AMSE JOURNALS-2017-Series: Modelling D; Vol. 37; N°1; pp 53-64
Submitted Dec. 2016; Revised March 4, 2017, Accepted March 25, 2017

Small Micro Enterprise Credit Assessment

Chen.W[1*], Duan.Y[1], Hu.G[2], Mao.Y[1]

1. Dept of Basic science Guangdong University of science and technology
Dongguan, Guangdong, China,(627478341@qq.com)*.
2. The Library, Guangdong University of science and technology
Dongguan, Guangdong, China

Abstract:

How to evaluate the small micro enterprise credit, many scholars at home and abroad are explore and researching, but are widespread evaluation index and evaluation efficiency is low, and its accuracy is not high. In this paper, through the establishment of a kind of based on fuzzy set and rough set with the analytic hierarchy process (AHP) of small micro enterprise credit evaluation model, which uses the theory of fuzzy sets and rough sets reduction for the evaluation of small micro enterprise credit evaluation indexes about Jane, and with the analytic hierarchy process (AHP), the quantitative relations between the weight of every index. So as to establish a more scientific and reasonable small micro enterprise credit evaluation system. Finally this system was applied to practical analysis and evaluation in application analysis data and real data comparison, the experimental results show that the model is convenient, fast and of high precision, can be well be used in small micro enterprise credit assessment.

Keywords:

Fuzzy sets; AHP; Credit evaluation; Reduction

1. The exordium

With China's social and economic system reform and development, the past planned economy has now been completely change, already the main fully into the market economy as the main body. Market economic system is a kind of economic system established under the condition of credit and credit. The more perfect a social credit the better, its economic operation condition, the better. If the rules of the social credit is damaged, it will affect the whole market economic order which will leads to a series of social problems. In 2008, for example, the US subprime mortgage crisis triggered a global financial crisis, and today the world economy is still in recession. It is obvious that the credit problem has become one of the very important factor for the development of world economy. Effective for small micro enterprise credit assessment, has been at home and abroad committed to solve this social problem by

many research institutions and it is in today's society an important research topic in economic field. The main research method is by using the method of statistical forecast analysis, according to the data already know, and through the statistics of packet classification, establish discriminant method, and on the basis of the use of statistical inference method to carry out the scientific prediction. Prediction of the most common statistical model are: (nonlinear) linear regression analysis, multivariate discriminant analysis, logistic regression analysis, the genetic algorithm and neural network algorithm and other methods. However, these methods are deadly not promote, adopted in statistical analysis of performance indicators, processed efficiency is low, too much accuracy is not high question [1,2].

At first, this paper puts forward to establish the basic principles of small micro enterprise credit evaluation system, the small micro enterprise credit evaluation was established based on the principle of initial evaluation system model, and on the basis of some, using the theory of rough set and AHP to simplify the simplification of the initial evaluation system, calculation method, analytic hierarchy process (AHP) are studied by using correlation coefficient of variation method, find out the dependence of high small micro enterprise credit financial indicators calculation analysis and screening, construct the small micro enterprise credit evaluation system. Finally the experiment selected the 100 ST companies before and ST data and data analysis of 100 non ST companies, will evaluate data comparing with real data. Experimental results show that the evaluation method is convenient, quick, high efficiency and high accuracy.

2. The theory preparation (rough set and the concept of the AHP model)

2.1. The relative concepts of rough set

Definition 1. Rough set

Polish scholar Z. Pawlak in 1982 proposed the theory of rough set, it is a kind of incompleteness and uncertainty of mathematical tools, and can effectively analyze imprecise, inconsistent, the inconsistent, incomplete (incomplete) and incomplete information, analyze the data, and reasoning, discover the implicit knowledge, reveal the potential regularity. Rough set theory, the theory of probability, fuzzy set and evidence theory and a mathematical tool of dealing with the uncertainty.

Definition 2. RS is approximation and lower approximation

In RS introduce two concepts: one is the lower approximation set, another is upper approximation set. Refers to the lower approximation set when a collection cannot be appropriately classified using effective equivalence relation, can be pushed through the other set to achieve the set of approximation. On those with X be understood as a set of equivalence relation and set.

$$\underline{R} = \left\{ x \middle| (\forall x \in U) \Lambda ([X]_R \subseteq X) \right\}$$

$$\overline{R} = \left\{ x \middle| (\forall x \in U) \Lambda [X]_R \cap X \neq \varphi \right\}$$

Where X ⊆ U, R is an equivalence relation, which is established on the U. Collection of bnR (x) = $\bar{R}$ (x) - $\underline{R}$ (x),R boundary line called X， PosR (x) =$\underline{R}$ (x) is called , R postive domain called X, negR(x)=$U - \bar{R}$(x) R negative domain called X.Obviously

$$\bar{R}(x) = \text{pos}\, R(x) \cup \text{bnR(x)}$$

Definition 3. The reduction of knowledge

For knowledge by selecting, sorting and refining, eliminate interference information, delete the redundant and repetitive information, maintain information system under the condition of invariable classification, use is easy to understand and accept the knowledge representation mode, so as to make the information more unobstructed[3,4].

This is knowledge reduction, it includes attributes reduction of form, content, reduction and reduction of these methods. Knowledge reduction is to have integrity, conciseness, orderliness, sharing and dynamic knowledge system. In rough set, think the knowledge in the knowledge base (attributes) is not equally important, and even that some of the knowledge is redundant.

The two relevant concepts of knowledge reduction: reduction (reduct) and the nucleus (core).

Assuming that there is an equivalence relation in the knowledge base R={P,Q},so, what's the intersection will constitute an equivalence relation, namely, $P \bigcap Q$ is also a kind of equivalence relation, and can be thought of as R on indiscernibility of equivalence relation, or are they belong to one equivalence class, remember to ind (R).Q and P is the domain for the following formula: $pos_p = \bigcup_{X \in U/Q} \underline{P(X)}$

Setting up an equivalence relation to S, and with U is divided into the U/S， If $pos_{(R-P)}(S) \neq pos_R(S),$ then relation R is not the default properties, called P and R is a reduction called attribute P. So the intersection of reduction set of P is are called P and written be Core(P)= ∩ red(P) .

Definition 4.Knowledge dependence and independence

In a given knowledge base K = (U, S), if the $\forall P, Q \in IND(K)$, then let:

$$\gamma_{\text{p}}(\text{Q})=\text{m}=\text{card}(\text{pos}_{\text{p}}(\text{Q}))/\text{card}(\text{U})$$

Where, $\gamma_{\text{p}}(\text{Q})$ knowledge system Q relative to the importance degree of P and card is collection base operator. If m = 1, then argues that Q is totally dependent on P, if m ∈ (0, 1),the Q part depend on the P. If m = 0, argues that Q is not dependent on the P.

Definition 5. Importance of knowledge

To express to the importance of the knowledge or property removed. After certain attributes, have to be removed, the partition on the domain U is changed and the attributes or "knowledge" are important to knowledge base.

For a given knowledge base K = {U, Q, V, f}, $\forall P \subseteq Q$ and $\alpha \in P$, its importance is:

$$Sig(\alpha, P, Q) = \gamma_{C \cup \{\alpha\}}(Q) - \gamma_C(Q);$$

In the formula, if the greater the Sig then affect c divided, the more important. If Sig = 0, shows a set of properties for the division of c will not change, so this attribute can be dropped from the knowledge base of attribute group.

Definition 6. Analytic Hierarchy Process (AHP)

AHP (Analytic Hierarchy Process, the AHP for short) is the elements related to the which decision is always broken down into objectives, principles, scheme, such as level, on the basis of the decision-making methods of qualitative and quantitative analysis. This method is the operational research of Sadie a professor at the university of Pittsburgh in the early 1970 s.

3. The small micro enterprise credit risk assessment model

3.1. The small micro enterprise credit evaluation index selection principle

At present, some financial institutions and credit rating agencies small micro enterprise, have net unified evaluation standard, and relevant departments also does not have to provide the reference standard, there is no consensus of evaluation standard. The Banks and financial institutions or credit rating agency for small micro enterprise credit risk evaluation is an important factor of credit rating index selection. In theory should be through a set of scientific credit evaluation index system, to accurately reflect the small micro enterprise credit condition, but the real operation of small micro enterprise credit evaluation has the certain difficulty. On the one hand, many factors affect small micro enterprise credit risk, is difficult to include all the factors, on the other hand, there may be a correlation evaluation of small micro enterprise credit conditions, are difficult to be excluded. Therefore, in building a small micro enterprise credit evaluation index system, we must according to the characteristics of small micro enterprises, and certain principles to be selected indicators. The main principle is as follows:

1). The principle of scientific and comprehensive

A set of scientific, comprehensive credit evaluation system for any type of small micro enterprise is very important. The indicators chosen must cooperate in order to avoid similar or overlapping indicators, which can't explain the content of the contradiction. Therefore, it is necessary to accurately grasp the meaning of each index in the index system of construction, according to the objective facts, objectively reflect the characteristics of the object recognition and measurement index system. Selection of index system should be accurately to cover all the influence factors of small micro enterprise credit conditions chosen amount should not be much but not too little. In order to avoid the content is not comprehensive, between similar this kind

of situation. This requires index choice must be scientific and comprehensive selection principles.

2). The principle of pertinence

Different evaluation subjects, often need to use the different purposes of the evaluation index system and evaluation methods. Because characteristics of small micro enterprise have itself different characteristics, so we must set up the index system, according to the actual situation, combined with the characteristics of small micro enterprises, adjust some indicators, establish a targeted credit evaluation index system[5,6].

3). Dynamic continuity principle

The development of small micro enterprises has the characteristics of the dynamic development and continuous improvement. As a result, the index system of index selection in building to reflect the small micro enterprise capital, technology and management and other aspects of the status quo and trend and potential, and select index also should keep dynamic index and static index, and must be able to reveal the inherent law of enterprise development. And the static and dynamic performance index respectively predict the development of small micro enterprise prospect, development status and level, so we chose to keep the dynamic and static index indicators[7].

4) Operability principles

Establishing index system is necessary to select a representative sample of comprehensive index, and must be operability index, the choice of indicators cannot too much, that will make the evaluation process is too complicated, whose actual operation will have a certain degree of difficulty. The choice of indicator can't too little which can lead to more one-sided ratings that cannot fully reflect the small micro enterprise credit standing.

5) The combination of qualitative and quantitative principles

Qualitative analysis is mainly based on human judgment. We often think, qualitative analysis is more convincing, more accurately reflect the characteristics of the object. But in order to make comprehensive analysis, qualitative analysis must be conducted. Qualitative analysis and quantitative analysis is unified, complement each other. Qualitative analysis is the premise of quantitative analysis. Therefore, only through the combination of qualitative analysis and quantitative analysis, the scientific and satisfactory results can be obtained.

3.2 The small micro enterprise credit evaluation of the initial evaluation index system

Small micro enterprise financial situation in a certain period of time reflects in financial financing and application status, and fully reflects the small micro enterprise business activity[8,9].It is a measure of small micro enterprise credit risk assessment and is an important factor. According to the experience of many scholars, according

to the small micro enterprise performance evaluation index system and evaluation index system of bank credit, combined with the characteristics of small micro enterprises, follow the system, scientific, objectivity, comparability and operability requirements, from the debt paying ability, operation ability, profit ability in seven aspects to establish the initial index system made up of 27 initial indicators. As shown in table 1.

	Level indicators	The secondary indicators	Variables identify
Small micro enterprise credit evaluation index system of the initial	Debt paying ability	Assets and liabilities ratio	X1
		Equity ratio	X2
		Cash flow ratio	X3
		Quick ratio	X4
		Current ratio	X5
	Profitability	Operating profit margin	X6
		The cost profit margins	X7
		Return on total assets	X8
		Return on equity	X9
	Ability to operate	Inventory turnover	X10
		Manager quality	X11
		Industry status	X12
		Accounts receivable turnover	X13
		Current assets turnover	X14
		Total asset turnover	X15
	Technology innovation ability	R&d investment ratio	X16
		Application has number of invention patents	X17
		Product innovation	X18
		Advanced technology products	X19
	Growth ability	Net profit growth	X20
		Total assets growth rate	X21
		Main business revenue growth	X22
		Net asset growth	X23
	Market prospect	Industrial policy	X24
		Market competitiveness	X25
	The regional economic Development level	Per capita GDP	X26
		Regional GDP growth	X27

Tab. 1 Initial credit evaluation index system

Index explanation is as follows:

1) Solvency (debt - paying ability) refers to the small micro enterprise with its assets to repay the long-term debt and short-term debt ability. Enterprise for cash payment ability and the ability to repay its debt, is the key to the healthy survival and development. Enterprise debt paying abilitys reflect an important symbol of the enterprise financial position and operating ability. Debt paying ability is to repay the debts of the enterprise bear ability or ensure degree, including the ability to repay the short-term debt and long-term debt. Companies often because there is no money outstanding debt ability lead to credit risk, the credit crisis.

2) The operating capacity refers to the enterprise the management operation ability, namely the enterprise ability uses the assets to make a profit. Enterprise operation ability of financial analysis ratios is: inventory turnover, accounts receivable turnover, operating cycle, current assets turnover and total asset turnover, etc. Small micro enterprise capital operation reflects the capital use of efficiency and ability. The faster the turnover of capital, the higher the efficiency capital use of the better the results higher, the ability to repay debt and credit.

3) Profitability refers the enterprise profit ability, also known as enterprise funds or capital appreciation ability, usually for a certain period of time business income amount of how many and its level of high and low. Profitability indicators including the operating profit margin, cost, profit margin, surplus cash cover, return on total assets, return on equity and return on capital to six. The stronger the small micro enterprise profit ability, the stronger the ability of credit guarantee.

4) Technical innovation and the ability to grow

Technology innovation refers to the innovation of production technology, including the development of new technology, or the application of existing technology innovation. Technology innovation is the key of enterprise survival and development.

5) The enterprise growth ability is to show the enterprise for the future development trend and development speed, including the expansion of enterprise scale, profit and an increase in owners' equity. Enterprise growth ability is as the change of market environment, enterprise assets scale, the ability of profitability, market share continue to grow, and reflects the enterprise's future development prospect.

6) The market prospect is prospects of the development of enterprises, including enterprise's current industrial policy, market competitiveness.

7) Refers to the regional economic development level of economic development in the area of a certain status, usually refers to a certain area of per capita GDP and the GDP growth rate.

3.3. The small micro enterprise credit evaluation index system reduction

1) Using correlation reduction

Correlation analysis is to research the mutual relationship between variables, and the close degree between the research variables. In other words, one of the purposes of correlation analysis, is never to judge its strict relationships between closely degree. Variable degree of closely related, we could be determined by calculating the correlation coefficient, correlation coefficient with the symbol "r" said. Formula is:

$$r = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2} \sqrt{(Y - \bar{Y})^2}}$$

The numerical range of related coefficient is:$-1 \leqslant r \leqslant 1$，as $r > 0$ is positive correlation, and as $r < 0$ is negative correlation.

Judge: |r| < 0.3, for weak correlation,

0.3 < |r| < 0.5, for low;

0.5 < |r| < 0.8, as the significant correlation;

0.8 < |r| < 1, is highly relevant;

|r| = 0, not related, |r| = 1, completely.

The evaluation index of correlation analysis basically has the following three processes:

First, the index standardization. Evaluation indexes of different dimension will affect the correctness of the analysis results, so before calculation need to standardize the original index data. Our raw data set index for Xi, standardized value of standard deviation for the Si, Zi, there are: $Z_i = \frac{X_i - \bar{X}}{S_i}$

Second, calculating the correlation coefficient:

$$r = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2} \sqrt{(Y - \bar{Y})^2}}$$

Third, the critical value, if r > M can delete evaluation index; X_i, are of the X_j .If r < M just keep these two evaluation indexes.

In the small micro enterprise credit evaluation index system (table 1), usually there will be a certain correlation between each evaluation index. This correlation will lead to small micro enterprise credit assessment information overlap, affect the objectivity of evaluation results, reduces the effectiveness of the evaluation results. Correlation analysis is to analyze the correlation of each index, delete the correlation indicators, and the small business credit evaluation result is not affected by correlation. According to the basic principles, we selected the related data of 27 evaluation index in table 1, for small micro enterprise credit evaluation index system to analyze related with spss16.0 statistical software package, to establish evaluation index correlation coefficient matrix. We determined the threshold m is 0.7, which is concluded that the correlation coefficient matrix. From the correlation coefficient, matrix is 6, the correlation coefficient of evaluation index is greater than 0.7 (table 2), we also delete the corresponding evaluation index. Finally retained 21 evaluation index.

Keep the evaluation index of Xi	The deleted evaluation index Xj	The correlation coefficient r_{ij}
Asset-liability ratio X1	Equity ratio X2	0.73
Current ratio X5	Quick ratio X4	0.95
Main business profit margins X6	Gross profit margin X7	0.85
Current assets turnover X14	Inventory turnover X10	0.79
Total asset turnover X15	Current assets turnover X14	0.76
Product technology advanced X19	Product innovation X18	0.81

Tab.2 The correlation coefficient analysis table

Specific reduction and procedures:

First step: In order to reduce the knowledge expression system to process data using the discrete classification matched, the property is divided into five categories, respectively corresponding to the five levels, each level corresponds to a belong to a range of data is defined, belong to an interval to a level number[10].

The second step: small micro enterprise financial indicators

For knowledge system $R=\{\mu_i(i=1,2,3,4,\cdots 29),D\}$, theory of condition attributes

$C=\{\mu_i,i=1,2,3,4,\cdots 29\}$,value properties for D, the theory of domain for U, with the value attribute D to the theory of domain U are divided into U / D. This article adopts the important degree of Pawlak algorithm implementation steps are as follows:

The first step in the calculation of relative D C of $CORE_D(C)$;

The second step Make B = $CORE_D(C)$, if the $\mathrm{pos}_B(D)=\mathrm{pos}_C(D)$, Then go to step 5;

The third step: $\forall c_i \in C/B$. Calculate the attribute importance:

$$sig(c_i,B)=\left|pos_{B\cup\{c_i\}}(D)\right|-\left|pos_B(D)\right|.$$

Get $C_m=\arg\max_{c_i\in C\setminus B} sig(c_i,B)$,Make $B=B\cup\{C_m\}$;

The fourth step : if $pos_{B\cup\{c_i\}}(D)\neq pos_B(D)$,Then go to step 3;

The fifth step : output B∈ REDc(D), and then implement the end.

Applying the above formula of dependent (3) and the rough set analysis program can calculate the $r_c(D)=0.955$， Therefore, it can be thought D 96% dependent on C, D values depend on C. Also, each index can be calculated on the decision attribute dependence. Table 2 lists the various indicators of decision attribute dependency.

2) Reduction method of Discrimination analysis

In actual application, flair for evaluation index, coefficient of variation is commonly used to describe: that among them, which are average standard deviation as the mean; coefficient of variation is larger, the flair of the indicators is stronger, the weaker conversely. Depending on the actual need, delete the evaluation index of coefficient of variation is relatively small, because its taste is weak[11,12].

According to the principle of using the SPSS statistics software to analysis after the first round of screening the remaining 21 indicators, after which the analysis of the variance, on the basis of the calculation of the coefficient of variation of the 21 indicators. The following table.

Variables identify	Discrimination coefficient	Variables identify	Discrimination coefficient
X1	0.51	X17	1.16
X3	2.47	X18	1.50
X5	1.16	X19	1.12
X6	1.12	X21	1.87
X8	7.13	X22	0.66
X9	5.21	X23	0.77
X11	0.46	X24	0.05
X12	0.95	X25	0.69
X13	1.61	X26	0.08
X15	0.76	X27	1.78
X16	0.73		

Tab.3 The coefficient of variation analysis table

According to the table: the quality of managers "X11",main business revenue growth rate "X22".Industrial policy "X24",and per capita "GDPX26", the four indexes variation coefficient are small, performance evaluation objects are very low score. So delete these four indicators, keep the rest of the 17 indexes constitute of the evaluation index system.

	Level indicators	The secondary indicators	Variables identify
Eventually the credit evaluation index	Profitability	Asset-liability ratio	Y1
		Cash flow ratio	Y2
		Current ratio	Y3
	Ability to operate	Main business profit margins	Y4
		Return on total assets	Y5
		Return on equity	Y6
	Technology innovation ability	Industry status	Y7
		Accounts receivable turnover	Y8
		Total asset turnover	Y9
	Growth prospects	R&d investment ratio	Y10
		Application has number of invention patents	Y11
	The regional economic development level	Net profit growth	Y12
		Market competitiveness	Y13
		Total assets growth rate	Y14
		Regional GDP growth	Y15
		Net asset growth	Y16
	The project technical level	Product technology advanced	Y17

Tab. 4. The final credit evaluation index system

Through the use of index screening method, and use of correlation analysis and discrimination analysis method, was carried out on the front set up index system of the initial reduction, remove redundant indicators, that finally it is concluded that composed of 17 indexes small micro enterprise credit evaluation index system. As shown in table 4.

4. The contrast analysis

Now select the data of 200 listed companies of a stock exchange experiment (data from the 200 listed companies of a stock exchange in 2014-2016 annual report). The experiment selected the 100 ST companies before and ST data and 100 non ST companies will evaluate data and real data comparison, if the more than 50 data directly to the list, workload is big, and we use the paper established the evaluation index system is to analyzed finally. The results obtained from this method which is compared with real market value, the result as shown in table 5.

In this paper, methods		Authenticity	To assess the accuracy	Accuracy（%）	Time（S）
2014	Not a ST company	100	96	97.50	0.53
	ST company	100	98		
2015	Not a ST company	102	100	98.50	0.56
	ST company	98	97		
2016	Not a ST company	107	103	97.85	0.54
	ST company	93	92		

Tab.5 Assessment value compared with true value table

As can be seen from the table, the three years in a row of data tracking experiment, which compared with real data, evaluation model and real data error less than 6%, in this paper and the computing time is less than 1 s.

5.Conclusion

At first, this paper puts forward the small micro enterprise credit evaluation system to establish the basic principles of small micro enterprise credit evaluation was established based on the principle of initial evaluation system model. On the basis of some, using the theory of rough set and AHP to simplify the simplification of the initial evaluation system, and USES AHP to quantify the degree of the influence of the key indicators of small micro enterprise credit, so as to establish a set of effective evaluation model. The system was applied to practice, in which choice of a stock exchange experiment data of 200 listed companies (data from 200 listed companies 2014-2016 annual report), and the experiment selected the 100 "ST" companies

before adding "ST" data and data of 100, the "ST" companies will assess data comparing with real data. Through the experiment results show that the model can well improve the computing speed and the accuracy of the operation. In small micro enterprise credit evaluation has a certain reference value and practical significance.

Reference：

[1]Duan.Y,Xiang.Y ,Comparative study of different genetic operator combination to solve TSP problem [J]. Science and technology. vol 28, No.5, 27-31, 2012.

[2] Chen.l, zhu.w，After the project evaluation in a rough set neural network modeling and simulation [J]. Journal of system simulation, vol 8, Issue 1:21. 58-61.2006

[3] Wang. J, Based on rough set and small micro enterprise credit risk evaluation model of AHP study [J]. Journal of new western (theory), vol 24, Issue1: 76-78, 2012

[4]Zhang.M，Zhou.Z, Based on rough sets and high technology enterprise credit evaluation index system of building [J] Tribune, in economic research, vol 25, Issue1: 29-41, 2010.

[5]Jiang.L, Diversified teaching evaluation index and evaluation method of analysis [J] new curriculum research (in the ten-day), 2014-02-11

[6]Kuang.S, Strategic emerging industries enterprise credit evaluation index system to build [D], Guizhou University of finance and economics, vol 4, Issue1: 28-32, 2013.

[7] Yan.H，Strategic emerging industries enterprise credit evaluation index system to build [D]. Master thesis, Guizhou University of finance and economics, vol 4, 2013

[8] Feng.C，Liang.J，Solve the more general travelling salesman problem [J]. AMSE Journals, Series Modelling D, vol 35, Issue 1, 9-23, 2014.

[9] Tang.M. Project risk assessment based on rough set neural network [J]. Market modernization, vol 29, Issue 1: 157 - 159.2008

[10] Feng.C，Liang.J，The solution of the more general traveling salesman [J]. AMSE Journals Series: Advances A, vol 51, Issue1：27-40, 2014，

[11] Ma.Y, li.B,Liu. T,Small and medium-sized high-tech enterprises growing environment evaluation system to build research [J]. Science and technology management research, 2006-03-30

[12]Duan.Y, Optimization design of the single processor scheduling algorithm in real-time system research [J]. Journal of operational research, vol 17, Issue1:1, 27-34, 2013.