



# Journal of Applied Sciences

ISSN 1812-5654

**science**  
alert

**ANSI***net*  
an open access publisher  
<http://ansinet.com>

## Chinese Micro-enterprise Credit Rating Model and Empirical Analysis

Zhang Li, Cao Shuyan and Wang Kun  
School of Information Technology and Management Engineering,  
University of International Business and Economics, Beijing, 100029, China

---

**Abstract:** Based on the existing researches on microfinance and characteristics of Chinese micro-enterprises, this paper build a micro-enterprise credit rating model by G1 method, which is a group decision assembly method. Then test the model with data of 137 micro-enterprises from Henan Province of China. The results show that the model is more reliable and accurate, which may provide a reference for micro-enterprise credit management of Chinese commercial banks.

**Key words:** Micro-enterprise, credit rating model, microfinance, G1 method

---

### INTRODUCTION

Micro-enterprise is a smaller economic organization than SMEs in the operation scale. In China micro-enterprises are generally self-employed enterprises. So its credit has distinctive features: (1) Small loan amount; (2) Short term loans and financing frequently; (3) Loan mainly for individual and private property owners and (4) Emphasis on individual effective asset-backed. On the other hand, as lenders often difficult to obtain complete, objective and verifiable information from their borrowers, micro-enterprise credit information asymmetry problem is particularly prominent. Thus researchers (Fouillet *et al.*, 2013) focus on the micro-enterprise credit rating and build scientific and effective credit rating index system by a variety of assessment methods with specific national conditions. In recent years, many Chinese banks are carrying out micro-credit businesses, such as Harbin Commercial Bank, Bank of Nanjing, Bank of Hangzhou. However, each bank is still in its exploratory stag of credit rating for the microfinance customer. There is no standard for micro-enterprises credit rating, which is usually determined based on the experience of loan officers. Therefore, index system, evaluation methods and management practices of micro-enterprise credit evaluation are worth to be further studied in China.

According to the characteristics of Chinese micro-enterprises and the existing research results, we build credit rating indicators and model using G1 method in this paper. And the performance of the model is tested by the empirical analysis.

### LITERATURE REVIEW

Loans of micro-enterprises are generally microfinance business. So scholars are more from the perspective of microfinance to research micro-enterprise credit evaluation, mainly including indicators and methods of credit evaluation research.

Credit evaluation indicators research: Some researchers list the credit evaluation indicators based on "5C" factor analysis (Character, Capacity, Capital, Collateral and Condition), "5W" factor analysis (Who, Why, When, What and How) and "5P Act" (Personal, Purpose, Payment, Protection and Perspective). According those factors, Schreiner (2000) studied the characteristics of borrowers, loans, and lenders and list the credit evaluation indicators for microfinance in the developing countries, which are predictive of repayment risk to some degree. And characteristics of borrowers are as follows: past arrears, experience as a borrower, borrower demographics, business characteristics, business and household financial data, other characteristics. Angelini (2007) pointed out a high explanatory power of microfinance credit evaluation indicators for Italian Banks, including individual characteristics, business characteristics and other characteristics, which also used in other developed countries. Baptista *et al.* (2006) use a probit model to analyze that micro-entrepreneur's age, gender, level of education and reason for becoming self-employed are more relevant for explaining the utilization of external funds. Van Gool *et al.* (2009) use two logistic regression models to observe that other debt, purpose, requested

duration, amount and beginning month, business capital, net earnings of household, household capital, cycles and year of initiation are significant to the credit scoring. Copestake (2007) found that the health status, sex, age, family labor force, household net worth of the borrowers would have an impact on the risk of microfinance. Sun and Wang (2006) pointed out that credit evaluation indicators for Chinese farmers mainly include household capital, level of education, liability status and purpose for borrowing. While Chen (2008) find that the characteristics of borrowers such as age, gender, marital status, education, dependent population, housing values??, sources of household income, household assets, average family income, credit history, the number of credit accounts, credit application status, private credit situation, judicial records case and payments to income ratio monthly are main factors that affect Chinese farmers credit. Although there are other studies about microfinance for Chinese farmers, it is short of studies for other types of micro-enterprises in China. Otherwise, from the above researches, we can know that different scholars have been led to different conclusions, and their studies are based on country-specific environment.

**Credit evaluation methods:** From the existing literature, we can know that credit risk analysis and management methods have been more mature in the developed countries. There are several credit risk measurement models, such as JP Morgan's credit metrics model, KMV model and Credit Portfolio View model, where credit scoring method is used widely (Zuccaro, 2010; Sabato, 2010). These methods build models based on the company's financial data, such as financial benefits, asset operations, solvency position, business development capabilities and performance capabilities. But the financial data in micro-enterprises is half-baked, there are limitations using those methods directly to measure micro-enterprise credit, especially there are some qualitative evaluation indicators. However, Mark (2004) noted credit scoring for microfinance can work. The difference is in the information, which is usually qualitative and informal. The new challenge of credit scoring is incorporating and adapting to this constraint. Van Gool *et al.* (2009) also found that credit scoring could be introduced as a refinement tool in the credit process, to combine both statistical and human best practices for microfinance. So some combining qualitative and quantitative methods were applied to microfinance credit rating, such as Fuzzy set and AHP combined with regression model (Fan *et al.*, 2010; Zhi and Yang, 2011).

However, AHP (Analytic Hierarchy Process) is often encountered the inconsistency of judgment matrix in practical applications. Although there have been many research on that problem, such as fuzzy method and vector angle cosine method, these methods do not solve the problem fundamentally. On the other hand, in China, the research on credit evaluation for micro-enterprises is only in its infancy and many studies mainly focused on the factors that may affect credit scores. Especially in the practice of micro-enterprise credit evaluation, most banks control risks by artificial approval based on the policies, information of businesses and the experiences of workers. Thus the decision results may be not consistent with each other.

Therefore, based on credit scoring method this paper tries to design a common indicator set and model for micro-enterprise credit evaluation, which may provide reference for Chinese commercial banks.

#### **CREDIT EVALUATION INDICATORS FOR CHINESE MICRO-ENTERPRISE**

According the existing research results, we analyze factors affecting micro-enterprise credit from both financial and non-financial sides, combining characteristics of micro-enterprise with internal and external conditions in China. The financial factors called "hard information" reflect the capital of micro-enterprise. Non-financial factors called "soft information" include external environmental factors and internal factors of enterprise and entrepreneur.

Financial factors are combined the financial information for individuals and families to reflect the true solvency. In China, as the family is basic unit of micro-enterprises and family expenses is often confused with enterprise expenses, other income of family members should be used as a source of repayment. Non-financial factors include external environmental factors and internal factors of enterprise and entrepreneur. Personal credit information is an important factor in evaluating micro-enterprise credit (Mark, 2004). Personal information analysis is emphasized on the basic quality and debt paying will of entrepreneur, while enterprise information is considered management space, business year and *et al.*, which may reflect the business situation. In addition, as the survival and risk of micro-enterprises vary largely and are highly vulnerable to the external environment, external environment need to be concerned in micro-enterprises credit evaluation. Detailed indicators are shown in Table 1.

**Table 1: Alternative credit evaluation indicators for micro-enterprise**

Impact factor	Evaluating contents	Evaluating indexes
Financial	The solvency	Average monthly net profit, asset-liability ratio, cash inflow and outflow ratio, average monthly income of family, average monthly revenues and amount of monthly repayment of other loans.
Non-financial	Basic quality	Age, marital status, health status, education level, household, employment status of family members, operation years
	Debt paying will	Credit status, business license, years of business license, social prestige, tax status, lifestyle, business venues
	External environment	Prospect of the industry, regional credit environment, geography

**Degree of membership analysis of alternative indicators:**

The membership is calculated as follows: for the indicator  $x_i$  in the alternative set, if there are  $m_i$  experts recognizing  $x_i$  to evaluate the micro-enterprise credit evaluation, the degree of membership for  $x_i$  can be calculated by  $R_i = m_i/m$ , where  $m$  is the total number of experts. The greater value of  $R_i$ , the more important of the indicator is for credit evaluation. Otherwise it should be deleted.

In order to calculate degrees of membership of indicators in Table 1, we have released a survey questionnaire to some credit and business management professionals who were asked to study indicators in Table 1 based on data availability, rationality and importance. We distributed 92 questionnaires and recovered 78 questionnaires, but there were only 67 valid questionnaires from postal savings banks, credit corroborative and micro-enterprises in a city of Henan Province. After statistical analysis of questionnaires, the memberships are obtained. There are two indicators removed from the set, which are occupational status of family members and regional credit environment as their degree of membership are less than 0.5. Thus 21 indexes are reserved in the set.

**Correlation analysis of indicators:** In order to remove duplicate information, 137 micro-enterprises' data from Postal Savings Bank in a city of Henan Province were used to analyze the correlation between indexes. SPSS 11.0 software was adopted in experiments. If the absolute correlation coefficient greater than 0.7, it indicates that two indexes are closely related. Results of experiments show that the correlation coefficient between two pairs of indexes are greater than 0.7. One is coefficient between business license and years of business license. The other is between average monthly net profit and average monthly revenue. Two indexes are deleted being their memberships relatively low. One is business license. The other is the average monthly revenue. Then a hierarchy index system for credit evaluation is established as shown in Table 2.

**WEIGHT INDICATORS BASED ON G1 METHOD**

There are five quantitative variables and 14 qualitative variables in the index system established in

**Table 2: Hierarchy indicators for micro-enterprise credit evaluation**

Target layer A	Criteria layer B	Program layer C
Indicators for micro-enterprise credit evaluation	Solvency B1	Average monthly net profit C1
		Amount of monthly repayment of other loans C2
		Asset-liability ratio C3
		Cash inflow and outflow ratio C4
Basic quality B2	Basic quality B2	Average monthly income of family C5
		Age C6
		Marital status C7
		Health status C8
		Education level C9
		Household C10
		Operation years C11
		Credit status C12
		Social prestige C13
		Tax status C14
Debt paying will B3	Debt paying will B3	Business license C15
		Business venues C16
		Lifestyle C17
		Prospect of the industry C18
External environment B4	External environment B4	Geography C19

Table 2. AHP is a common decision-making method for qualitative data. However, AHP is often encountered the inconsistency of judgment matrix in practical applications. G1 method can be used to process same decision problem as AHP, the two methods have same assumptions and applicability. While G1 method can solve the inconsistency problem of AHP fundamentally and has small amount of calculation. We use G1 method for micro-enterprise credit evaluation in this study.

**Main idea of G1 method:** The main idea of G1 method (Wang and Guo, 2004) is layered weight and its basic steps are as follows:

- Each expert determines the important order of indicators for each layer
- Each expert determines  $r_k$  indicating indicator  $x_{k-1}$  is importance than  $x_k$ . The value of  $r_k$  can be assigned as shown in Table 3
- Based on  $i_{th}$  expert's judgment  $r_{k-1}^i$ , calculate  $w_k^i$  as weight of  $i_{th}$  index using Eq. 1:

$$w_i^1 = \left( 1 + \sum_{k=2}^i \prod_{j=k}^i r_j^1 \right) \tag{1}$$

And then obtain weights of other indexes in the same layer by Eq. 2:

Table 3:  $r_k$  assigned reference

Value	Explanation
1.0	$x_{k-1}$ is as important as $x_k$
1.2	$x_{k-1}$ is slightly important than $x_k$
1.4	$x_{k-1}$ is obviously important than $x_k$
1.6	$x_{k-1}$ is strong important than $x_k$
1.8	$x_{k-1}$ is extremely important than $x_k$

$$w_k^i = r_k^i w_k^i, k = i, i-1, \dots, 2 \quad (2)$$

Calculate weight of the  $i_{th}$  indicator based on group decision. Supposing there are  $m$  experts and  $n$  indicators needed to be weighted and each expert weights  $w_i^1$  ( $i = 1, 2, \dots, n; 1 = 1, 2, \dots, m$ ) for each indicator. If the weight of  $i_{th}$  expert is:

$$d_i \left( 0 < d_i < 1, \sum_{i=1}^m (d_i) = 1 \right)$$

the weight of the  $i_{th}$  indicator based on group decision can be calculated by Eq. 3:

$$w_i = \sum_{i=1}^m d_i w_i^1 \quad (3)$$

Using the above steps to calculate the weight of all indicators in turn. And then relative to the goal layer, calculate the weight for each indicator in program layer by the weighted average.

**Weight micro-enterprise credit evaluation indicators:** According to the hierarchy of indicators, the order of indicators' importance and the value of  $r_k$  for each layer are given by 5 experts from Postal Savings Bank. Assume that experts' weights are the same and set to 0.2. For example, one expert gives the order of indicators' importance for layer  $B$  is  $B1 > B3 > B2 > B4$ , and  $r_2 = w_1/w_2 = 1.4$   $w_4 = 0.1387$  and  $d_i = 0.2$  in layer  $B$  can be obtained by Eq.3. The weight of other indicators can be obtained by similar process. Results are shown in Table 4.

### CREDIT EVALUATION MODEL AND EMPIRICAL ANALYSIS

**Credit scoring:** Based on the above evaluation indicators and weights, use Eq. 4 to compute the credit score of each micro-enterprise, where  $score_i$  is score for  $i_{th}$  enterprise,  $n = 19$  is the number of indicators and  $score_{ij}$  is the value of  $j$  indicator for  $i$  enterprise.

$$score_i = \sum_{j=1}^n w_j score_{ij} \quad (4)$$

Table 4: Evaluation variables and weights

	BC	B1 0.3420	B2 0.2662	B3 0.2803	B4 0.1115	Weight relative to goal layer
C1		0.2003				0.0685
C2		0.1988				0.0680
C3		0.2120				0.0746
C4		0.1876				0.0725
C5		0.2013				0.0689
C6			0.1009			0.0269
C7			0.1381			0.0368
C8			0.1580			0.0420
C9			0.1554			0.0413
C10			0.1543			0.0410
C11			0.1677			0.0444
C12				0.1993		0.0559
C13				0.1783		0.0500
C14				0.1701		0.0477
C15				0.1689		0.0473
C16				0.0999		0.0280
C17				0.1985		0.0556
C18					0.5838	0.0656
C19					0.4162	0.0464

The data for empirical analysis come Postal Savings Bank in a city of Henan Province, which contain 137 micro-enterprises' loans application forms and survey data collected by the loan officer since January 2010. Enterprises are divided into two groups based on their monthly repayments. One group is poor credit customers whose repayments are overdue more than three months. The rest is good credit customers. In our empirical analysis data, there are 16 poor credit samples identified by 1 and 121 good credit samples identified by 0. The empirical data are preprocessed in order to eliminate the dimensional impacting on the evaluation results. All variables (indicators) are standardized into the range of [0,1].

**Accuracy testing for credit evaluation model:** According to the standard of Chinese credit rating, credit rating is divided into nine grades, followed by AAA, AA, A, BBB, BB, B, CCC, CC, C. We determine sample proportion and credit score range of each credit rating, as shown in Table 5. In our research, grade B and the following grade are defined as poor credit. Others are defined as good credit. Credit scores of 137 micro-enterprises are calculated. According to criteria in Table 5, the accuracy of model for poor credit enterprises is 100%, while for good credit is 90.9%. That is to say, the model incorrectly judges good credit enterprises as poor credit enterprises. However, losses of loaning to a poor credit enterprise are far greater than refusing to lend to a good credit enterprise, the error of model can be accepted in practice. We select data from another 20 companies, in which there are 3 poor credit companies. Using the above model to evaluate credit, the accuracy of poor credit companies

Table 5: Sample proportion and credit score range

Grade	Score range	Sample proportion (%)
AAA	61-100	8
AA	55-61	16
A	45-55	30
BBB	40-45	16
BB	35-40	10
B	30-35	8
CCC	25-30	6
CC	20-25	4
C	0-20	2

identified is also 100%. Therefore, empirical results show that the above index system and model is feasible to evaluate micro-enterprise credit, and the data is easy to obtain. So the model can provide a reference for micro-enterprise credit management of commercial banks in China.

### CONCLUSIONS

With potential market value of financial services for micro-enterprises perceived by banks gradually, the research on micro-enterprise credit evaluation methods is causing more and more attention. According to the characteristics of micro-enterprises and their loans, this paper built a micro-enterprise credit evaluation model providing a reference for micro-enterprise credit management in China. And then we use actual samples to verify the performance of the model, but as the number of samples limited, results of this paper need to get further refinement in the practice of credit management.

### ACKNOWLEDGEMENT

This study was supported by National Social Science Foundation of China (Grant No. 13BTQ027), Beijing Philosophy and Social Science Planning Foundation (Grant No. 12JGB034).

### REFERENCES

Angelini, E., 2007. Italian Banks' Credit Approach Towards Low-Income Consumers and Microenterprises: Is There a Bias Against Some Segments of Customers? In: *New Frontiers in Banking Services*, Anderloni, L., M.D. Braga and E.M. Carluccio (Eds.). Springer, Berlin, Germany, pp: 299-321.

Baptista, J.A., J.J. Ramalho and J.V. Da Silva, 2006. Understanding the microenterprise sector to design a tailor-made microfinance policy for Cape Verde. *Portuguese Econ. J.*, 5: 225-241.

Chen, L.W., 2008. Study and development of decision-tree algorithm on farmer credit evaluation. *Comput. Eng. Appl.*, 44: 242-244.

Copstake, J., 2007. Mainstreaming microfinance: Social performance management or mission drift? *World Dev.*, 35: 1721-1738.

Fan, M. and Y.C. Wang *et al.*, 2010. SME credit rating model based on AHP method. *Commun. Finance Account.*, 2: 53-55.

Fouillet, C., M. Hudon, B. Harriss-White and J. Copstake, 2013. *Microfinance studies: Introduction and overview*. Oxford Dev. Stud., 41: S1-S16.

Mark, S., 2004. Benefits and pitfalls of statistical credit scoring for microfinance. *Savings Dev.*, 28: 63-86.

Sabato, G., 2010. Assessing the quality of retail customers: Credit risk scoring models. *IUP J. Financial Risk Manage.*, 7: 35-45.

Schreiner, M., 2000. Credit scoring for microfinance: Can it work? *J. Microfinance Rev.*, 2: 105-118.

Sun, Q. and Z.J. Wang, 2006. An application of model LOGIT into the risk identification of small amount of agricultural credit. *J. Nanjing Audit Univ.*, 3: 27-29.

Van Gool, J., B. Baesens, P. Sercu and W. Verbeke, 2009. An analysis of the applicability of credit scoring for microfinance. Katholieke Universiteit Leuven Leuven, Belgium. University of Southampton, Southampton, United Kingdom. <http://www.aabri.com/OC09manuscripts/OC09042.pdf>

Wang, X.J. and Y.J. Guo, 2004. Aggregate analysis of group decision making based on G1 method. *Chin. J. Manage. Sci.*, 12: 14-16.

Zhi, H. and Z. Yang, 2011. Research on credit rating of SMEs based on combination evaluation. *Proceedings of the International Conference on Business Management and Electronic Information*, Volume 1, May 13-15, 2011, Guangzhou, China, pp: 661-664.

Zuccaro, C., 2010. Classification and prediction in customer scoring. *J. Modelling Manage.*, 5: 38-53.