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The Research on Credit Risk Assessment Model of Agriculture-Related Organizations Based on Set of Theoretical

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Abstract
The credit of agriculture-related organizations has a stronger dynamic uncertainty than the general main credit. Although the traditional assessment model can evaluate the main credit from different aspect, it stresses the independence of the object and forced the uncertainty into the certainty to deal with. These methods do not suit for the agriculture-related organizations which have loosely organized and extensive internal links. This paper presents the set of the set of theoretical to integrate the existing assessment model. Also the paper established the credit risk assessment model suit for agriculture-related organization. The research should have some theoretical value and practical significance for the assessment of credit risk of agriculture-related organizations.

Key words: Set of theoretical; Agriculture-related organization; Credit risk; Assessment model

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INTRODUCTION
The agriculture-related organization is the organization which is affected by the characteristics of agriculture production and is closely related to the benefit of farmers and agricultural industry development[1]. By now, there are three forms of agriculture-related organization in developed countries including business farms, part-time farmers and cooperative economic organizations[2]. However, there are mainly four forms of agriculture-related organization in china[3]. That's including "company + farmaers", specialized cooperative economic organization, community cooperative economic organization[1] and stock cooperative organization in rural areas. In order to facilitate the discussion, the agriculture-related organization we discussed in this paper only refers the independent legal. The credit rating of agriculture-related organization is a subsystem of corporate credit rating, but not exactly the same with it. Compared to the general main credit, the agriculture-related organization has the following four characteristics: (i) more widely informal association in it; (ii) the structure is relatively loose; (iii) internal members have equal status; (iv) the internal members have more opportunistic tendencies. These four characteristics illustrate that the credit of agriculture-related organization has more dynamic than other main credit.

The traditional assessment models of credit risk can be mainly divided into three categories. The first category of the assessment models are the models based on structure model[4] and simplified model[5]. These models have rigorous theoretical foundation but they do not make

[1] The discussion of agriculture-related organization in this paper does not include the form of community cooperative organization. That's because this organization does not have the ability to bear to civil liability.

full use of historical information. The second category is the intelligent models represented by neural network model. These models have strong adaptability but require lots of training simples. The last category is widely used statistical measurement models such as logistic model[8], SVM[9] and a large number of decision making models and experts systems.

All the models above do not perfectly suitable for credit risk assessment for agriculture-related organization. That is because the small-scale production, lower level of information transparency and small of loan amount[10] of agriculture-related organization especially individual householders, private owners, etc. in one hand. In the other hand, the financial market in china is imperfect. It lack of complete information data for agriculture-related organization[11]. From another respective, each traditional assessment model has its own advantage. So the paper's point is to integrate the traditional assessment model of credit risk.

In this view, this paper integrates the traditional assessment of credit risk with set pair theory. In this paper, series of uncertain numbers are estimated by the combination of the specific traditional assessment model and macro-environment. In practice, the model with set pair theory can be amended according to the actual situation based on the principal of dynamic uncertainty.

The first parts of this paper is the introduction of the model of credit risk assessment for agriculture-related organization based on set pair theory; the second parts of this paper integrates the traditional models with set pair theory; in the third parts of this paper, the model with set pair theory is analyzed; the fourth parts of this paper presents a simple example and the last parts is the conclusion and discussion of this paper.

1. THE FRAMEWORK OF THE CREDIT RISK ASSESSMENT MODEL WITH SET PAIR THEORY

The set pair theory researches a pair of sets which is based on the specific issues that needs to be studied. This theory describes the connection degree of the two given sets with the form as $\mu = a + bi + cj$. Because a thing can be always divided into two aspects[12-13]. Generally, the connection degree of a pair of sets can be interpreted as $\mu = a + bi - c$, $i \in [-1,1]$, $a, b, c > 0$, $a + b + c = 1$. a and c both describes the deterministic parts of the relationship of the pair of sets. Further, a respects the same of the two sets in the pair and c respects the opposition of the two sets in the pair. The b describes the uncertain parts of the relationship of the pair of sets. Illustrated by the loan of uncertainty i. From the definition of i, it is easy to see that the i describe the trend of uncertainty. If the $i \in [-1,0]$, the uncertainty will increase the total risk. And if the $i \in [0,1]$, the uncertainty will decrease the total risk.

Specifically, a pair of sets composed of two sets A and B. This pair of sets is described as $H = (A, B)$ in a given background W. Suppose there are N characteristics in sets. S characteristics are the same in both A and B. P characteristics are different in A and B. And the other $F = N - S - P$ characteristics are neither same nor different in A and B. Further, define the S/N as the same degree in W; define the F/N as the different degree in W; define the P/N as the opposite degree in W. Then the connection degree can be represented as

$$\mu(W) = \frac{S}{N} + \frac{F}{N} i - \frac{P}{N} \tag{1}$$

Suppose

$S/N = a$, $F/N = b$, $P/N = c$, then $\mu(W) = a + bi - c$.

As the discussion above, the key point to establish the credit risk assessment with set pair theory is the determination of same degree, different degree and opposite degree. The principal to determine the three degrees below can be obeyed: (1) confirm the different definition of the three degrees in different traditional models; (2) full use the known results in the traditional models; (3) reflect the characteristics of the traditional models; (4) focus on the background of specific issue.

1.1 CART MODEL WITH THE FRAMEWORK OF PAIR SET THEORY

The model of classification and regression trees (CART) classified the grade of index to evaluate the credit risk of the main credit. The Figure 1 gives a example of CART model. In this model, B_1, B_2 and B_3 are the nodes of bankruptcy. NB_4 and NB_5 are the nodes of safe.

According to the Figure 1, the credit risk can be classified into five types. The connection degree of the pair of sets H = (bank, agriculture-related organization) is $\mu_A = a + bi - c$.

$\mu_A > 0$ is credible consistency. It illustrates the lower credit risk; $\mu_A < 0$ is credible reverse. It illustrates the higher credit risk.

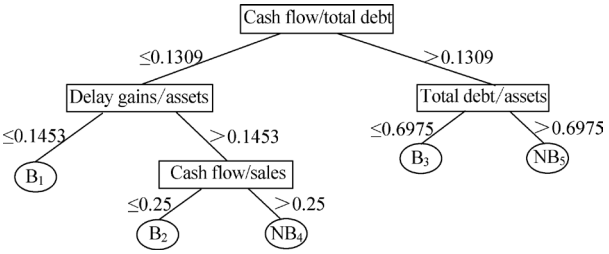

Figure 1
The Assessment Model of CART

According to the Figure 1, the connection degree can be represented as

(1) Risk-Free Loan

$$\mu_A = \frac{6}{10} + \frac{4}{10} i \tag{2}$$

(2) Low Credit Risk Loan

$$\mu_A = \frac{5}{10} + \frac{4}{10}i - \frac{1}{10} \tag{3}$$

(3) Special Attention Loan

$$\mu_A = \frac{4}{10} + \frac{4}{10}i - \frac{2}{10} \tag{4}$$

(4) High Credit Risk Loan

$$\mu_A = \frac{1}{10} + \frac{4}{10}i - \frac{5}{10} \tag{5}$$

(5) Inevitable Loss Loan

$$\mu_A = \frac{4}{10}i - \frac{6}{10} \tag{6}$$

1.2 Zate Model with the Framework of Pair Set Theory

Zate model is another credit risk assessment model established by Altaman. It represented as

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + X_5 \tag{7}$$

X_1 is working capitals divided by total assets; X_2 is delay gains divided by total assets; X_3 is EBIT divided by total assets; X_4 is stock market value divided by book value of total debt; X_5 is sales divided by total assets.

The credit risk of loan is low when $Z > 2.657$, and the credit risk of loan is high when $Z < 2.657$. When $Z < 0$, the losses is inevitable. The range of Z is [0, 5.3]. Then the connection degree of the pair of sets H = (bank, agriculture-related organization) can be represented as

$$\mu_B = \begin{cases} -1, Z \in (-\infty, 0) \\ \dfrac{Z}{5.3}i - \dfrac{5.3 - Z}{5.3} \\ \dfrac{Z}{5.3} + \dfrac{5.3 - Z}{5.3}i \end{cases} \tag{8}$$

$\mu_B > 0$ is credible consistency. It illustrates the lower credit risk; $\mu_B < 0$ is credible reverse. It illustrates the higher credit risk.

1.3 Chesser Model with the Framework of Pair Set Theory

Chesser established a model in 1974 which can be represented as

$$Y = 2.0403 - 5.241X_1 + 0.0053X_2 - 6.6507X_3 + 4.04X_4 - 0.79X_5 - 0.01X_6 \tag{9}$$

X_1 is cash flow divided by total assets; X_2 is sales divided by total assets; X_3 is EBIT divided by total assets; X_4 is total debt divided by total assets; X_5 is fixed assets divided by total assets; X_6 is current assets divided by sales.

The probability of default is

$$P = \frac{1}{1 + \alpha^{1-\tau}} \tag{10}$$

In which $a = 2.71828$.

When $P > 50\%$, the main credit is likely to default; when $P \leq 50\%$, the main credit is likely to performance. The connection degree of the pair of sets H = (bank, agriculture-related organization) can be represented as

$$\mu_C = \begin{cases} \dfrac{1}{2} + (\dfrac{1}{2} - P)i - P, P \leq 50\% \\ (1 - P) + (P - \dfrac{1}{2})i - \dfrac{1}{2}, P > 50\% \end{cases} \tag{11}$$

$\mu_C > 0$ is credible consistency. It illustrates the lower credit risk; $\mu_C < 0$ is credible reverse. It illustrates the higher credit risk.

1.4 Credit Rating Model with the Framework of Pair Set Theory

The credit rating often divided the credit risk into 5 grades. *AA*、*AB*、*BA*、*BB* and *C*.

The connection degree from the highest grades *A* to the lowest grades *C* of the pair of sets H = (bank, agriculture-related organization) can be represented as

$$\mu_D = \begin{cases} \dfrac{7}{10} + \dfrac{2}{10}i - \dfrac{1}{10} \\ \dfrac{6}{10} + \dfrac{3}{10}i - \dfrac{1}{10} \\ \dfrac{5}{10} + \dfrac{3}{10}i - \dfrac{2}{10} \\ \dfrac{4}{10} + \dfrac{3}{10}i - \dfrac{3}{10} \\ \dfrac{6}{10}i - \dfrac{4}{10`} \end{cases} \tag{12}$$

$\mu_D > 0$ is credible consistency. It illustrates the lower credit risk; $\mu_D > 0$ is credible reverse. It illustrates the higher credit risk.

2. THE MODEL WITH SET PAIR THEORY OF AGRICULTURE-RELATED ORGANIZATION

Suppose there are m experts evaluate the program H including n traditional assessment models. For model h_k, there are A_k experts approve it. And there are C_k experts oppose it. $B_k = m - A_k - C_k$ experts abstain from voting.

Then note

$$\mu(m) = WRI$$

$$(W_1, \cdots, W_n) \begin{bmatrix} A_1, B_1, C_1 \\ \cdots\cdots\cdots \\ A_n, B_n, C_n \end{bmatrix} \begin{bmatrix} 1 \\ i \\ -1 \end{bmatrix} \tag{13}$$

Where $\begin{bmatrix} A_1, B_1, C_1 \\ \cdots\cdots\cdots \\ A_n, B_n, C_n \end{bmatrix} \begin{bmatrix} 1 \\ i \\ -1 \end{bmatrix}$ is called the decision-making matrix, there W is the matrix of weight, I is unit vector. Consider the equal weight, the $\mu(m)$ can be represented as

$$\mu(m) = WRI$$
$$(\frac{1}{n},\cdots,\frac{1}{n})\begin{bmatrix} A_1, B_1, C_1 \\ \cdots\cdots\cdots \\ A_n, B_n, C_n \end{bmatrix}\begin{bmatrix} 1 \\ i \\ -1 \end{bmatrix} \quad (14)$$

According to the actual background, calculates the variable as below

$$a = f(A_1,..., A_n) \quad (15)$$
$$b = g(B_1,..., B_n) \quad (16)$$
$$c = h(C_1,..., C_n) \quad (17)$$

The connection degree of bank and the agriculture-related organization is

$$\mu(m) = a + bi - c \quad (18)$$

To analyze the relationship of a, b, c can conclude the credit appraisal of the agriculture-related organization.

3. EXAMPLE

Suppose there are four models $h_1,\ldots, h_4$. Then suppose the financial institutions evaluate the credit risk of agriculture-related organization with the same weight. Then the decision-making matrix can be represented as

$$\begin{bmatrix} A_1, B_1, C_1 \\ ..... \\ A_4, B_4, C_4 \end{bmatrix}\begin{bmatrix} 1 \\ i \\ -1 \end{bmatrix} \quad (19)$$

Further, suppose the four models are the models discussed in the section two of this paper. The evaluation results of the agriculture-related organization with the four models are

First, the CART model

$$\mu_A = 0.4 + 0.4i - 0.2 \quad (20)$$

Second, the Zate model calculates $Z = 2.747$, then the connection degree is

$$\mu_B = \frac{Z}{5.3} + \frac{5.3 - Z}{5.3}i = 0.52 + 0.48i \quad (21)$$

Third, the Cheeser model calculates $P = 40\% < 50\%$, then the connection degree is

$$\mu_C = \frac{1}{2} + (\frac{1}{2} - P)i - \frac{4}{10} = 0.5 + 0.1i - 0.4 \quad (22)$$

Fourth, the model classified the agriculture-related organization in grades *BA,* then the connection degree is

$$\mu_D = 0.5 + 0.3i - 0.2 \quad (23)$$

Then the decision-making matrix is

$$\mu(m) = \begin{bmatrix} 0.40,0.40,0.20 \\ 0.52,0.48,0.00 \\ 0.50,0.10,0.40 \\ 0.50,0.30,0.20 \end{bmatrix} \quad (24)$$

Considering the risk and the profit

(1) Consider the average connection degree $\bar{\mu}(H) = \bar{a} + \bar{b}i - \bar{c}$.

$$\bar{a} = \frac{1}{n}\sum_{k=1}^{n} A_k = (0.4 + 0.52 + 0.5 + 0.5)/4 = 0.48 \quad (25)$$

$$\bar{b} = \frac{1}{n}\sum_{k=1}^{n} B_k = (0.4 + 0.48 + 0.1 + 0.3)/4 = 0.295 \quad (26)$$

$$\bar{c} = \frac{1}{n}\sum_{k=1}^{n} C_k = (0.2 + 0.4 + 0.2)/4 = 0.2 \quad (27)$$

In the worst situation, if $\bar{c} + \bar{b}i > \bar{a}$ is satisfied, i.e. $0.2 + 0.295i > 0.48$. Then $i > 0.95$. But the range of i is $[-1,1]$. So the condition $\bar{c} + \bar{b}i > \bar{a}$ is hard to satisfy. The credit risk of this agriculture-related organization is low.

(2) In the respective of risk

Suppose

$$a_{\min} = \min(a_1,...,a_4) = 0.4 \quad (28)$$
$$c_{\max} = \max(c_1,...,c_4) = 0.4 \quad (29)$$
$$b = 1 - a_{\min} - a_{\max} = 0.2 \quad (30)$$

So

$$\mu(H) = 0.2i \quad (31)$$

From the formula (31), the credit risk of the agriculture-related organization is highly dependent on i. So the evaluation of credit risk of this agriculture-related organization should must attention to the external macro-environment.

Composites the conclusion above, the credit risk of this agriculture-related organization is low.

CONCLUSION

This paper has pointed out the insufficient of the traditional based on the characteristics of the agriculture-related organization. As a attempt, this paper introduce the set pair theory to integrate the traditional credit risk assessment models as a new credit risk assessment with set pair theory for agriculture-related organization with the principal of dynamic uncertainty. Generally, the credit risk assessment with set pair theory has follow advantages: (i) Consider the credit risk of agriculture-related organization in different aspects in order to conclude more accurate conclusion; (ii) Small amount of calculation and have greater flexibility; (iii) Evaluate the credit risk of agriculture-related organization with dynamic respective in order to catch the actual characteristics.

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