 | 75.295 | 1.021 | 6.807 | 75.295 |
| 6 | 0.868 | 5.786 | 81.081 |  |  |  |
| 7 | 0.74 | 4.932 | 86.014 |  |  |  |
| 8 | 0.561 | 3.741 | 89.755 |  |  |  |
| 9 | 0.48 | 3.202 | 92.957 |  |  |  |
| 10 | 0.313 | 2.087 | 95.044 |  |  |  |
| 11 | 0.265 | 1.768 | 96.812 |  |  |  |
| 12 | 0.233 | 1.552 | 98.364 |  |  |  |
| 13 | 0.195 | 1.297 | 99.661 |  |  |  |
| 14 | 0.035 | 0.23 | 99.892 |  |  |  |
| 15 | 0.016 | 0.108 | 100 |  |  |  |



**Figure 1.** The gravel diagram.

Based on the five main components extracted from the table of main component interpreting variance statistical, the five main components are named F1, F2, F3, F4 and F5. Main component scores are calculated from the main component coefficient score matrix, and the following linear relations are obtained:

F1 = 0.157X1 + 0.16X2 + 0.117X3 + 0.079X4 + 0.138X5 + 0.001X6 + 0.134X7 + 0.064X8 - 0.058X9 - 0.087X10 - 0.115X11 + 0.168X12 + 0.172X13 + 0.156X14 - 0.173X15

F2 = 0.204X1 + 0.212X2 + 0.045X3 + 0.157X4 + 0.193X5 + 0.086X6 + 0.184X7 - 0.132X8 + 0.019X9 + 0.106X10 + 0.102X11 - 0.197X12 - 0.192X13 - 0.152X14 + 0.084X15

F3 = 0.013X1 + 0.049X2 - 0.141X3 + 0.118X4 - 0.011X5 + 0.134X6 - 0.037X7 + 0.147X8 + 0.341X9 + 0.341X10 - 0.329X11 + 0.169X12 + 0.165X13 + 0.1X14 - 0.053X15

F4 = -0.192X1 - 0.186X2 - 0.441X3 + 0.273X4 + 0.205X5 + 0.197X6 + 0.336X7 + 0.399X8 - 0.094X9 - 0.154X10 - 0.168X11 + 0.055X12 + 0.009X13 - 0.126X14 + 0.22X15

F5 = 0.076X1 + 0.12X2 + 0.337X3 - 0.06X4 - 0.212X5 + 0.654X6 - 0.225X7 + 0.225X8 - 0.397X9 + 0.091X10 + 0.041X11 + 0.104X12 + 0.063X13 - 0.129X14 + 0.233X15

**Table 5.** Composition score coefficient matrix

|  |  |
| --- | --- |
|  | **Composition** |
| 1 | 2 | 3 | 4 | 5 |
| X1 | .157 | .204 | .013 | -.192 | .076 |
| X2 | .160 | .212 | .049 | -.186 | .120 |
| X3 | .117 | .045 | -.141 | -.441 | .337 |
| X4 | .079 | .157 | .118 | .273 | -.060 |
| X5 | .138 | .193 | -.011 | .205 | -.212 |
| X6 | -.001 | .086 | .134 | .197 | .654 |
| X7 | .134 | .184 | -.037 | .336 | -.225 |
| X8 | .064 | -.132 | .147 | .399 | .255 |
| X9 | -.058 | .019 | .341 | -.094 | -.397 |
| X10 | -.087 | .106 | .341 | -.154 | .091 |
| X11 | -.115 | .102 | .329 | -.168 | .041 |
| X12 | .168 | -.197 | .169 | .055 | .104 |
| X13 | .172 | -.192 | .165 | .009 | .063 |
| X14 | .156 | -.152 | .100 | -.126 | -.129 |
| X15 | -.173 | .084 | -.053 | .220 | .233 |

In the expression of the first main component, the 12th, 13th, 14th and 15th of the indicators are larger, and these four indicators play the main role. We can regard the first main component as a comprehensive index reflecting the flow ratio, quick ratio, cash ratio and asset-liability ratio of the listed company.

In the second main component, the first and second indicators have a great influence, so the second main component can be regarded as a comprehensive index reflecting the profitability of the listed company and represented by the return on net assets and the net interest rate of total assets.

In the third main component, the ninth, tenth and eleventh indicators are greater than the remaining indicators, which can be regarded as a comprehensive index reflecting the operating capacity of the listed company and affected by the influence of inventory turnover, the turnover rate of total assets and current assets turnover.

In the fourth main component, the third and fourth indicators have a great influence, which can be regarded as a comprehensive index reflecting the profitability of listed companies and affected by the sales gross profit margin and the net sales interest rate.

In the fifth main component, the third, sixth, seventh and ninth indicators have a great influence. Therefore, the fifth main component can be regarded as a comprehensive index reflecting the growth ability of the listed company and expressed by the year-on-year growth rate and the year-on-year growth rate of operating profit.

Z is the critical value commonly used in the model to determine the financial risk and default risk of enterprises. Z is less than 1.81, the financial risk is serious and the possibility of betraying the contract and bankruptcy is extremely high; when Z is greater than 1.81 and less than 2.675, the financial condition of the company is unclear and its operation is unstable; when Z is above 2.675, the financial condition is relatively healthy and the possibility of default and bankruptcy is minimal. This paper use critical value Z to define the size of enterprise business credit risk, which not only has higher accuracy but also has advantages in specific predictions compared to general studies with ST defining enterprises’ default. Besides, ST suffered two consecutive years’ loss, which can not reflect the situation that when a company has a deficit in its first year, its business credit risk increases, which can be overcome with Z to determine the size of the company’s credit risk.

Based on the sample company value, this paper divides the sample company into two types- one is of high business credit risk and the is of low business credit risk. According to the characteristics of the manufacturing industry, Z of 2.675 is the critical value of enterprise risk, and when a company’s Z > 2.675 (1), the company’s business credit risk is considered low and less likely to default. When a company’s Z <2.675 (0), it is considered that the company has a high business credit risk and a greater probability of default.

By the relevant expression obtained from the main component analysis, we can calculate the value of F1, F2, F3, F4, F5 in each sample enterprise, and compare and analyze them with the Y value of enterprises. Y of default enterprise is 0, and the Y of the non-default enterprise is 1. Logistic model regression analysis is done with statistical software. In order to obtain the impact of F1, F2, F3, F4, F5 on supply chain financial risk, the method is to remove backward and gradually backward.

**4.3 Model regression analysis**

**Table 6** is the basic information data sheet that gives the data into model. The total 111 unweighted sample cases shown in the table were filtered as Logistic regression, and 0 for missing and unselected cases.

**Table 6.** Summary of case processing

|  |  |  |
| --- | --- | --- |
| **Unweighted casesa** | **N** | **Percentage** |
| Selected cases | Cases included in the analysisMissing casesTotal  | 1110111 | 1000100 |
| Unselected cases | 0 | 0 |
| Total | 111 | 100 |

**Table 7** is the assignment table of dependent variables and in SPSS the default assignment in the binary variable is 1. From the table, assign No Default to 1 and Default to 0.

**Table 7.** The factor variable encoding

|  |  |
| --- | --- |
| **Initial value** | **Inner value** |
| Default | 0 |
| No default  | 1 |

**Table 8** is the initial model classification prediction table, where the model does not contain any independent variables and only constant items. The left of the table represents the actual observations and the right represents the predicted value and accuracy of the model. At this time, all listed companies do not default, the predicted correct rate of 71.2%.

**Table 8.** Initial model classification prediction

|  |  |  |
| --- | --- | --- |
|  | **Observed** | **Predicted** |
| Y | Percentage correction |
| Default | No default |
| Step 0 | Y | Default No default | 00 | 3279 | 0100 |
| Total percentage |  |  | 71.2 |

From **Table 9** we can see the way of original model coefficient being assigned value. First, only the constant term is assigned value, and the result is B = 0.904, the standard error is SE = 0.21, the OR of Sig. = 0 is Exp (B) = 2.469, having reached significant levels.

**Table 9.** Inspection results of the model parameters

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | B | S.E | Wals | df | Sig | Exp(B) |
| Step 0 | Constant (quantity) | 0.904 | 0.21 | 18.6 | 1 | 0 | 2.469 |

**Table 10** summarizes the results of the correlation tests between the dependent and independent variables. The iterative results of the final Cox&Snell R and Nayelkerke R values are 0.519 and 0.742 respectively, which indicates a moderate correlation in the field of 5 principal variables and agricultural supply chain financial risk. Combined with the model summary table and the comprehensive inspection table of the model coefficient, in the backward elimination method of eliminating the variables from the Wald test results, the card square value is gradually smaller, and most of the Sig values are small, indicating that the model is more significant.

**Table 10.** Model Summary

|  |  |  |  |
| --- | --- | --- | --- |
| **Step**  | **-2 The log likelihood value** | **Square of Cox & Snell R**  | **Square of Nagelkerke R** |
| 123456789 10 11 | 42.851a 43.129a 43.816a 45.165b 45.805b 46.578b 47.222b 48.391b 49.865b 51.837c 52.069b | 0.557 0.556 0.554 0.548 0.546 0.542 0.54 0.535 0.529 0.52 0.519 | 0.797 0.796 0.792 0.784 0.78 0.776 0.772 0.765 0.756 0.744 0.742 |

**Table 11** shows the fitting test results of total model regression. By method of Hosmer-Lemeshow test, df = 8, Hosmer-Lemeshow test card square value 4.545 <15.507 (critical value of card square test), we passed the test. The final P is 0.805, which is much larger than 0.05 and does not reach a significant level, indicating that the overall good fitness of the independent regression and the independent variable’ s good prediction of the dependent variables.

**Table 11.** The Hosmer and Lemeshow tests

|  |  |  |  |
| --- | --- | --- | --- |
| **Step 1** | **Card-up side** | **df** | **Sig.** |
| 1 | 4.27 | 8 | 0.832 |
| 2 | 8.057 | 8 | 0.428 |
| 3 | 3.741 | 8 | 0.88 |
| 4 | 5.014 | 8 | 0.756 |
| 5 | 7.485 | 8 | 0.485 |
| 6 | 7.458 | 8 | 0.488 |
| 7 | 7.028 | 8 | 0.534 |
| 8 | 6.995 | 8 | 0.537 |
| 9 | 8.389 | 8 | 0.396 |
| 10 | 4.69 | 8 | 0.79 |

Through iterative regression, the data of step 11 is selected and X1, X2, X4, X7, X15 of **Table 12** showed in the regression equation is retained. The significant levels of these 5 variables are below 5% except X7, so the relevant variables pass the test and the estimated regression model is as follows:

In$\frac{p}{1−p} $= 16.661 + 0.717X1 - 1.566X2 + 0.013X4 + 0.004X7 - 0.32X15

 (1)

In formula (1), P represents the probability of the enterprise’ s compliance , so the closer P is to 1, the greater the compliance probability of the financing enterprise is; and the closer the P is to 0, the smaller the compliance probability of the financing enterprise is. Therefore, the P predicted by enterprises can be used as an important reference for banks to provide financing services to financing companies.

**Table 12.** Variables in the equation

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **B** | **S.E** | **Wals** | **df** | **Sig.** | **Exp (B)** | **EXP (B)’s** | **95% C.I.** |
| Lowerlimit | Upper limit |
|  | X1 | 0.717 | 0.26 | 7.597 | 1 | 0.006 | 2.047 | 1.23 | 3.408 |
| Step11a | X2X4X7X15Constant quantity | -1.5660.0130.004-0.32 16.661 | 0.5520.0060.0030.084 4.283 | 8.054.4423.03214.539 15.131 | 11111 | 0.0050.0350.08200 | 0.2091.0131.0040.726 17211689.01 | 0.0711.0010.9990.616 | 0.6161.0251.0090.856 |

**5. Model example verification**

Taking the company 1 in the sample as an example, P = 0.52288% of enterprise 1 indicates that the probability of enterprises’ compliance 1 is very low. Banks had better not provide financing services for the sample company 1, and they can obtain the P of the remaining 110 samples in the sample.

According to **Table 13**, in the sample of 32 default enterprises observed in this paper, through empirical model analysis, the accuracy rate of 24 predicted default enterprises is 75%. While for the observed 79 non-default enterprises, 73 were predicted via model prediction , so the accuracy rate is 92.4%. While the overall prediction accuracy of this model is 87.4%.It can be seen that the obtained Logistic regression model has a high accuracy for the prediction of financial risk in the agricultural supply chain.

**Table 13.** Classification table

|  |  |  |
| --- | --- | --- |
|  | Observed | Predicted |
| Y | The correction of the percentage  |
| 0 | 1 |
| Step 11 | Y | 01 | 246 | 873 | 7592.4 |
| Total percentage |  |  | 87.4 |

**6. Conclusion**

This paper discusses the background and status of China’s agricultural supply chain finance, and understands that the main obstacles to the development of agricultural supply chain finance come from difficulties in financing and in the evaluation and management of commercial banks and listed companies of credit risk. In order to solve this problem and to change the difficult financing situation in the agricultural supply chain finance field, it is very important to improve the credit management of the financing institutions to the listed agricultural enterprises.

For the selection of model indicators, this paper i based on the principles of comprehensiveness, conciseness and operability, and on considering the influence of market macroscopic factors to enhance the accuracy of model prediction on the basis of ensuring that the model information is rich and easy to explain practical problems. From many indicators involving commercial credit risk, 15 indicators were selected to reflect the information related to the company and build a credit risk model accordingly. These 15 indicators contain information on the company’s growth, operations, solvency, and profitability.

Based on the extracted public factors, the problem of determining the SME commercial credit risk turns into calculating the SME default rate. Define such a dichotomy as a dependent variable and as a F1~F5Build a binomial Logistic regression model with software as independent variables. The gradual regression analysis uses “backward wald method” to analyze the model. The maximum likelihood ratio method is used to estimate the parameters and test is used to analyze the significance of independent variables in the model. The original indicators are used to express public factors, and after de-standardization, a model of commercial credit risk is obtained. The effectiveness of the model is tested by observing the sample data. The observations show that 0.500 of default probability value of the sample company, the accuracy of model’ s prediction of high default and low default is 75% and 92.4% respectively, and the total prediction accuracy of the regression model is 87.4%, indicating that the model has good accuracy for predicting credit risk.

**Conflict of interest**

The authors declare that they have no conflict of interest.

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