Research on the Grading Model of Financial Risk Alarm Condition Based on Extension Discrimination

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Abstract—According to the basic principle and method of extension discrimination, this paper constructs an extension discrimination grading model of enterprise's financial risk alarm condition based on the financial risk monitoring indicators. Then it measures and grades the financial risk alarm condition of some listed companies using financial indicators. The model and method will supply a management tool of financial risk for the investors' decision, securities market management department's supervision and internal managers' management.

Keywords—extension evaluation; financial risk; matter-element model; grading model

I. INTRODUCTION

Because science and technology changes quickly and competition in market becomes intensive increasingly, so market environment also changes quickly. So enterprise faces some uncertainty event in market and financing risk accompanies nearly each enterprise. Enterprises' management idea, technology and system are all facing severe challenge. So called financial risk is the risk induced by debt crisis. The crisis displays as the badness of financial status which influenced by uncertainty factors. It is especially important to judge financial risk condition accurately and determine the grade of financial risk alarm condition in the research of evaluation method of financial risk[1].

II. MATTER-ELEMENT MODEL CONSTRUCTION OF FINANCIAL RISK ALARM CONDITION

Anything can be described with three factors which include "things, characteristic, value", so as to analyze and calculate the things qualitatively and quantitatively. The ordered triad composed of the three factors is named matter-element which is the fundamental element to describe things. If "R" represents matter-element, "M" represents things, "C" represents M's characteristic, so $V(x)$ represents the measure value corresponding to "C". $V(x)$ is membership corresponding to C's measure value, so set $R = (\text{things, characteristic, value}) = (M, c, v)$ [2].

If the quantity of financial risk alarm condition grading indicators is m, set the indicators are $c_1, c_2, \dots, c_m$. Based on

the indicators, set the financial risk alarm condition has n level grades, which is described as a comprehensive matter-element model as below. The model represents the "classical field" in extension discrimination.

$$R_j = \begin{bmatrix} N_j & c_1 & V_{j1} \\ & c_2 & V_{j2} \\ & \dots & \dots \\ & c_m & V_{jm} \end{bmatrix} = \begin{bmatrix} N_j & c_1 & \langle a_{j1}, b_{j1} \rangle \\ & c_2 & \langle a_{j2}, b_{j2} \rangle \\ & \dots & \dots \\ & c_m & \langle a_{jm}, b_{jm} \rangle \end{bmatrix} \quad j = 1, 2, \dots, n \quad (1)$$

In formula (1), R_j represents the matter-element model of the j_{th} financial risk alarm condition grade, N_j represents the j_{th} grade of financial risk alarm condition, $V_{jk} = \langle a_{jk}, b_{jk} \rangle$ represents the value range of the k_{th} indicator in the j_{th} grade. Matter-element model formed with the measure indicator's allowable value range is named sectional field. The formula of sectional field is shown as follow.

$$R_p = \begin{bmatrix} N_p & c_1 & V_{p1} \\ & c_2 & V_{p2} \\ & \dots & \dots \\ & c_m & V_{pm} \end{bmatrix} = \begin{bmatrix} N_p & c_1 & \langle a_{p1}, b_{p1} \rangle \\ & c_2 & \langle a_{p2}, b_{p2} \rangle \\ & \dots & \dots \\ & c_m & \langle a_{pm}, b_{pm} \rangle \end{bmatrix} \quad (2)$$

In formula (2), R_p represents sectional field of matter-element model of financial risk alarm condition, N_p represents all the grades of financial risk alarm condition. $V_{pk} = \langle a_{pk}, b_{pk} \rangle$ represents allowable value range of the indicator c_k in N_p , in the formula, $V_{jk} \subset V_{pk}$, $j=1,2,\dots,n$, $k=1,2,\dots,m$. Enterprise's financial risk alarm condition is represented by the matter-element model as follow.

$$R = \begin{bmatrix} N & c_1 & V_1 \\ & c_2 & V_2 \\ & \dots & \dots \\ & c_m & V_m \end{bmatrix} \quad (3)$$

In formula (3), R represents matter-element model of enterprise's financial risk alarm condition, N represents enterprise's financial risk alarm condition, V_k represents the value of the k_{th} indicator.

III. EXTENSION DISCRIMINATION MODEL CONSTRUCTION OF ALARM CONDITION GRADING

After construction of matter-element model of enterprise's financial risk alarm condition, then we should grade each single indicator's financial risk alarm condition and the comprehensive financial risk alarm condition. So we should calculate the membership value between financial risk alarm condition matter-element model and its classical field. In actual evaluation, there are different calculating methods of membership value with concrete indicators[3]. The common method is elementary correlative model in extension discrimination as follow.

$$\rho(V_k, V_{jk}) = \left| V_k - \frac{a_{jk} + b_{jk}}{2} \right| - \frac{b_{jk} - a_{jk}}{2}, j = 1, 2, \dots, n; k = 1, 2, \dots, m \quad (4)$$

$$\rho(V_k, V_{pk}) = \left| V_k - \frac{a_{pk} + b_{pk}}{2} \right| - \frac{b_{pk} - a_{pk}}{2}, j = 1, 2, \dots, n; k = 1, 2, \dots, m \quad (5)$$

Formula (4) and (5) represent V_k 's memberships value of the intervals which include V_{jk} and V_{pk} . When $\rho(V_k, V_{jk}) \geq 0$ or $\rho(V_k, V_{pk}) \geq 0$, it represents V_k is not in V_{jk} or V_{pk} ; when $\rho(V_k, V_{jk}) \leq 0$ or $\rho(V_k, V_{pk}) \leq 0$, it represents V_k is in V_{jk} or V_{pk} . In addition, different negative value represents that V_k 's location is different in V_{jk} or V_{pk} .

$$D(V_k, V_{jk}, V_{pk}) = \begin{cases} \rho(V_k, V_{pk}) - \rho(V_k, V_{jk}), V_k \notin V_{jk} \\ -1, V_k \in V_{jk} \end{cases} \quad (6)$$

Formula (6) represents V_k 's location value of V_{jk} and V_{pk} .

$$K_j(V_k) = \frac{\rho(V_k, V_{jk})}{D(V_k, V_{jk}, V_{pk})}, j=1, 2, \dots, n, k=1, 2, \dots, m \quad (7)$$

Formula (7) represents the k_{th} measurement indicator c_k 's of the j_{th} enterprise financial risk alarm condition level. When $K_j(V_k) \geq 0$, it represents that V_k belongs to V_{jk} . V_{jk} represents that V_k has how many attributions of V_{jk} . When $K_j(V_k) \leq 0$, it represents that V_k does not belong to V_{jk} . $K_j(V_k)$ represents the distance between V_k and V_{jk} .

So we can calculate each financial risk measuring single indicator's correlative degree matrix with each alarm grade.

The matrix is described as $K = [K_j(V_k)_{m \times n}]$, so:

$$\max_{1 \leq j \leq n} K_j(V_k) = K_i(V_k) = K^*(V_k), k = 1, 2, \dots, m \quad (5)$$

$K_i(V_k)$ represents the k_{th} indicator's financial risk alarm condition placing in the i_{th} grade. $K_i(V_k)$ decides the grades of each single indicator's financial risk alarm condition. Enterprise's financial risk comprehensive alarm condition's correlative degree of the j_{th} grade is as follow[4].

$$K_j(R) = \sum_{i=1}^n \lambda_i K_j(V_i), j = 1, 2, \dots, n \quad (6)$$

Through the formula $K_j(V_k) = \max_{1 \leq j \leq n} K_j(R)$, enterprise's financial risk comprehensive alarm condition placing in the j_{th} grade.

In addition, "i" represents the grade of each single indicator's financial risk alarm condition. The single indicator with the maximal "i" is the critical control point. Furthermore, maybe there is not only one critical control point.

IV. APPLICATION EXAMPLE OF FINANCIAL RISK ALARM CONDITION GRADING MODEL

Based on the above theoretical model and method, according to 《Industry Classification Guide of Listed Company in China》, the paper chooses 17 listed companies in social service industry and grades their financial risk alarm condition to explain the application of the discrimination model.

There are 7 selected measuring indicators including $c_1 - c_7$ in the application example. The indicators are described as c_1 = net asset earning rate, c_2 = operating income growth rate, c_3 = current ratio, c_4 = assets-liability ratio, c_5 = interests cash ratio, c_6 = net capital increasing ratio, c_7 = net operating cash growth rate. There are 4 grades of financial risk alarm condition including N_1 = No Alarm, N_2 = Light Alarm, N_3 = Moderate Alarm, N_4 = High Alarm[5].

Based on the statistical data of financial indicators, the classical field element model, sectional field element model and matter-element model of financial risk alarm condition are as follow.

Classical field element model:

$$R_1 = \begin{bmatrix} N_1 & c_1 & < 0.01, 35 > \\ & c_2 & < 0, 20 > \\ & c_3 & < 0, 3 > \\ & c_4 & < 0, 0.6 > \\ & c_5 & < 0.15, 1 > \\ & c_6 & < 0, 2 > \\ & c_7 & < 0, 20 > \end{bmatrix} \quad R_2 = \begin{bmatrix} N_2 & c_1 & < -0.01, 0.01 > \\ & c_2 & < -0.1, 0 > \\ & c_3 & < 3, 5 > \\ & c_4 & < 0.6, 0.7 > \\ & c_5 & < 0, 0.15 > \\ & c_6 & < -0.3, 0 > \\ & c_7 & < -0.2, 0 > \end{bmatrix}$$

$$R_3 = \begin{bmatrix} N_3 & c_1 & < -0.05, -0.01 > \\ & c_2 & < -0.5, -0.1 > \\ & c_3 & < 5, 8 > \\ & c_4 & < 0.7, 0.8 > \\ & c_5 & < -0.5, 0 > \\ & c_6 & < -1, -0.3 > \\ & c_7 & < -1, -0.2 > \end{bmatrix} \quad R_4 = \begin{bmatrix} N_4 & c_1 & < -0.2, -0.05 > \\ & c_2 & < -1, -0.5 > \\ & c_3 & < 8, 10 > \\ & c_4 & < 0.8, 2 > \\ & c_5 & < -1, -0.5 > \\ & c_6 & < -3, -1 > \\ & c_7 & < -12, -1 > \end{bmatrix}$$

Sectional field element model:

$$R_p = \begin{bmatrix} N_p & c_1 & < -0.2, 35 > \\ & c_2 & < -1, 20 > \\ & c_3 & < 0, 10 > \\ & c_4 & < 0, 2 > \\ & c_5 & < -1, 1 > \\ & c_6 & < -3, 2 > \\ & c_7 & < -12, 20 > \end{bmatrix}$$

Limited by the paper length, we choose the listed company “HXKJ” as an example. Its matter-element model of financial risk alarm condition is as follow.

$$R = \begin{bmatrix} N & c_1 & -0.114 \\ & c_2 & 0.246 \\ & c_3 & 1.367 \\ & c_4 & 0.559 \\ & c_5 & 0.275 \\ & c_6 & -0.107 \\ & c_7 & -4.384 \end{bmatrix}$$

Through the formula (3) and (7), correlative matrix is calculated as follow.

$$K = [K_j(V_k)]_{7 \times 4} = \begin{bmatrix} \text{No Alarm} & \text{Light Alarm} & \text{Moderate Alarm} & \text{High Alarm} \\ -0.591 & -0.548 & -0.427 & 2.927 \\ 0.246 & -0.165 & -0.217 & -0.374 \\ 1.367 & -0.544 & -0.727 & -0.829 \\ 0.078 & -0.068 & -0.201 & -0.301 \\ 0.208 & -0.147 & -0.275 & -0.517 \\ -0.048 & -0.054 & -0.084 & -0.298 \\ -0.365 & -0.355 & -0.308 & -0.800 \end{bmatrix}$$

Through correlative matrix and formula (5), $K^*(V_1) = K_4(V_1)$, $K^*(V_2) = K_1(V_2)$, $K^*(V_3) = K_1(V_3)$, $K^*(V_4) = K_1(V_4)$, $K^*(V_5) = K_1(V_5)$, $K^*(V_6) = K_1(V_6)$, $K^*(V_7) = K_3(V_7)$. The listed company’s net asset earning

rate $i=4$, so its alarm condition grade is “High Alarm”; its operating income growth rate, current ratio, assets-liability ratio, interests cash ratio and net capital increasing ratio $i=1$, so their alarm condition grade is “No Alarm”; its net operating cash growth rate $i=3$, so its alarm condition grade is “Moderate Alarm”. Each indicator’s weight is calculated through AHP method, so $W(\lambda_1, \lambda_2, \dots, \lambda_7) = (0.18, 0.08, \dots, 0.29)$ Through

formula (6), $K_1(R) = -0.070$, $K_2(R) = -0.282$, $K_3(R) = -0.311$, $K_4(R) = 0.527$, so $K_i(R) = \max_{1 \leq j \leq n} K_j(R) = K_4(R) = 0.527$.

So the listed company’s financial risk alarm condition grade is “Highest Alarm”. Among the seven indicators, the alarm condition of net asset earning rate is the highest one, so it is “High Alarm”. Net asset earning rate is the critical control point of financial risk.

If other listed companies’ data are calculated through the model, we can get the single indicator’s alarm condition grade and comprehensive alarm condition grade. We also can find its critical control point of financial risk. The result is shown in Table I.

TABLE I. RESULTS OF FINANCIAL RISK ALARM CONDITION GRADING

Listed company	Single indicator’s alarm condition grade				Comprehensive alarm condition grade	Critical control point
	c_1	c_2	$\dots$	c_7		
HXKJ	High Alarm	No Alarm	...	Moderate Alarm	High Alarm	c_1
GLLY	No Alarm	No Alarm	...	Moderate Alarm	No Alarm	c_7
...	...	...	...	...	...	...
S*ST ZG	Moderate Alarm	Light Alarm	...	Moderate Alarm	High Alarm	c_4, c_5
GLLH	No Alarm	No Alarm	...	High Alarm	No Alarm	c_7
STDHA	No Alarm	No Alarm	...	No Alarm	No Alarm	c_6
JBFZ	No Alarm	No Alarm	...	High Alarm	High Alarm	c_5, c_7
DLSY	Light Alarm	No Alarm	...	Light Alarm	No Alarm	c_1
BSGF	No Alarm	No Alarm	...	Light Alarm	No Alarm	c_7

In Table I, form the results of listed companies’ single indicator’s alarm condition and comprehensive alarm condition grade, the comprehensive alarm condition grade of HXKJ, S*STZG and JBFZ is “High Alarm”. The other 14 listed companies are all “No Alarm”. Among the 14 listed companies, single indicator’s alarm condition of LJLY, ZQL and QSKG are all “No Alarm”. Other 11 listed companies’ certain single indicator exists alarm condition. STZG’s comprehensive alarm condition grade is “High Alarm” except that current ratio is “No Alarm”. The other 6

indicators all exists certain alarm. Especially assets-liability ratio and interests cash ratio is "High Alarm". The critical control point of its financial risk is assets-liability ratio and interests cash ratio; STDHA's comprehensive alarm condition grade is "No Alarm". But its interests cash ratio is "Light Alarm" and net capital increasing ratio is "High Alarm". Its critical control point of financial risk is net capital increasing ratio.

V. CONCLUSIONS

The grading results from the grading model of financial risk alarm condition based on extension discrimination can explain the grading model's accuracy. In addition, the result is by classic field and sectional field. It is also influenced by the chosen indicators and their weights. It is a further researching issue how to decide the classic field and sectional field of financial risk alarm condition grade scientifically and how to choose the financial risk indicators reasonably and calculate the weights scientifically.

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